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ASSESSMENT OF THE DATA ON DISTRIBUTION, HABITATS AND POPULATION SIZE OF *LIPARIS LOESELII* (ORCHIDACEAE) IN LITHUANIA

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Abstract

Žalneravičius E., Gudžinskas Z., 2016: Assessment of the data on distribution, habitats and population size of *Liparis loeselii* (Orchidaceae) in Lithuania [Duomenų apie *Liparis loeselii* (Orchidaceae) paplitimą, buveines ir populiacijų dydį Lietuvoje įvertinimas]. – Bot. Lith., 22(1): 3–15.

Liparis loeselii is a declining orchid species in almost all European countries, mostly because of habitat loss. Therefore, good knowledge about the species ecology, distribution and populations is required in order to substantiate measures for its conservation. The aim of this research was to evaluate all available information about distribution, habitat types and population sizes of *L. loeselii* in Lithuania, in order to reveal the current state of our knowledge and identify information gaps. The study was based on the analysis of herbarium specimens and information in publications and various databases (a total of 481 unique records were used: 118 from herbaria, 121 from literature and 242 from databases). Intensive accumulation of information about *L. loeselii* started in the second half of the 20th century and a particularly large number of records were made in the period from 2010 to 2015 during the implementation of inventory and mapping of EU Habitats all over Lithuania. A summary of all information about *L. loeselii* revealed that it was registered in a total of 93 grid squares, and is mainly confined to uplands. The available information is quite sufficient for the evaluation of the species distribution and prevailing habitats, but is incomplete for the evaluation of population sizes, demographic structures and population trends under changing habitat conditions. Additional investigations are, therefore, required to enable a more accurate assessment of the size and viability of the *L. loeselii* metapopulation in Lithuania.

Keywords: data cumulation, fens, history, investigations, population demography, review, transition mires.

INTRODUCTION

Because of the loss of specific habitats and environmental disturbances induced by human activities, several plant species have declined significantly. About 21% of vascular plant species in Europe have been classified as threatened (Silva et al., 2008) and specific measures for their conservation and restoration should be applied. Large scale land use intensification causes the destruction and degradation of natural habitats, of which wetlands are especially sensitive. Wetland drainage and peat excavation are the main causes of habitat and biodiversity losses in bogs, fens and mires. Even small hydrological alterations can cause major changes in wetland plant communities (Wheeler et al., 2004; Acreman et al., 2007). Further degradation of plant communities and habitats is often related to changes in land-use practice (Segerström & Emanuelsson, 2002; Andersen et al., 2015).

The conservation of an endangered species depends on understanding of its actual distribution, population structure and dynamics as well as on the knowledge about the main environmental factors that determine viability of its populations (Janečková et al., 2006; Schrautzera et al., 2010; Hornemann et al., 2012). This information is of supreme importance for conservation of endangered species, management and restoration of its habitats.

Liparis loeselii (L.) Rich. (Orchidaceae) occurs across a large part of Europe, West Asia and North America. It is mainly restricted to warm temperate

zones and mountain regions in the southern parts of its range (Moore, 1980; McMaster, 2001; Pillon et al., 2007). *L. loeselii* is a small perennial orchid with pseudobulbs, which mainly grows in herbaceous vegetation in base-rich, wet, oligotrophic fens, marshes and other types of wetlands, and occasionally in dune slacks and reflooded turbaries (Wheeler et al., 1998; Pillon et al., 2007; Oostermeijer & Hartman, 2014).

Currently, *L. loeselii* is a declining species in Europe, mostly because of habitat loss (Pillon et al., 2007). It is included into the lists of protected species in almost all European countries and with few exceptions it is considered critically endangered (Czech Republic, Hungary, Slovakia, Sweden, etc.), endangered (Great Britain, Finland, Italy, Russia, etc.) or vulnerable (France, Latvia, Poland, Switzerland, etc.) (Procházka & Potůček, 1999; Averyanov, 2000; Cepurīte, 2003; Kull et al., 2008; Valentin et al., 2010; Kopeć & Michalska-Hejduk, 2011, etc.). It is presumably extinct in Bulgaria (Trifonov, 2009; Milanović, 2012). The species is listed in the Annex II of the *European Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora* (92/43/EEC). The species is also listed in the Annex I of the *Convention on the Conservation of European Wildlife and Natural Habitats* and the Annex I of the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES).

In Lithuania, *L. loeselii* has been legally protected since 1962. In 1992, it was listed in the *Red Data Book of Lithuania* and included in the category of vulnerable species (Lapelė, 1992). In the latest edition of the *Red Data Book of Lithuania* and in successive lists of protected species, it has remained in the same category (Ryla, 2007).

In Lithuania, *L. loeselii* is mostly distributed in the eastern and south-eastern parts of the country, where the main undamaged wetland habitats are located. In other parts of the country, the species is rare (Gudžinskas & Ryla, 2006). It usually occurs in transition mires, quaking bogs and alkaline fens, less common in spring fens, rarely on shores of lakes and in quarries. It prefers open, well-illuminated habitats, although it is sometimes found in wetland habitats with sparse cover of shrubs or reeds (Gudžinskas & Ryla, 2006).

In Europe, the main attention is paid to the investigations on population structure and dynamics of *L. loeselii*. The most thoroughly studied are populations occurring in dune slacks in Great Britain (Jones, 1998), France (Valentin et al., 2010) and the Netherlands (Oostermeijer & Hartman, 2014). Populations of *L. loeselii* in fen, mire and other wetland habitats are less studied, although they form the main and most diverse habitat of the species. In many cases, the published results are based on a small number of populations available in a certain country or study area (Wheeler et al., 1998; Roze et al., 2014). Long-term dynamics of *L. loeselii* populations in many types of fen and mire habitats as well as relationships between vegetation succession and changes in populations are poorly known, because studies are usually based on short-term or single-census investigations (Oostermeijer & Hartman, 2014) and only in a few cases the results of long-term research are presented (Wheeler et al., 1998).

In Belgium, the research on artificial propagation and translocations of *L. loeselii* has been performed (Landuyt et al., 2015). Genetic diversity and ecological differentiation of this species has been studied on the material from several populations in Europe and North America (Pillon et al., 2007; Vanden et al., 2014).

The aim of this study was to compile all available information about distribution, habitat types and the size of *L. loeselii* populations in Lithuania in order to evaluate the current level of knowledge and identify gaps therein. The major questions in our study were as follows: (a) are the observed increases or decreases in the number of records related to the spread of this species? (b) have different researchers evaluated the size of populations and, if so, are the data sufficient for the estimation of demographic structure and population viability? (c) what are the most important habitats of this species and what information about their conditions can be obtained from the sources of information?

MATERIALS AND METHODS

We analysed the data on *Liparis loeselii* in Lithuania from three information sources: herbarium specimens, publications and database records. We studied herbarium specimens deposited at the Herbarium of Vilnius University (WI, Vilnius) and the Herbarium of the Institute of Botany of the Nature Research Centre (BILAS, Vilnius), which also includes re-

cently transferred collections of former Herbarium of the Station of Nature Research and Environmental Education (HSUD, Marijampolė). The label data on a total of 118 *L. loeselii* herbarium specimens were included. The second dataset, comprising 176 records of the studied species, was obtained from publications (Appendix 1). The third dataset, consisting of 350 records, was obtained from the Information System on Protected Species of the Ministry of Environment of Lithuania (SRIS). Hence, we compiled a total of 644 records of *L. loeselii* (state of the end of 2015).

All primary records were scrutinized and cross-checked in order to reveal repetitive information from different sources. If a herbarium specimen was clearly associated with information published at a later date or with a database record, it was accepted as the primary source. Subsequently, the reference or database information repeating the record of the herbarium specimen was removed from further analysis. When the same information appeared in several replications, the oldest record was included in the analysis.

Publications with general information about the species or a review of *L. loeselii* distribution, but containing no information about exact locations (e.g. Balevičienė, 1981; Lapelė, 1992; Stukonis, 1995, 1996; Obelevičius, 1997, etc.) were not included into our analysis.

Information about habitats of *L. loeselii* obtained from the data sources was generalized regarding habitat characteristics. When the description of a locality did not enable an assignment to one of the main habitat types (fen, transition mire, quaking bog, etc.), the record was assigned to the major habitat type, i.e. to wetlands. In cases when the EU habitat type was indicated (European Commission, 2007; Rašomavičius, 2012), the information was accepted unchanged.

Herbarium specimen labels always contained the exact collection date, but part of the literature references did not specify the date of observation of *L. loeselii* at a certain locality. In such cases, the date of the publication was used as the year of the record.

All records of *L. loeselii* that were selected for further analysis were classified into four periods according to the date of observation. The first period started with the beginning of botanical investigations in Lithuania and continued up to the year 1900, the second period lasted from 1900 to 1950, the third period – from 1950 to 2000, and the fourth period – from 2000 to the end of 2015. These four periods were used throughout the data analysis, except for a graph of the cumulative number of records of the species, for which the periods of a decade were used.

Distribution maps of *L. loeselii* in Lithuania were compiled using a system of grid cells (Gudžinskas, 1993). Each grid cell represents area of approximately 10 × 10 km (10′ longitude and 6′ latitude). All localities recorded in the same grid cell on the map are marked by a single symbol. Distribution maps of *L. loeselii* in different periods were compiled, excluding the data on records made for the previous periods.

RESULTS

Accumulation of information about *Liparis loeselii*

As a result of cross-check of datasets, 163 records were removed and the remaining 481 unique records were used for further analysis (118 herbaria, 121 literature and 242 database records). In the 19th century, *L. loeselii* was recorded only four times in the present territory of Lithuania. Therefore, this period was not included in the graph showing the cumulative number of records (Fig. 1). Starting with the beginning of the 20th century up to the year 1950, the number of records increased by 17, thus, on average, during this 50-year period, 0.34 records of *L. loeselii* a year were made.

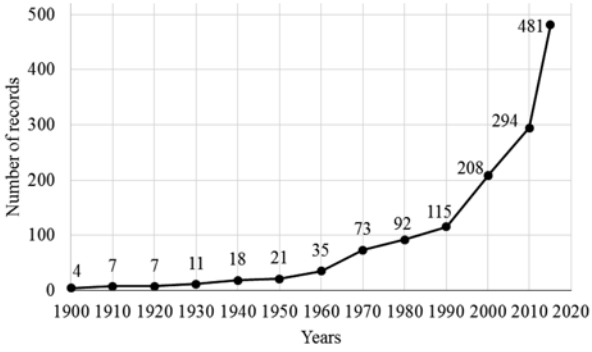

Fig. 1. Cumulative curve of the number of *Liparis loeselii* records in Lithuania by decades of the 20th and 21st centuries

A notable increase in the number of observations of *L. loeselii* started in the 1950s. During this decade, on average, 1.40 records a year have been made for

this species. Even more significant increase took place in the 1960s, when on average 3.80 new records of this species were made each year. However, most of the information about *L. loeselii* has been collected since 2000 onwards (Fig. 1). During 15 years (2000–2015), the number of records of *L. loeselii* has increased more than twice compared to the number of records collected from the first observation (B.S. Jundziłł, 1811) up to the year 2000. Thus, during the last 15 years, on average, 18.20 new records of *L. loeselii* have been made annually, whereas during the entire 20th century, the average annual number of records was 2.04, and during the second half of the 20th century, it has been recorded on average 3.74 times a year. A particularly large number of records of *L. loeselii* were collected in 2010–2015. In the course of six years, *L. loeselii* has been observed 187 times (Fig. 1) or on average 31.17 times a year. Thus, during more than 200 years of investigations on the flora of Lithuania, 481 unique records of *L. loeselii* have been collected.

Distribution of *Liparis loeselii*

Our analysis of herbarium specimens and sources of references revealed that from the beginning of botanical investigations in Lithuania to the end of the 19th century the data on distribution of *L. loeselii* were very scarce. In the 19th century, localities of this species were described in four references (B.S. Jundziłł, 1811; J. Jundziłł 1822; Baliński, 1835; Zelencov, 1890). All records were collected around Vilnius and in Trakai region (Fig. 2).

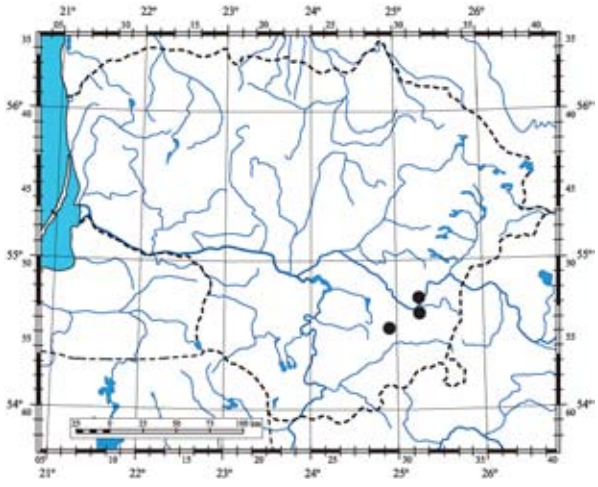

Fig. 2. Distribution of *Liparis loeselii* in Lithuania based on records collected up to the year 1900

In 1900–1950, *L. loeselii* was reported in eight references and nine herbarium specimens were collected. A total of 17 unique records were made during this period and all localities fall into 13 grid squares. Most records included relatively precise information about geographical and administrative position. However, information about the exact location of the site was frequently missing, and this information is currently not recoverable. Most localities were situated in southern Lithuania, and only few were reported from the northern part of the country (Fig. 3).

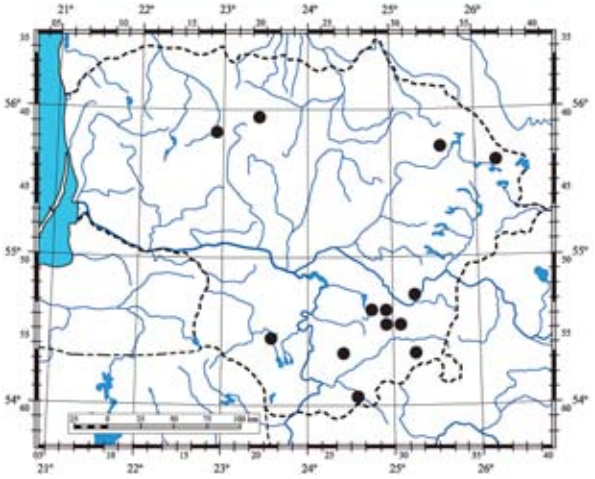

Fig. 3. Distribution of *Liparis loeselii* in Lithuania based on records collected in 1900–1950

In 1950–2000, there were made 187 unique records of *L. loeselii* from 62 grid cells. The main data sources were 95 herbarium specimens and 86 references in publications. Six other unique records were not confirmed by herbarium specimens or reported in publications, but were included in the database on protected species. Most records made during this period included precise information about administrative position of the locality and frequently contained information about minor geographical attributes (names of lakes, mires, fens, etc.). Most localities revealed during this period were concentrated in eastern and southern Lithuania, and only few were recorded in other regions (Fig. 4).

Most data on *L. loeselii* distribution were gathered in 2000–2015, a total of 273 unique records from 61 grid cells. The main data source (236 records) was field observations collected by numerous observers and included into the database on protected plant species of Lithuania. Much less information was found

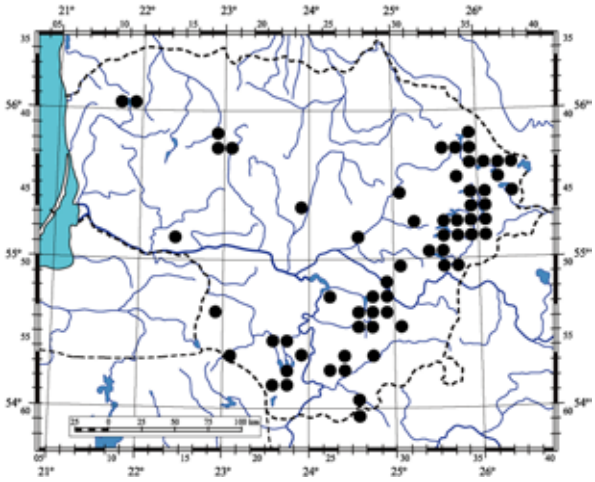

Fig. 4. Distribution of *Liparis loeselii* in Lithuania based on records collected in 1950–2000

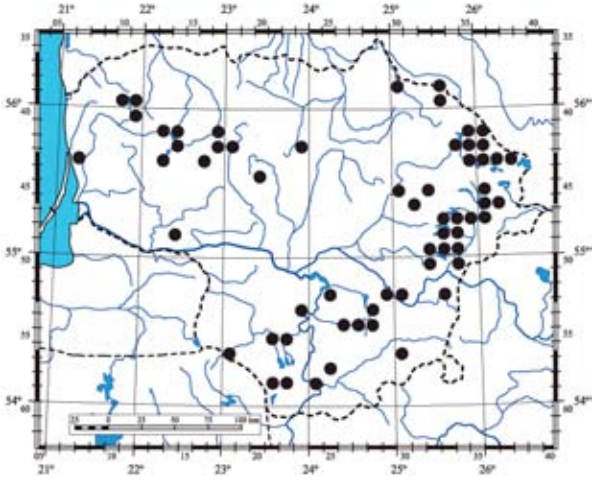

Fig. 5. Distribution of *Liparis loeselii* in Lithuania based on records collected in 2000–2015

in literature references (23 records) and in herbaria (14 herbarium specimens). Most records included precise information about administrative position of the locality, minor geographical attributes, and they frequently contained geographical coordinates. The most abundant information about the localities of *L. loeselii* in that period comes from north-eastern Lithuania and somewhat less from southern and western parts of the country (Fig. 5).

Generalization of all available information about the localities of *L. loeselii* revealed that it was registered in Lithuania in 93 grid cells (Fig. 6). In six grid cells, the species is considered extinct, because after habitat destruction new observations of this species have not been reported since the 1950s. In

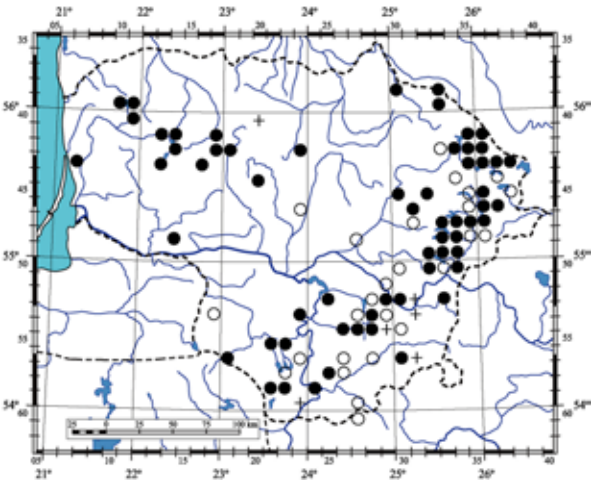

Fig. 6. Known distribution of *Liparis loeselii* in Lithuania up to the year 2015 (+ – extinct, ○ – recorded up to the year 2000 and no later reports, ● – recorded in 2000–2015)

26 of the 62 grid cells in which the species was registered up to the year 2000, it was not reported beyond, and there is no current information about the state of these populations. Most of these records were made in 1950–2000, and it is highly likely that several of these populations are extinct. In 2000–2015, *L. loeselii* was recorded in 61 grid cells (Fig. 6). The state of most of the populations recorded during that period has been fairly well-documented.

Data on habitats

Analysis of the records of *L. loeselii* revealed different interpretations and accuracy of habitat characterizations in different periods. Up to the year 1950, most of the records included either general information about the habitat (e.g. wetland, fen) or none at all. Later on, the accuracy of the information provided on habitat characteristics increased, and a number of well-distinguished or specific habitats such as quaking bog, spring fen or transition mire was indicated on herbarium specimen labels as well as in literature references (Table 1). In 1950–2000, it was indicated in most cases that *L. loeselii* occurred in fens (49 records), quaking bogs (32 records) and transition mires (25 records).

Starting with the year 2000, the data on habitat characteristics were quite precise and only a small fraction of the records did not provide information about the habitat type. In the latest period, the EU classification of important habitats was adopted and,

therefore, these habitat types were specified in numerous records. Out of a total of 273 records, 121 records from that period included information about the EU habitat type. *L. loeselii* was registered occurring in five types of EU habitats (European Commission, 2007; Rašomavičius, 2012): 7110 *Active raised bogs, 7140 Transition mires and quaking bogs, 7160 Fennoscandian mineral-rich springs and spring fens, 7210 *Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*, and 7230 Alkaline fens. In cases when the EU habitat classification was not applied, narrowly defined habitat descriptions were usually provided. In that period, *L. loeselii* was most frequently recorded from fens (41 records), transition mires (32 records), quaking bogs (25 records) and spring fens (17 records) (Table 1). Occasionally, the habitat description was not informative enough and could only be broadly interpreted as wetland habitat.

Table 1. Specification of habitats of *Liparis loeselii* in records collected during different time periods

Habitat	>1900	1900–1950	1950–2000	2000–2015
Not indicated	2	8	17	13
Fen	1	3	49	41
Spring fen	–	–	7	17
Transition mires	–	–	25	32
Quaking bogs	–	–	32	25
Raised bog	–	–	3	0
Wetland	–	6	42	19
Reedbed	–	–	9	1
Swamp forest	1	–	3	1
Quarry	–	–	0	3
European Union Habitats				
7110 *Active raised bogs	–	–	–	1
7140 Transition mires and quaking bogs	–	–	–	67
7160 Fennoscandian mineral-rich springs and springfens	–	–	–	4
7210 *Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*	–	–	–	2
7230 Alkaline fens	–	–	–	47

Although in the latest records the habitat types were indicated precisely, the state of the site and the suitability of habitat conditions for *L. loeselii* were only indicated in a few cases. Increased dominance of trees, shrubs and reeds was occasionally mentioned as forming a threat to the habitat and the species.

Population size and structure

Data on *L. loeselii* population size were absent in all records up to the year 1950. In 1950–2000, indications of the size and the state of the population started to appear both on herbarium labels and in literature references. Nevertheless, in 65.8% of records (123 cases) from that period there is no indication of *L. loeselii* abundance at the observation site. When the abundance was described, it was in most cases (22.5% of records, or 42 cases) only generalized information about the population size (few individuals, not abundant, rather abundant, etc.). Exact numbers of observed individuals, without segregation of their life stages, were indicated in a mere 9.6% of records (18 cases), and the size of the observed populations ranged from 1 to 25 individuals. An approximate number of individuals were given in 2.1% of records (4 cases) (Table 2). In the most recent period, most records included information about the population size and this information was missing in only 1.8% of records (five cases). Exact number of individuals in surveyed populations were included in 46.5% of records (127 cases), and the number of *L. loeselii* ranged between 1 and 200 individuals. Generalized information about the population size was found in 45.1% of records (123 cases), whereas an approximate number of individuals were given in 6.6% of records (18 cases) (Table 2).

Table 2. Indication of the abundance of *Liparis loeselii* in recorded populations

Abundance	>1900	1900–1950	1950–2000	2000–2015
Accurate	–	–	18	127
Approximate	–	–	4	18
Generalized	–	–	42	123
Not indicated	4	17	123	5

Up to the year 1950, none of the records included information about the life stages of the observed *L. loeselii* individuals. In 1950–2000, no information about the life stages of observed plants was provided in 55.6% of the records (104 cases). In 42.8% of the records (80 cases), it was mentioned that a certain number of generative individuals were found, whereas 1.1% of all records (two cases) mentioned that only

vegetative individuals were observed at the studied sites. More detailed information was included in only 0.5% of all records (one case). This record included data on the presence of both generative and vegetative individuals in the observed population. During the latest period, most records contained information about the life stages of the observed *L. loeselii* individuals. In 56.0% of the records (153 cases), it was mentioned that only generative individuals were observed, whereas 27.1% of the records (74 cases) reported the presence of only vegetative individuals. Only few records (9.5% of the records, or 26 cases) provided information about the presence of both generative and vegetative individuals. In this period, only a small percentage of all records (7.0% of the records, or 19 cases) did not present any information about the life stages of observed individuals.

DISCUSSION

Accumulation of the data

Accumulation of scientific information about a particular species depends on numerous factors such as the number of professional researchers and amateur observers, their scientific and personal interests, policy of science and general policy, economy, existing environmental and conservational problems and the search of ways to solve such problems, possibilities to publish research results and even following modern trends in research and approaches to monitoring species (Hopkins & Freckleton, 2002; Dickinson et al., 2010; Miller-Rushing et al., 2012). Almost all these factors have influenced the data flow on the occurrence of *Liparis loeselii* in Lithuania.

Up to the year 1900, the species was recorded only four times. Investigations on the flora were at the initial stages of development and more attention was paid to discover species than to document their actual distribution. Moreover, only few professional botanists were active in the field at the time (Merkys, 1960). In 1900–1920, the number of *L. loeselii* records hardly increased. In that period, three records were made in Šiauliai region (Moellendorf, 1902; Hryniewiecki, 1933). In 1920, the Lithuanian University (later Vytautas Magnus University) was established and consecutive investigations on the flora of Lithuania were started under the supervision of Prof. K. Regel (Klimavičiūtė, 2002). At the same time, the flora of southeast Lithuania was studied by the botanists of the Stefan Batory University (later Vilnius University) in Vilnius. Nevertheless, up to the year 1940, *L. loeselii* was recorded from only 11 localities (Fig. 1). Thus, it can be assumed that fen and mire plants were investigated only by occasion.

During and shortly after the World War II, new information about the flora of Lithuania has been collected occasionally. In 1950, botanical investigations in Lithuania became more intense with the intention to study the flora of the country exhaustively (Ričkienė, 1997). The first significant rise in the number of *L. loeselii* records took place from 1950 to 1980 (Fig. 1), but increased even more in 1990 and still continues. This recent increase in the availability of information can be explained by several factors. In 1990, numerous new nature conservation areas were established and inventories of their biodiversity were performed (Barauskas et al., 2004). The publication of new records of protected species was enhanced by the issue of the periodical "Raudoni lapai", which has been published annually by the Ministry of Environment since 1993. During the next decade (2000–2010), selection and designation of special protected areas and implementation of the EU Habitat Directive enhanced the information flow on distribution and habitats of *L. loeselii* even more. The particularly large number of records of *L. loeselii* from 2010 to 2015 was caused by the inventory and mapping of EU Habitats all over Lithuania.

Distribution

The analysis of distribution of *Liparis loeselii* in Lithuania revealed that its populations are concentrated in the regions with higher elevations, and occur only solitarily in lowland regions. This distribution pattern is caused by several factors. In higher regions, suitable habitats are much more frequent compared to lowlands, and they were less affected by the large-scale drainage of wetlands that took place between the 1960s and 1980s (Kunskas, 1986; Liužinas, 1995). Fens, transition mires and other wetland habitats are currently much more degraded in lowland areas than at higher elevations, although some of these survived the drainage.

The concentration of *L. loeselii* at higher elevations is also found for other species of the Orchidace-

ae, e.g. *Corallorhiza trifida* Châtel., *Dactylorhiza maculata* (L.) Soó and *Malaxis monophyllos* (L.) Sw. (Gudžinskas, 2001; Gudžinskas & Ryla, 2006).

Currently, *L. loeselii* is known from 93 grid cells, whereas on the distribution map compiled in 2006 its presence was confirmed in 63 (Gudžinskas & Ryla, 2006) and in 2007 in 64 grid cells (Ryla, 2007). It is reported that seeds of some orchid species can be dispersed by wind over a large distances (Arditti & Ghani, 2000). Recent studies in France, Belgium and the Netherlands based on genetic diversity of *L. loeselii* populations have revealed high levels of effective long-distance seed dispersal (Vanden Broeck et al., 2014). However, we suppose that the increase in the number of *L. loeselii* localities in Lithuania can be explained by the increasing number of investigations on suitable habitats for this species, and not by its colonization of new areas and habitats. Emergence of a few new populations in newly formed habitats such as quarries can be explained by the long-distance seed dispersal.

Summarizing all information, we can conclude that the current distribution of *L. loeselii* in Lithuania is quite well-known, and, hence, only few additional localities are expected to be discovered in the future.

Population characteristics

The analysis of the data presented in records on the size and life stage structure of the observed populations revealed that this information is insufficient to draw general conclusions about the viability of the Lithuanian metapopulation of *L. loeselii*. Observations only on flowering individuals are not sufficient to characterize orchid populations (Wells & Cox, 1991). Therefore, more detailed studies that take into account seedlings, juveniles and vegetative and flowering adult individuals are necessary in order to evaluate the status of plant populations (Wells & Cox, 1991; Oostermeijer et al., 1994).

Though single-census investigations on the size and structure of *L. loeselii* populations can provide valuable information (Oostermeijer & Hartman, 2014), long-term studies can present even more relevant data on population changes and are, thus, more useful for the selection and evaluation of conservation and habitat management measures. The studies in North America revealed high mortality of *L. loeselii* individuals during five-year interval, though the decline in population size was much lower during the same period. Therefore, it was concluded that population stability of *L. loeselii* populations is maintained mainly by recruitment, rather than longevity of individuals (McMaster, 2001). In Europe, most of the habitats suitable for this species for a long time have been preserved in certain successional stage by human activities such as mowing and haymaking (Segerström & Emanuelsson, 2002). *L. loeselii* is a species characteristic of early successional stages of fen and mire communities (Vanden Broeck et al., 2014), thus, the maintenance of favourable habitat conditions and proper habitat management is the most important task to ensure conservation of this species.

The analysis of information about *L. loeselii* in Lithuania enabled us to conclude that distribution and habitat preferences of this species are currently quite well-known. The knowledge about population size, structure and dynamics is, however, insufficient for a good evaluation of the status of the species according to the EU and IUCN criteria (IUCN, 2012). Thus, more thorough studies should be performed to provide a good scientific basis for population conservation measures and habitat management actions.

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REFERENCES

Acreman M.C., Fisher J., Stratford C.J., Mould D.J., Mountford J.O., 2007: Hydrological science and wetland restoration: some case studies from Europe. – Hydrology Earth System Sciences, 11(1): 158–169.

Andersen D.K., Ejrnæs R., Vinther E., Svendsen A., Bruun H.H., Buchwald E., Vikstrøm T., 2015: Forvaltning af rigkær. Udgangspunkt i voksesteder for mygblomst. – Aarhus.

Arditti J., Ghani A.K.A., 2000: Numerical and phys-

ical properties of orchid seeds and their biological implications. – New Phytologist, 145: 367–421.

Averyanov L.V., 2000: *Liparis loeselii* (L.) Rich. – In: Noskov G.A. (ed.), Red Data Book of Nature of the Leningrad Region, 2: 228–229. – St. Petersburg.

Balevičienė J., 1981: Pelkių bendrijos. – In: Giniūnas K. (ed.), Lietuvos TSR nacionalinis parkas: 48–49. – Vilnius.

Baliński M., 1835: Opisanie statystyczne miasta Wilna. – Wilno.

Barauskas R., Baškytė R., Kirstukas M., Mikalauskas G., Snitkienė L., Valantiejienė V., 2004: Lietuvos gamta. Saugomos teritorijos. – Kaunas.

Cepurīte B., 2003: Lēzela lipare. *Liparis loeselii* (L.) Rich. – In: Andrušaitis G. (ed.), Latvijas Sarkanā Grāmata, 3: 578–579. – Rīga.

Dickinson J.L., Zuckerberg B., Bonter D.N., 2010: Citizen science as an ecological research tool: challenges and benefits. – The Annual Review of Ecology, Evolution, and Systematics, 41: 149–172.

European Commission, 2007: Interpretation Manual of European Union Habitats. EUR27. – Brussels.

Gudžinskas Z., 1993: Genus *Ambrosia* L. (*Asteraceae*) in Lithuania. – Thaiszia (Košice), 3: 89–96.

Gudžinskas Z., 2001: Diversity, state, and protection of *Orchidaceae* species in Lithuania. – Journal Europäischer Orchideen, 33(1): 415–441.

Gudžinskas Z., Ryla M., 2006: Lietuvos gegužraibiniai (*Orchidaceae*). Orchids (*Orchidaceae*) of Lithuania. – Vilnius.

Hopkins G.W., Freckleton R.P., 2002: Declines in the numbers of amateur and professional taxonomists: implications for conservation. – Animal Conservation, 5(3): 245–249.

Hornemann G., Michalski S.G., Durka W., 2012: Short-term fitness and long-term population trends in the orchid *Anacamptis morio*. – Plant Ecology, 213: 1583–1595. DOI 10.1007/s11258-012-0113-6.

Hryniewiecki B., 1933: Tentamen Florae Lithuaniae. – Warszawa.

IUCN, 2012: IUCN Red List Categories and Criteria. Version 3.1. – Gland–Cambridge.

Janečková P., Wotavová K., Schödelbauerová I., Jersáková J., Kindlmann P., 2006: Relative effects of management and environmental conditions on performance and survival of populations of a terrestrial orchid, *Dactylorhiza majalis*. – Biological Conservation, 129: 40–49.

Jones P.S., 1998: Aspects of the population biology of *Liparis loeselii* (L.) Rich. var. *ovata* Ridd. ex Godfrey (Orchidaceae) in the dune slacks of South Wales, UK. – Botanical Journal of the Linnaean Society, 126: 123–139.

Jundziłł B.S., 1811: Opisanie roślin Litewskich według układu Linneusza. – Wilno.

Jundziłł J., 1822: Raport Pana Józefa Jundziłła do fakultetu fizyczno-matematycznego w Uniwersytecie Imperatorskim wileńskim, przysłany z podroży botanicznej po gubernii wileńskiej. – Pamiętnik Farmaceutyczny Wileński, 2: 438–446.

Klimavičiūtė J., 2002: Botanikos mokslo raida Lietuvoje 1919–1943 m. – Vilnius.

Kopeć D., Michalska-Hejduk D., 2011: How threatened is the Polish wetland flora? – International Journal of Oceanography and Hydrobiology, 41(3): 79–89.

Kull T., Sammul M., Kull K., Lanno K., Tali K., Gruber B., Schmeller D., Henle K., 2008: Necessity and reality of monitoring threatened European vascular plants. – Biodiversity Conservation, 17: 3383–3402.

Kunskas R., 1986: Lietuvos pelkių durpėdara ir mineralizacija, jų klodų būklė. – Geografijos metraštis, 22–23: 40–59.

Landuyt van W., T'jollyn F., Brys R., Broeck A. vanden, 2015: Translocatie-experiment bij groenknolorchis (*Liparis loeselii*). – Brussel.

Lapelė M., 1992: Dvilapis purvuolis. – In: Balevičius K. (ed.), Lietuvos raudonoji knyga: 284. – Vilnius.

Liužinas R., 1995: Lietuvos durpynų kadastras. – Vilnius.

McMaster R.T., 2001: The population biology of *Liparis loeselii*, Loesel's twayblade, in a Massachusetts wetland. – Northeastern Naturalist, 8(2): 163–178.

Merkys A., 1960: Botanikos ir žemės ūkio mokslų raida Vilniaus universitete XVIII–XIX a. – In: Iš mokslų istorijos Lietuvoje: 50–60. – Vilnius.

Milanović Đ., 2012: *Liparis loeselii* (L.) Rich. – a plant rediscovered in the Balkan peninsula. – Botanica Serbica, 36(2): 85–89.

Miller-Rushing A., Primack R., Bonney R., 2012: The history of public participation in ecological research. – Frontiers in Ecology and the Environment, 10(6): 285–290.

Moellendorf O. von, 1902: Materialy dlja flory Kovenskoj gubernii (Perečen rastenij, naxodjaščixsja v Kovenskoj gubernii, kak diko rastuščix, tak i vozdelyvaemyx). – Kovna.

Moore D.M., 1980: Genus *Liparis* L.C.M. Richard. – In: Tutin T.G. (ed.), Flora Europaea, 5: 350. – Cambridge.

Obelevičius S., 1997: Naujos į Lietuvos raudonąją knygą įrašytų augalų rūšių radvietės Anykščių rajone. – Raudoni lapai, 5: 32–37.

Oostermeijer J.G.B., van't Veer R., Den Nijs J.C.M., 1994: Population structure of the rare, long-lived perennial *Gentiana pneumonanthe* in relation to vegetation and management in the Netherlands. – Journal of Applied Ecology, 31: 428–438.

Oostermeijer J.G.B., Hartman Y., 2014: Inferring population and metapopulation dynamics of *Liparis loeselii* from single-census and inventory data. – Acta Oecologica, 60: 30–39.

Pillon Y., Qamaruz-Zaman F., Fay M.F., Hendoux F., Piquot Y., 2007: Genetic diversity and ecological differentiation in the endangered fen orchid (*Liparis loeselii*). – Conservation Genetics, 8: 177–184. DOI 10.1007/s10592-006-9160-7.

Procházka F., Potůček O., 1999: *Liparis loeselii* (L.) L.C.Rich. – In: Čeřovský J., Feráková V., Holub J., Maglocký Š., Procházka F., Červená kniha ohrožených a vzácných druhů rostlin a živočichů ČR a SR, 5: 230. – Bratislava.

Rašomavičius V., 2012: EB svarbos natūralių buveinių inventorizavimo vadovas. – Vilnius.

Ričkienė A., 1997: Botanikos mokslo metmenys Lietuvoje po Antrojo pasaulinio karo. – In: Lietuvos jaunųjų botanikų darbai: 197–200. – Vilnius.

Ryla M., 2007: Dvilapis purvuolis – *Liparis loeselii* (L.) Rich. – In: Rašomavičius V. (ed.), Lietuvos raudonoji knyga: 276. – Vilnius.

Roze D., Jakobsone G., Megre D., Belogrudova I., Karlovska A., 2014: Survival of *Liparis loeselii* (L.) as an early successional species in Engure region described based on ecological peculiarities during the annual cycle. – Proceedings of the Latvian Academy of Sciences. Section B, 68(1/2): 93–100. DOI: 10.2478/prolas-2014-008

Schrautzera J., Fichtnera A., Huckaufa A., Rasranb L., Jensenc K., 2010: Long-term population dynamics of *Dactylorhiza incarnata* (L.) Soó after abandonment and re-introduction of mowing. – Flora, 206: 622–630.

Segerström U., Emanuelsson M., 2002: Extensive forest grazing and hay-making on mires – vegetation changes in south-central Sweden due to land use since Medieval times. – Vegetation History and Archaeobotany, 11: 181–190.

Silva J.P, Toland J., Jones W., Eldridge J., Thorpe E., Campbell M., O'Hara E., 2008: LIFE and endangered plants. Conserving Europe's threatened flora. – Luxembourg.

Stukonis V., 1995: Kėdainių rajono bioįvairovė ir jos išsaugojimas. – In: Europos gamtos apsaugos metai-95 Lietuvoje. Respublikinės konferencijos dalyvių pranešimų santraukos: 23–24. – Vilnius.

Stukonis V., 1996: Kėdainių rajono flora. – Baltasis gandras, 3(4): 8–10.

Trifonov G., 2009: *Liparis loeselii* (L.) Rich. New floristic record in the Balkans, 10. – Phytologia Balcanica, 15: 135.

Valentin B., Toussaint B., Duhamel F., Valet J.M., 2010: Plan national d'actions en faveur du Liparis de Loesel. Conservatoire botanique national de Bailleul. – Paris.

Vanden Broeck A., Van Landuyt W., Cox K., De Bruyn L., Gyselings R., Oostermeijer G., Valentin B., Bozic G., Dolinar B., Illyés Z., Mergeay J., 2014: High levels of effective long-distance dispersal may blur ecotypic divergence in a rare terrestrial orchid. – BMC Ecology, 14: 1–20.

Wells T.C.E., Cox R., 1991: Demographic and biological studies on *Ophrys apifra*: some results from a 10 year study. – In: Wells T.C.E., Williams J.H. (eds), Population Ecology of Terrestrial Orchids: 47–61. – The Hague.

Wheeler B.D., Gowing D.J.G., Shaw S.C., Mountford J.O., Money R.P., 2004: Eco-hydrological guidelines of lowland wetland plant communities. – Environment Agency: 85.

Wheeler B.D., Lambley P.W., Geeson J., 1998: *Liparis loeselii* (L.) Rich. in eastern England: constraints on distribution and populations development. – Botanical Journal of the Linnean Society, 126: 141–158.

Zelencov A.O., 1890: Očerk klimata i flory Vilenskoj gubernii. – Scripta Botanica Petropolitana, 3: 227–412.

DUOMENŲ APIE *LIPARIS LOESELII* (ORCHIDACEAE) PAPLITIMĄ, BUVEINES IR POPULIACIJŲ DYDĮ LIETUVOJE ĮVERTINIMAS

Egidijus ŽALNERAVIČIUS, Zigmantas GUDŽINSKAS

Santrauka

Dvilapis purvuolis (*Liparis loeselii* (L.) Rich.) – gegužraibinių (Orchidaceae) šeimos augalas, paplitęs Europoje, Vakarų Azijoje ir Šiaurės Amerikoje. Lietuvoje rūšis saugoma nuo 1962 m. Dabar dvilapis purvuolis įrašytas į Lietuvos saugomų gyvūnų, augalų ir grybų rūšių sąrašą, taip pat saugomas Europos mastu ir pagal tarptautines sutartis.

Naudojant herbariumų, publikacijų ir Saugomų rūšių informacinės sistemos (SRIS) duomenis straipsnyje nagrinėjamas dvilapio purvuolio paplitimas, buveinės ir populiacijų dydis Lietuvoje. Iš įvairių informacijos šaltinių buvo surinkti 644 įrašai. Atmetus šaltiniuose pasikartojančius duomenis, buvo atrinktas ir analizei panaudotas 481 originalus įrašas. Duomenys analizės metu buvo suskirstyti į keturis laikotarpius (iki 1900 m., nuo 1900 m. iki 1950 m., nuo 1950 m. iki 2000 m. ir nuo 2000 m. iki 2015 m.). Įvertintas skirtingais istoriniais laikotarpiais buvęs šios rūšies paplitimas šalyje, išnagrinėta informacija apie buveines ir populiacijų dydį.

Iki XX a. pradžios šalyje buvo nustatytos keturios dvilapio purvuolio radavietės. Iki XX a. vidurio daugiausia dvilapio purvuolio radaviečių buvo žinoma Vilniaus krašte. Vėlesniais laikotarpiais duomenų apie dvilapio purvuolio paplitimą ėmė sparčiai daugėti. Ypač reikšmingai duomenų gausėjo nuo 1960 m., kai Lietuvoje suintensyvėjo botaniniai tyrimai ir buvo pradėtas rengti kapitalinis leidinys apie Lietuvos florą. Nuo 1990 m. Lietuvoje pradėtos steigti saugomos teritorijos, buvo vykdoma jų botaninių vertybių inventorizacija. Per laikotarpį nuo 1950 m. iki 2000 m. dvilapis purvuolis paminėtas 86 publikacijose ir surinkti 95 herbariumo pavyzdžiai. Daugiausia informacijos apie šią rūšį buvo surinkta per laikotarpį nuo 2000 m. iki 2015 m. Labai daug duomenų surinkta Lietuvoje vykdant Europos Bendrijos svarbos buveinių inventorizaciją. Per paskutinį laikotarpį dvilapis purvuolis paminėtas 23 publikacijose, surinkta 14 herbariumo pavyzdžių, o Saugomų rūšių informacinėje sistemoje pateikti 236 nauji įrašai.

Nustatyta, kad dvilapis purvuolis daugiausia paplitęs Lietuvos rytinėje ir pietrytinėje dalyse, kuriose yra daugiau išlikusių rūšiai tinkamų buveinių. Vidurio Lietuvos žemumoje ir Žemaičių aukštumoje rūšis gana reta, o kitose šalies dalyse – labai reta. Iš viso rūšis užregistruota 93 botaniniuose kvadratuose, tačiau dalyje vietų rūšis šiuo metu yra išnykusi arba naujų duomenų apie populiacijas nėra.

Pagal šaltiniuose pateiktus duomenis nustatyta, kad dvilapis purvuolis aptinkamas penkių tipų Europos Bendrijos svarbos buveinėse. Dažniausiai rūšis aptinkama tarpinių pelkių ir liūnų, kiek rečiau – šarmingų žemapelkių bei nekalkingų šaltinių ir šaltiniuotų pelkių buveinėse. Iki XX a. vidurio visuose šaltiniuose rūšies populiacijų gausumas nebuvo nurodomas, o vėlesniuose šaltiniuose dažniausiai buvo nurodomas tikslus aptiktų individų skaičius arba gausumas įvertintas abstrakčiai.

Tyrimu nustatyta, kad įvairiuose šaltiniuose pateikiama informacija apie dvilapį purvuolį gana tiksliai apibūdina rūšies paplitimą Lietuvoje, tačiau pateikiamų duomenų dažniausiai neužtenka išsamiam populiacijų ir jų buveinių būklės vertinimui, taip pat neįmanoma tiksliai nustatyti visoje šalyje esančios šios rūšies populiacijos dydį. Stinga duomenų apie populiacijų sudėtį ir kaitą, kurie labai svarbūs siekiant nustatyti rūšies apsaugos ir buveinių tvarkymo priemones.

APPENDIX 1

List of publications used as a source of information about records of *Liparis loeselii*

Aliukonis A., 2009: 2008 metais stebėtos saugomos rūšys Labanoro regioniniame parke. – Raudoni lapai, 11: 40–44.

Balevičienė J., 1988: Bolota. – In: Pakalnis R. (ed.), Rastitel'nyj pokrov nacional'nogo parka Litovskoj SSR: 56–62. – Vilnius.

Balevičienė J., Balevičius A., Balevičius K., Grigaitė O., 1996: Retos ir nykstančios Veisiejų regioninio parko augalų rūšys. – Raudoni lapai, 4: 29–32.

Balevičius K., 1962: Naujos retųjų augalų augimvietės. – Mūsų girios, 8: 28–29.

Balevičius K., Lapelė M., 1994: Saugomos Asvejos regioninio parko floros rūšys. – Raudoni lapai, 2: 30–33.

Balsevičius A., 1994: Naujos kai kurių saugomų Lietuvos floros rūšių radimvietės Pietvakarių Lietuvoje. – Ekologija, 4: 15–19.

Balsevičius A., 1994: Saugomos Lietuvos floros rūšys Grandų botaniniame draustinyje. – Raudoni lapai, 2: 43–45.

Balsevičius A., Katilius K., 1998: Saugomos induočių augalų rūšys Žuvinto rytiniame ir šiaurrytiniame apyežeryje. – Raudoni lapai, 6: 40–42.

Čebatariūtė D., 1999: Alksno kraštovaizdžio draustinio floristiniai tyrimai. – Lietuvos jaunųjų botanikų darbai: 14–15. – Vilnius.

Čerkauskas A., 2010: Informacija apie 2009 m. rastas saugomas rūšis Gražutės regioniniame parke ir kitose Lietuvos vietose. – Raudoni lapai, 12: 19–23.

Galinis V., 1974: Ežero apylinkių ir salų sausumos augalija. – In: Logminas V. (ed.), Kretuonas: 52–54. – Vilnius.

Galinis V., Ragaišytė J., 1972: Kai kurių retų augalų Lietuvos TSR floroje naujos radimvietės. – Lietuvos TSR Aukštųjų Mokyklų Mokslo Darbai, Biologija, 12: 25–29.

Jankauskienė M., Lapelė M., 1994: Retos augalų rūšys Žemaitijos nacionaliniame parke. – Raudoni lapai, 2: 26–28.

Jankevičienė R., 1960: Lietuvos TSR floros kai kurių retesniųjų rūšių naujos radimvietės. – Lietuvos TSR Mokslų Akademijos Darbai, Serija C, 3(23): 21–25.

Jankevičienė R., Lazdauskaitė Ž., 1981: Flora ir jos retosios rūšys. – In: Giniūnas K. (ed.), Lietuvos TSR nacionalinis parkas: 64–67. – Vilnius.

Jankevičienė R., Lekavičius A., Lisaitė B., 1962: Kai kurių retesnių Lietuvos TSR augalų naujos radimvietės. – Lietuvos TSR Mokslų Akademijos darbai, Serija C, 3(29): 61–75.

Kulbis A., Meškauskaitė E., Motiekaitytė V., Nikitenka D., Sprainaitytė S., Zableckis N., 2000: Nauji duomenys apie saugomas ir retas augalų rūšis Trakų rajone. – Raudoni lapai, 7: 61–64.

Lapelė M., 1993: Retosios Viešvilės rezervato floros rūšys. – Raudoni lapai, 1: 36–37.

Lapelė M.V., Šarkinienė I.V., 1987: Flora i fauna zapovednikov SSSR. Flora zapovednika Žuvintas. – Maskva.

Lapelė M., Lekavičius A., 1993: Flora sosudistyx rastenij zapovednika. – In: Zajančkauskas P. (ed.), Zapovednik Žuvintas: 158–186. – Vilnius.

Lekavičius A., 1960: Kai kurių Lietuvos TSR augalų naujos radimo vietos. – Lietuvos TSR Mokslų Akademijos Darbai, Serija C, 2(22): 3–7.

Lekavičius A., Jankevičienė R.L., 1969: Bolee redkie i novye vo flore Litvy taksony (1. Paportnikoobraznye i odnodol'nye). – Lietuvos TSR Mokslų akademijos darbai, Serija C, 1(48): 19–29.

Lekavičius A., Lapelė M., 1984: Retosios augalų rūšys. – In: Balevičius K. (ed.), Čepkelių rezervatas: 75–78. – Vilnius.

Lopeta V., 2007: Retos augalų, grybų ir gyvūnų rūšys Kurtuvėnų regioniniame parke. – Raudoni lapai, 9: 8–18.

Lopeta V., 2007: Retos rūšys Šiaulių ir Kelmės rajonuose. – Raudoni lapai, 9: 19.

Lopetienė E., Lopeta V., 2007: Retos augalų rūšys Pakėvės telmologiniame draustinyje. – Raudoni lapai, 9: 60–61.

Malakauskienė O., Šarkinienė I., Budriūnas A., Jankavičiūtė G., 1968: Sistematičeskoe opisanie flory ozera i bolota Žuvintas. – In: Zajančkauskas P. (ed.), Zapovednik Žuvintas: 111–126. – Vilnius.

Matulevičiūtė D., 1994: *Scheuchzerio-caricetea nigrae* (Nordhagen 1936) R. Tx. 1937. Mezooligotrofiniai mažieji viksvynai. – In: Rašomavičius V. (ed.), Aukštadvario apylinkių augmenija: 203–216. – Vilnius.

Meškauskaitė E., Juzėnas S., 2012: Nauji duomenys apie saugomų augalų radavietes Gražutės kraš-

tovaizdžio draustinyje (Gražutės regioninis parkas). – Raudoni lapai, 14: 26–27.

Motiekaitytė V., 1996: Saugotinos augalų bendrijos Kurtuvėnų regioniniame parke. – Raudoni lapai, 4: 51–52.

Mowszowicz J., 1938: Wykaz roślin naczyniowych Wileńszczyzny z wyszczególnieniem dotychczas podanych stanowisk. – Wilno.

Naujalis J., Tupčiauskaitė J., Motiekaitytė V., Meškauskaitė E., 1995: Retų augalų rūšių paplitimas Kurtuvėnų regioniniame parke. – Raudoni lapai, 3: 32–33.

Obelevičius S., 1994: Naujos saugomų augalų rūšys Anykščių regioniniame parke. – Raudoni lapai, 2: 29–30.

Obelevičius S., 1995: Retosios ir apyretės augalų rūšys Anykščių rajone. – In: Kulbis A. (ed.), Floristiniai radiniai. 1994 m. vegetacijos sezonas: 11–19. – Vilnius.

Obelevičius S., Stukonis V., 1994: Naujos saugomų augalų rūšys Anykščių regioniniame parke. – Raudoni lapai, 2: 29–30.

Regelis K., 1931: Fontes florae Lituanae – Lietuvos floros šaltiniai. – Scripta Horti Botanici Universitatis Vytauti Magni, 1: 221–289.

Šablevičius B., 1998: Naujos retų rūšių radvietės Rytų Lietuvoje 1997–1998 metais. – Raudoni lapai, 6: 30–32.

Šablevičius B., 2000: Naujos retųjų augalų augavietės Rytų Lietuvoje 1999 metais. – Raudoni lapai, 7: 41–42.

Šablevičius B., 2011: Naujos retųjų rūšių radimo vietos 2010 m. – Raudoni lapai, 13: 18–22.

Šablevičius B., 2012: Naujos retų rūšių radimo vietos Lietuvoje 2010–2011 m. – Raudoni lapai, 14: 19–21.

Sinkevičius Ž., 1993: Retosios augalų rūšys Žuvinto rezervate ir apsauginėje zonoje. – Raudoni lapai, 1: 37–38.

Sinkevičius Ž., 1995: Naujos retųjų augalų radvietės Žuvinto rezervate ir apsauginėje zonoje. – Raudoni lapai, 3: 25.

Sławiński W., 1924: Zielone jeziora pod Wilnem. – Wilno.

Snarskis P., 1938: Keletas naujų retesnių Lietuvos augalų augimo vietų. – Gamta, 3: 251–258.

Snarskis P., 1954: Vadovas Lietuvos TSR augalams pažinti. – Vilnius.

Snarskis P., 1963: Orchidažiedžiai – Microspermales. – In: Natkevičaitė-Ivanauskienė M. (ed.), Lietuvos TSR flora, 2: 566–628. – Vilnius.

Strazdaitė J.J., Jankevičienė R.L., Kuzas A.P., Lazdauskaitė Ž.P., 1973: Trakasskij botaničeskij zakaznik. – Lietuvos TSR Mokslų akademijos darbai, Serija C, 4(64): 29–47.

Survilaitė A., 2008: Naujos saugomų augalų radavietės Kriogžlio telmologiniame draustinyje 2005–2006 metais. – Raudoni lapai, 10: 24.

Šarkinienė I., 1967: Naujos kai kurių retesnių Lietuvos TSR augalų radimvietės. – Lietuvos TSR Aukštųjų Mokyklų Mokslo Darbai. Biologija, 7: 187–192.

Tučienė A., 1979: Vandens augalija. – In: Anykščių šilelis: 47–49. – Vilnius.

Tučienė A., 1984: Žemapelkių augalija. – In: Balevičius K. (ed.), Čepkelių rezervatas: 57–61. – Vilnius.

Tupčiauskaitė J., 1987: Naujos labai retų ir retų augalų rūšių radimvietės Lietuvoje. – Lietuvos TSR Aukštųjų Mokyklų Mokslo Darbai. Biologija, 25: 33–40.