PRESENT STATE OF RARE SPECIES *LIGULARIA GLAUCA* IN NORTHERN ROMANIA

Ciprian Claudiu Mânzu¹, Cezar Valentin Tomescu², Alina Georgiana
Cişlariu¹

Key words: relict species, nature reserve, historical data, population size, xero-mesophilous grasslands.

Abstract. Although the taxonomic issue of *Ligularia glauca* remains a subject for further research, the "Fânaşele seculare de la Calafindeşti" Nature Reserve, maintains its scientific relevance. Dependent on different author's opinion, this site preserves either the only *L. glauca* population from Romania, or the only *L. carpatica* population from the lower altitude xero-mesophytic meadows from Romania. Vegetation description dates from the last 40 years ago and is lacking information regarding the size of *L. glauca* population. Therefore, within the aim of our study is to inventory *L. glauca* population from Calafindeşti and to highlight the main factors of anthropic origin with a negative effect on this population.

Introduction

Throughout history, all species experienced periodical range restrictions and expansions. Among the climate relict species, whose geographic distribution has reduced mainly because of changes in climate, the glacial relicts had a wider spread in the cold period of the Quaternary and since the LGM (Last Glacial Maximum) they suffered significant restraints (Hampe and Jump 2011). The habitat fragmentation processes following glaciations affected the characteristics of the remnant glacial relict populations. Their ability to withstand repeated climate changes (Ronikier et al. 2012) determined the relict populations to be of particular interest for studies of phylogeography or genetic diversity conservation (Hampe and Petit 2005).

Climate relicts are important components of local and regional biodiversity (Eriksson 2000), serving as models for understanding the effect of climate changes on the actual flora (Thuiller et al. 2008, Horsak et al. 2010).

¹ Faculty of Biology, Alexandru Ioan Cuza University of Iaşi, Romania; corresponding author: C.C. Mânzu (ciprian.manzu@uaic.ro)

² Forestry Faculty, Ştefan cel Mare University of Suceava, Romania

For the effective conservation of relict species, it is necessary to know their origin and to investigate the current state of the populations. One of the main problems concerning the conservation of Romanian plants is the insufficiently documented distribution of the species (Sârbu 2007, Sârbu et al. 2007, Primack et al. 2008). Another important issue is the lack of information on the status of the populations. For example, in Romania the geographic range of the glacial relict *Ligularia sibirica* is relatively well known, but information on the population size or structure is lacking (Sârbu et al. 2007, Mânzu et al. 2013).

The current state of relict populations cannot be correctly evaluated in the absence of informations on the habitat quality, its changes being considered the most important factor affecting the viability of the plant populations and their persistence over time (Brys et al. 2004, Schleuning and Matthies 2009). The climate change will affect the glacial relict populations, but on short term, the main threat remaining the anthropogenic impact (Hampe & Jump 2011). Factors such as local habitat conditions, anthropic disturbances, intra- and interspecific competition, may be as important factors affecting viability of the relict populations as the biogeographic impact of fragmentation under the effect of climate change (Hobbs and Yates 2003). Even if we consider that some relict species are protected on a national or European level, habitat destruction is taking place at a faster pace than the establishment of the protective measures (Hájek et al. 2010).

As the demographic parameter are useful tools that reflect habitat conditions and the response of plant populations to their changes (Cişlariu et al. 2018), our study aimed to evaluate the population of *Ligularia glauca* in terms of the number of individuals and the anthropogenic factors that can affect its viability, in the only known site from Northern Romania.

Material and methods

Study species

Of the 130 species of the *Ligularia* (L.) Cass. genus, only two, *L. sibirica* (L.), Cass. and *L. glauca* (L.) O. Hoffm. have colonised Europe (Chater 1976, Liu et al. 1994), both species being glacial relicts (Beldie 1979, Horsak et al. 2010).

In Romania, *L. glauca* (Asteraceae) (Fig. 1) is a heliophilous species, xero-mesophilic to mesophilic, ranging from the hill level (in meadows), to mountainous and subalpine regions, on calcareous rocks, from 350 m to 900-1000 m, and even 1650-1700 m altitude (Negrean and Dihoru 2008). It can be considered a Euro-Siberian species, regarding its main distribution area being the southern part of the western and central Siberia (Russia). The European

populations are disjunct and reduced, occurring only in Western Ukraine (Western Podolia), Romania, Bulgaria and Slovakia (Horsak et al. 2010).

The status of this species in its Euro-Siberian area is still up for debate, some authors considering the living of two different subspecies (Horsak et al. 2010), while others even consider the existence of two distinct species, *L. glauca* (in Siberia), and *L. carpatica* (Schott, Nym. et Kotschy) Pojark in Europe (Pojarkova 1961, Horsak et al. 2010). In Romania the approaches vary between considering the existence of two different species (Tudorică 1978, Beldie 1979), *L. carpatica* and *L. glauca*, or of a single species, either *L. glauca* (Chatter 1976, Sîrbu et al. 2001, Oprea 2005, Negrean and Dihoru 2008, Horsak et al. 2010), or *L. carpatica* (Greuter 2006, Sîrbu et al. 2013). Since the taxonomic problem is not within the aim of this paper, we will further consider *L. glauca* s. lato (Chatter 1976, Negrean and Dihoru 2008, Horsak et al. 2010), with the following distribution in Romania: Suceava (Calafindești); Alba (Trascău Mountains); Argeș (Făgăraș Mountains); Bacău (Ghimeș Pass); Bistrița Năsăud (Rodnei Mountains); Buzău (Mount Siriu); Dâmbovița (Leaota Massif); Prahova (Bucegi Mountains); Vâlcea (Buila Mountains) (Negrean and Dihoru 2008).

Fig. 1. *Ligularia glauca* in Calafindești Nature Reserve (Photo: C.V. Tomescu)

Although the issue regarding the two species requires further studies, two ecological variants can be distinguished within the Romanian populations: first, the population from Calafindești (Suceava County) developing in a xero-mesophilic meadow, from the hill region; and second, the populations from the mountainous region, from higher altitudes developing on rocky slopes, where *L. glauca* manifests as a saxicolous xero-mesophilic species. Furthermore, in its main range area (Altai Mountains) the species seems to have also two ecological optima, developing in the more humid climate of the northern Altai, where it prefers meadow steppes, but also drier steppes and herb-rich birch forests; and also in the continental southern part of the Altai where it occupies tundra grasslands and tundra scrub (Horsak et al. 2010).

Study site

The "Fânațele seculare de la Calafindești" (The secular hayfields of Calafindești) Nature Reserve is located in the Northern Suceava County, on the Calafindești village territory (Fig. 2). Although founded as a reserve of local interest since 1979 and afterwards included in the protected areas of national

Fig. 2. Study site location (based on Google Earth satellite images)

interest through the Law 5/2000, precise data on the location of the protected area are missing (<http://www.mmediu.ro>, <http://eunis.eea.europa.eu>). Țibu publishes in 1997 a hand drawing map that can be used for the approximate location of the site. According to the geographical landmarks visible on the

map, the reservation is located between the communal road DC39 (in the Southern part), the Horaiț stream (in the Eastern part), La Unguri rivulet (Bahna lui Știr) (in the Northern part) and the European road E85 (in the Western part).

According to the current information, the reservation has no custodian, nor management plan, the terrain being private (<http://www.anpm.ro/web/apm-suceava>).

The fieldwork was carried between 2015-2018; the area occupied by the *L. glauca* population being delineated by GPS. Our study focus on population inventory (by GPS marking of each subpopulation and by individuals counting) and on analysing the anthropic impact on the populations throughout the vegetation period.

Results and discussion

Within the fieldwork, in the year 2018 we inventoried 13 *L. glauca* subpopulations, with a total number of 4487 individuals (Fig. 3). The area occupied by the *L. glauca* population is fragmented by the cultivated areas (Figs. 3; 4c, d), most of the individuals being identified in the Southern part of the site (47.8555556 N, 26.0594444 E) (Fig. 3). This area seems to fit the

Fig. 3. Distribution of *Ligularia glauca* in Calafindești Nature Reserve (red dots represent the centre of each subpopulation, with number of individuals)

species environmental requirements, through the micro-relief conditions such as prone slope, which obstructs the soil ploughing. Fig. 1 shows the *L. glauca* population in an area altered by the anthropogenic impact, most of the surrounding lands being cultivated. The Northern *L. glauca* subpopulation (47.85694444 N, 26.05527778 E) is on a land used for mowing. Therefore, some *L. glauca* subpopulations show a strong resistance capacity, as they grow even on periodically cultivated areas (Fig. 3).

It is worth mentioning that during our field studies, we reconfirmed species such as *Iris sibirica* (threatened at European level) (Khela 2013) and *Fritillaria meleagris* from the study area.

The main threats of this population are the disturbances of anthropogenic origin. Thus, the area with *L. glauca* is surrounded and fragmented by cultivated areas (Figs. 3; 4c, d). Moreover, the site with *L. glauca* is used as a shortcut between the agricultural plots for the farm equipment (personal observations). We also observed the practice of burning the meadow in the beginning of spring, with a negative effect mainly on the prevernal and vernal flora (Fig. 4a). Fortunately, after the burning, during the vegetation season no negative effects were observed on *L. glauca* population (Fig. 4b).

Fig. 4. a. burnt heyfield (April 2018); b. *Ligularia glauca* in Calafindeşti Nature Reserve (June 2018); c, d. general view from the heyfield with *L. glauca* (June 2017, 2018) (Photo: a, b, c - C.C. Mânzu; d - C.V. Tomescu)

The strong anthropogenic impact since the first signs of the species occurrence in the area (1936), led to the instauration of protective measures. According to Țibu (1997), the area occupied by *L. glauca* 50 years ago was much higher. The effects of anthropogenic impact have been observed even since the designation of the area as a natural reserve of local interest, through converting the meadows into agricultural land. The exact surface of the protected site is disputable. Thus, in 1979, a surface of 17,3 hectares (Țibu 1997) was suggested. After only one year, though, the effective measurements from the field showed the actual area with *L. glauca* as being only 11,73 hectares (Țibu 1997). Since that period, there has been a lack of protection measures which led to the increasing human impact through the land cultivation and creation of drainage channels. After 20 years from its establishment, the protected area becomes a natural reserve of national interest (Law 5/2000) but with the same area as in 1979 (17.3 hectares). Nevertheless, according to the available data (<http://www.anpm.ro/web/apm-suceava>), the reservation appears to have an area of 7 hectares, towards cca. 2,5 hectares showed by our measurements (referring only to area occupied by *L. glauca* population).

Analysing and comparing historical data with actual data raises some issues. First, the articles on *L. glauca* from Calafindești lack precise location data and information regarding the population size (an exception makes the personal, but not quantifiable considerations, such as *L. glauca* is abundant - Țibu 1997). Most actual discussion on *L. glauca* population from Calafindești (Chifu et al. 2006) are based on an article published in 1981 by Seghedin and Boșcaiu. Based on these informations (field observations dating from 1979), *L. glauca* phytocoenoses were included in *Anthoxantho-Agrostietum capillaris* Silinger 1933 *ligularietosum glaucae* Chifu, Mânzu, Zamfirescu 2006, and in *Cirsietum rivularis* Nowinski 1928 Associations (Chifu et al. 2006). Although the cited paper lacks details regarding the relevés location (being mention only the Calafindești locality), based on the analysis on the reservation scheme and the observations made by Țibu (1997), we consider that the relevés published by Seghedin and Boșcaiu were carried out in an area altered by conversion into arable land or pasture. This can explain the differences in the official data on the reservation area at the time of its establishment (17,3 hectares) and the current one (7 hectares). Recent studies from the area mention none of the fore-cited vegetation types, *L. glauca* being identified in *Convolvulo-Agropyretum repentis* Felföldy 1943 and *Filipendulo vulgaris-Arrhenatheretum elatioris* Hundt et Hübl 1983 (Tomescu 2016). These data seem to sustain our view that the location of the relevés published by Seghedin and Boșcaiu is not the same as those of the investigated *L. glauca* population.

Conclusions

Further studies on the distribution from Romania and taxonomic status of *Ligularia glauca* sensu lato are needed. Whether in the "Fânaşele seculare de la Calafindeşti" Nature Reserve is the only population of *L. glauca* in Romania or the only population of *L. carpatica* in lowland xero-mesophilic meadows in Romania, its scientific value remains as high. Our observations also highlight the need for a national monitoring program for protected areas and populations of rare species. This would allow a correct understanding of the actual distribution of the species, the characteristics of populations, and the occurring changes (either natural or anthropic).

Under the impact of global warming, reduction and degradation of natural habitats, establishing effective conservation measures requires information on population structure and size, their reproductive success, and characteristic habitats. Perennial species (like *L. glauca*) do not depend only on a high rate of germination to maintain their populations, the survival and development of seedlings, the survival of adult individuals, being also important factors for the long-term performance of populations (Hornemann et al. 2012, Heinken and Weber 2013). Aggressive anthropogenic actions along with the lack of real management measures and the inefficiency of conservation measures may lead to the disappearance of the *L. glauca* population from Calafindeşti before global warming can make its effects.

References:

1. Beldie, A. (1979), *Flora României. Determinator ilustrat al plantelor vasculare*, II. Edit. Acad. R.S.R., Bucureşti: 184-185.
2. Brys, R., Jacquemyn, H., Endels, P., Van Rossum, F., Hermy, M., Triest, L., De Bruyn, L., Blust, G.D.E. (2004), *Reduced reproductive success in small populations of the self-incompatible Primula vulgaris*. J. of Ecology, 92:5- 14.
3. Chater, A.O. (1976), *Ligularia* Cass. In: Tutin, T.G., Heywood, V.H., Burges, N.A., Valentine, D.H. (Eds.). *Flora Europaea, IV. Plantaginaceae to Compositae (and Rubiaceae)*. Cambridge University Press, UK: p. 205.
4. Chifu, T., Mânzu, C., Zamfirescu, O. (2006) *Flora şi vegetaţia Moldovei. II. Vegetaţia*. Edit. Univ. „Al. I. Cuza”, Iaşi.
5. Cişlariu, A.G., Mânzu, C.C., Zamfirache, M.M. (2018), *Habitat requirements and germination performance of some relict populations of Ligularia sibirica (Asteraceae) from Romania*. Plant Ecology and Evolution, 151 (3): 314-326. <https://doi.org/10.5091/plecevo.2018.1422>
6. Eriksson, O. (2000), *Functional roles of remnant plant populations in communities and ecosystems*. Glob. Ecol. Biogeogr. 9: 443-449. <https://doi.org/10.1046/j.1365-2699.2000.00215.x>

7. Greuter W. (2006+), *Compositae (pro parte majore)*. – In: Greuter W., Raab-Straube, E. von (ed.): *Compositae*. Euro+Med Plantbase - the information resource for Euro-Mediterranean plant diversity.
8. Hájek, M., Hájková, P., Apostolová, I., Horsák, M., Rozbrojová, Z., Sopotlieva, D., Velez, N. (2010), *The insecure future of Bulgarian refugial mires: economic progress versus Natura 2000*. Oryx, 44: 539-546. <https://doi.org/10.1017/S0030605310000530>
9. Hampe A, Petit R.J. (2005), *Conserving biodiversity under climate change: the rear edge matters*. Ecol. Lett., 8:461-467. <https://doi.org/10.1111/j.1461-0248.2005.00739.x>
10. Hampe, A., Jump, A.S. (2011), *Climate relicts: past, present, future*. Annual Review of Ecology, Evolution, and Systematics, 42: 313-333. <https://doi.org/10.1146/annurev-ecolsys-102710-145015>
11. Heinken, T., Weber, E. (2013), *Consequences of habitat fragmentation for plant species: do we know enough? Perspectives in Plant Ecology, Evolution and Systematics*, 15: 205-216. <https://doi.org/10.1016/j.ppees.2013.05.003>
12. Hobbs R.J., Yates C.J. (2003), *Impacts of ecosystem fragmentation on plant populations: generalizing the idiosyncratic*. Australian Journal of Botany 51: 471-488. <https://doi.org/10.1071/BT03037>
13. Hornemann, G., Weiss, G., Durka, W. (2012), *Reproductive fitness, population size and genetic variation in Muscari tenuiflorum (Hyacinthaceae): the role of temporal variation*. Flora, 207: 736-743. <https://doi.org/10.1016/j.flora.2012.07.005>
14. Horsak M., Chytry M., Pokryszko B.M., Danihelka J., Ermakov N., et al. (2010), *Habitats of relict terrestrial snails in southern Siberia: lessons for the reconstruction of palaeoenvironments of full-glacial Europe*. J. Biogeogr. 37: 1450-1462. <https://doi.org/10.1111/j.1365-2699.2010.02280.x>
15. Khela S. (2013), *Iris sibirica*. The IUCN Red List of Threatened Species 2013: e.T203236A2762502. Downloaded on 10 January 2019.
16. Liu S.W., Deng D.S., Liu J.Q. (1994), *Origin, evolution and distribution of Ligularia Cass. (Compositae)*. Acta Phytotaxonomica Sinica, 32: 514-525. (in Chinese with English abstract).
17. Mânzu C., Gherghel I., Zamfirescu Ș., Zamfirescu O., Roșca I., Strugariu A. (2013) *Current and future potential distribution of glacial relict Ligularia sibirica (Asteraceae) in Romania and temporal contribution of Natura 2000 to protect the species in light of global change*. Carpathian Journal of Earth and Environmental Sciences. 8 (2): 77-87.
18. Negrean G., Dihoru G. (2009), *Ligularia glauca (L.) O. Hoffm. in Engler&Prantl*, In Dihoru, G., Negrean, G. *Cartea Roșie a plantelor vasculare din România*. Edit. Acad. Rom., București: 316-317.
19. Opre, A. (2005), *Lista critică a plantelor vasculare din România*. Edit. Univ. „Al. I. Cuza”, Iași: p. 384.
20. Pojarkova A.I. (1961), *Ligularia Cass.* In: Șișkin, B.K., Bobrov, E.G. (Eds.). *Flora U.R.S.S.*, XXVI. Moskva. Akademia Nauk CCCP: 788-857. (In Russian).
21. Primack, R.B., Pătroescu, M., Rozyłowicz, L., Ioja, C. (2008), *Fundamentele conservării diversității biologice*. București. AGIR.
22. Ronikier M., Schneeweiss G.M., Schonswetter P. (2012) *The extreme disjunction between Beringia and Europe in Ranunculus glacialis s. l. (Ranunculaceae) does*

- not coincide with the deepest genetic split – a story of the importance of temperate mountain ranges in arctic-alpine phylogeography. *Molecular Ecology*. 21 (22): 5561-5578. <https://doi.org/10.1111/mec.12030>
23. Sârbu, A. (Ed.) (2007), *Arii speciale pentru protecția și conservarea plantelor în România*. Victor B. Victor, București, Romania.
24. Sârbu, A., Oprea, A., Sârbu, I. (2007), *Plants from the Habitat Directive – Annexe IIb, presents in Romania*. Buletinul Grădinii Botanice Iași, 14, 23-28.
25. Sârbu, I., Ștefan, N., Ivănescu, L., Mânzu, C. (2001) *Flora ilustrată a plantelor vasculare din estul României*, II. Edit. Univ. Al. I. Cuza Iași: 208-209.
26. Sârbu I., Ștefan N., Oprea A. (2013), *Plante vasculare din România: determinant ilustrat de teren*. Edit. Victor B Victor, București: p. 830.
27. Schleuning M., Matthies D. (2009), *Habitat change and plant demography: assessing the extinction risk of a formerly common grassland perennial*. *Conservation Biology* 23: 174-183. <https://doi.org/10.1111/j.1523-1739.2008.01054.x>
28. Seghediu T.G., Boşcaiu N. (1981), *Fînațele cu Ligularia glauca (L.) O. Hoffm. de la Calafindești (Jud. Suceava)*. Studii și comunicări de ocrotirea naturii, Suceava: 396-403.
28. Thuiller W, Albert C., Araújo MB, Berry P.M., Cabeza M., Guisan A., Hickler T., Midgley G.F., Paterson J., Schurr F.M., Sykes M.T., Zimmermann N.E. (2008) *Predicting global change impacts on plant species' distributions: Future challenges*. *Perspectives in Plant Ecology, Evolution and Systematics*. 9 (3-4): 137-152. <https://doi.org/10.1016/j.ppees.2007.09.004>
29. Țibu D. (1997), *Rezervația naturală de la Stejari-Horaț*. *Analele Bucovinei*, IV (1): 165-170.
30. Tomescu C.V. (2016), *Biodiversitatea florei și vegetației ecosistemelor naturale din bazinul râului Suceava*. Edit. Casa Cărții de Știință, Cluj-Napoca.
31. Tudorică, A. (1977), *Răspîndirea speciilor Ligularia glauca (L.) O. Hoffm. și Ligularia carpatica (Sch., N. et Ky.) Pojark. în flora României*. Studii și comunicări de ocrotirea naturii, Suceava: 189-193.
- <http://eunis.eea.europa.eu/sites/183856>
<http://www.anpm.ro/web/apm-suceava/arii-naturale-protejate-de-interes-national/>
http://www.mmediu.ro/beta/wp-content/uploads/2012/07/2012-07-26_legislatie_arii_protejate_legea5din2000amenajareteritoriuzoneprotejate.pdf