

To collect or not to collect? The ZA and ZAHO herbarium specimens of some frequent species

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Abstract

This paper presents representation of four frequent species in Croatia: *Fagus sylvatica* L., *Aposeris foetida* (L.) Less., *Hacquetia epipactis* (Scop.) DC. and *Sanicula europaea* L., in ZA and ZAHO herbaria collections. The revision and the analyses of the material are presented. The comparison between the recorded distribution data in the Flora Croatica Database and the distribution based on herbarium specimens is made. Since these are common and easily recognizable species they are rarely collected and their representation in the collections is inversely proportional to their number and distribution in nature.

Keywords: *Aposeris*, *Fagus*, *Hacquetia*, *Sanicula*, ZA, ZAHO

Rešetnik, I., Bešenić, M., Dujmović, L., Rubinić, M., Vrbaneć, Z. (2019): Sakupljati ili ne? Zastupljenost nekih čestih vrsta u ZA i ZAHO. Glas. Hrvat. bot. druš. 7(2): 47-54.

Sažetak

U radu je prikazana zastupljenost četiriju čestih vrsta u hrvatskoj flori: *Fagus sylvatica* L., *Aposeris foetida* (L.) Less., *Hacquetia epipactis* (Scop.) DC. i *Sanicula europaea* L., u sklopu herbarijskih zbirki ZA i ZAHO. Napravljena je revizija i analiza svih herbarijskih primjeraka. Učinjena je usporedba podataka o rasprostranjenosti tih vrsta u Flora Croatica bazi podataka s onima o njihovoj rasprostranjenosti prema herbarijskim primjercima. Budući da se radi o uobičajenim i lako prepoznatljivim biljkama primjerci se ne sakupljaju često te je njihova zastupljenost u herbarijskim zbirkama obrnuto proporcionalna njihovoj brojnosti i rasprostranjenosti u prirodi.

Ključne riječi: *Aposeris*, *Fagus*, *Hacquetia*, *Sanicula*, ZA, ZAHO

Introduction

The herbarium collections have for a long time been one of the primary sources of information for the distribution of plants. However, the collection of specific taxa has always been skewed towards either “more interesting” and frequently rarer and endemic species or towards morphologically more variable and often taxonomically more problematic taxa. As a consequence the common and taxonomically not intricate species are rarely collected as their identification in the field is straightforward and occurrence numerous.

The four species analysed in this paper are common representatives of Croatian forest vegetation and all belong to genera represented with only one species in the Croatian flora. *Fagus sylvatica* L. is the most abundant deciduous tree species of the European temperate zone. It is a highly competitive species over a broad range of environmental site conditions, frequently forming more or less monodominant stands. Its distribution extends from southern Europe to southern England and southern Sweden (Jalas & Suominen 1976). In Croatia it is the only member of the genus *Fagus*, while in the Eastern Europe and towards Asia Minor, *F. orientalis* Lipsky is also occurring. The other three investigated species are frequent beech forest understory species although the overall distributional ranges of two of them are smaller than the distribution of European beech. *Sanicula europaea* L. is one of the three representatives of this cosmopolitan genus in Europe (Hand 2011). It is distributed throughout Europe, while the two other European species are found on the margins of the continent (*S. azorica* Seub., an endemic of the Azores, and *Sanicula uralensis* Kleopow ex Kamelin, Czubarov & Shmakov occurring only in Eastern European Russia). *Aposeris foetida* (L.) Cass. ex Less. is an only member of the genus and is distributed in most of Europe, excluding the most northern and south-eastern parts (Greuter 2006). The only member of the genus *Hacquetia*, *H. epipactis* (Scop.) DC., has narrower distribution

and is found in central Europe, Apennine Peninsula and the western part of the Balkan Peninsula (Hand 2011). The Croatian populations thus represent the most southern populations of the species.

The aim of this paper is to provide the revision of four frequent forest species in the herbaria collections ZA and ZAHO in order to: 1) determine the number, origin and the age of herbarium sheets, and to 2) provide comparison between their recorded natural distributions in Croatia and the distribution data based on herbarium specimens.

Material and methods

In 2017 a detailed study of the species *Fagus sylvatica*, *Aposeris foetida*, *Hacquetia epipactis* and *Sanicula europaea* was made in herbarium collections ZA and ZAHO. During this process, all herbarium specimens were mounted onto new herbarium sheets and the original metadata from all herbarium labels were included in the Flora Croatica Database (FCD) (Nikolić 2018) as described in Šegota et al. (2017). Furthermore localities were georeferenced by using the GeoRef application (Croatian Agency for Environment and Nature 2018) and finally all specimens were scanned and imported in FCD. The systemized and digitalized specimens are freely available through the FCD portal (<https://hirc.botanic.hr/fcd>) and on the Herbarium ZA and ZAHO web site (<http://herbariumcroaticum.biol.pmf.hr/>).

Results

In total, 288 herbarium sheets were found within the two collections, with 167 sheets stored in ZA and 121 sheets stored in ZAHO (Table 1). The highest number of sheets, 96 in total, belonged to *H. epipactis* (47 and 49 in ZA and ZAHO, respectively) (Table 1). The herbarium specimens originate from 13 European countries and the majority of herbarium sheets were collected in Croatia (234 sheets i.e. 81%), followed by Macedonia (13 sheets) and

Slovenia (10 sheets). For ten herbarium specimens the collecting location was unknown. Regarding the Croatian territory, the collecting sites of all four species are mostly scattered within the north-western regions while the collection of herbarium specimens is lacking from the eastern and southern regions (Slavonia, Dalmatia, and Istria; Figs. 1-4). According to the location data on the herbarium labels it was possible to georeference 86% of herbarium sheets. The most productive collector of the studied herbarium material was Ivo Horvat (120 herbarium sheets, one herbarium sheet in ZAHO is without the collector name, date and locality), who is the only collector of the ZAHO collection. Ljudevit Rossi stored 61 herbarium sheets, Dragutin Hirc 15, while other 64 collectors contributed with less than seven herbarium sheets each. Twelve sheets, mostly from ZA, are lacking the information about

the collector(s) or the collector's name is illegible. In terms of collecting period, the majority of specimens were collected between 1900s and 1950s (Fig. 5), while only specimens from two sheets were collected since 2001 (specimens of *S. europaea*, collected in 2017 by V. Šegota, K. Husnjak Malovec and T. Vilović). Thirty six herbarium sheets lack data on collecting period. The average age of the collected specimens is approximately 96 years, with the oldest specimen of *F. sylvatica* dating from 1802 and collected in Germany by unknown collector.

Discussion

The detailed investigation of *Fagus sylvatica*, *Aposeris foetida*, *Hacquetia epipactis* and *Sanicula europaea* herbarium specimens stored in the ZA and ZAHO collections revealed that all material was correctly

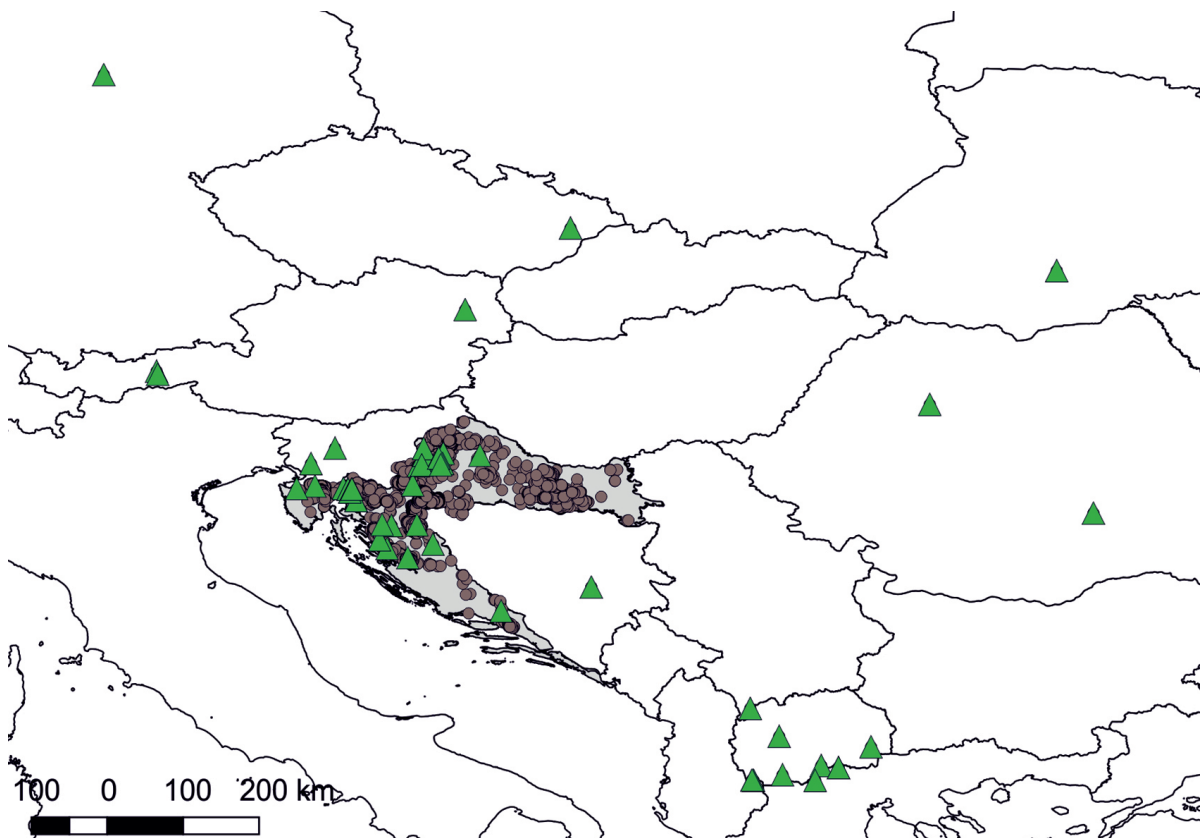


Figure 1. Distribution map of *Fagus sylvatica* from Croatia and neighbouring countries. Green triangles represent the localities from herbarium specimens of ZA and ZAHO collections, brown dots represent the literature, field and other observation data stored in FCD.

identified as it was anticipated. On some of the herbarium labels only the genus name was written but we suppose that this was most probably only the shorter way of writing the taxon name rather than the questionable identity of the collected specimens. Thus far, it was assumed that the oldest known specimens in ZA were from 1820s (M. Plazibat, pers. comm.), however, the *F. sylvatica* specimen dating from 1802 was found in ZA Herbarium generale. The ZA Herbarium generale consists of taxa generally not native in Croatia and was formed via exchange with mostly European botanists and herbaria during the 19th century. So far this part of the ZA received little attention although interesting specimens could be found there as demonstrated recently with genus *Fritillaria* revision (Šegota et al. 2017). Additionally, the single specimen of *Fagus orientalis* in ZA was also found there.

The total number of the collected herbarium specimens is not proportional to their number and distribution in nature (Figs 1-4). This is most visible in the example of *F. sylvatica* where out of 8,526 georeferenced localities in FCD, only 73 localities are based on herbarium specimens (Fig. 1). The distribution of collected specimens is also uneven. Although *F. sylvatica* is not uncommon forest species in eastern Croatia there is not a single herbarium specimens from that region in ZA and ZAHO. The specimens are also lacking from central Croatia and some parts of western Croatia. The eastern part of Croatia is also very poorly represented with herbarium specimens for other three taxa – with only one herbarium sheet of *A. foetida* and *S. europaea* and without any herbarium sheet of *H. epipactis* (Fig. 2-4). The similar situation is also visible for Moslavina, Dalmatia and Istria regions. This is

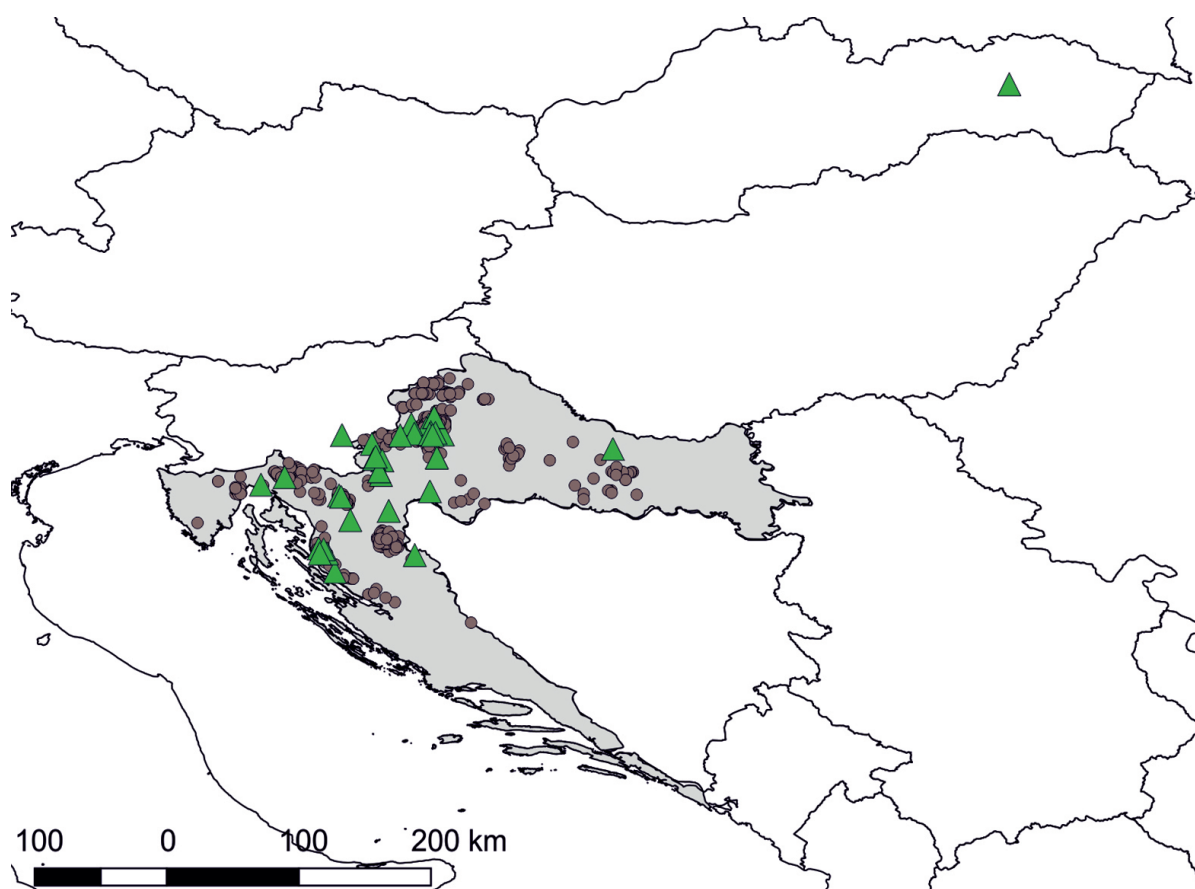


Figure 2. Distribution map of *Aposeris foetida* from Croatia and neighbouring countries. Green triangles represent the localities from herbarium specimens of ZA and ZAHO collections, brown dots represent the literature, field and other observation data stored in FCD.

especially important for taxa which have their distribution limits in Croatia, such as *H. epipactis*, and for which it would be essential to have herbarium specimens as confirmation for the most eastern and southern literature and field observations.

As these are all common members of Croatian forest vegetation one would perhaps anticipate their higher representation in the collections. The reason for this disproportion is most probably due to the fact that their identification in the field is straightforward and the occurrence is numerous therefore they are not morphologically and taxonomically intricate. This misbalance is not specific for ZA and ZAHO collections. If we compare the obtained numbers with the number of herbarium sheets available through some European virtual herbaria we can see the similar trend. For example, *F. sylvatica* is represented with 29 sheets in WU,

53 sheets in W and B, and 580 sheets in P (<https://herbarium.univie.ac.at>, <https://www.bgbm.org/en/herbarium>, <https://science.mnhn.fr>). We can find data for nine, 43, 11 and 153 sheets of *A. foetida*, three, eight, one and 108 sheets of *H. epipactis* and 10, 42, 59 and 863 sheets of *S. europaea* in WU, W, B and P herbaria, respectively. However, we should keep in mind that these collections are only partially available online and that these numbers are highly dependable on the digitalization status of the respected herbaria and thus the real number of herbarium sheets in the mentioned collections is most probably much higher. Nevertheless, we can at least assume that these common species are usually not on the priority lists for digitalization as this is usually reserved for the type material, older collections and rare and endemic species (i.e. Global Plants Initiative, <https://plants.jstor.org/>).

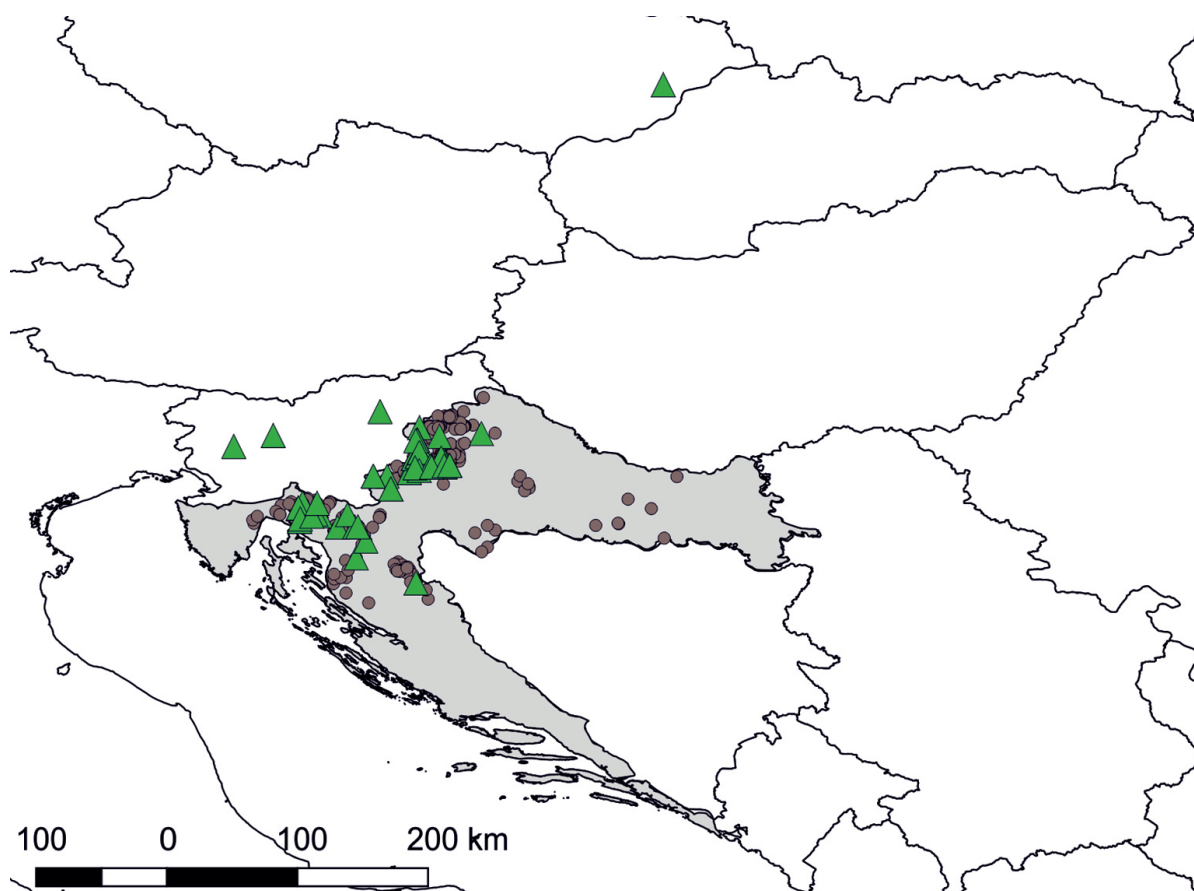


Figure 3. Distribution map of *Hacquetia epipactis* from Croatia and neighbouring countries. Green triangles represent the localities from herbarium specimens of ZA and ZAHO collections, brown dots represent the literature, field and other observation data stored in FCD.

The fact that the rarer, endemic and usually the more threatened species are sometimes oversampled because of their higher scientific value and that, accordingly, their number in the collections is similar or even higher than the number of common species is also visible through searches of herbaria collections (Garcillán & Ezcurra 2011, Minter et al. 2014). For example, *Fritillaria meleagris* L., a species listed as VU for Croatia (IUCN 2018) is in ZA and ZAHO represented with 108 herbarium sheets (37 and 71 in ZA and ZAHO, respectively; Šegota et al. 2017) which is more than the number of herbarium sheets of individual common species analysed in this paper (Table 1). The quick survey of the occurrence data available through GBIF portal (GBIF 2018) also offers some interesting findings. The tree species, *F. sylvatica*, is represented with 402,339 georeferenced occurrences, followed by 67,595 occurrences of *S. europaea*, 11,434 occurrences of *A. foetida* and only 89 occurrences of *H. epipactis*.

Comparably, the rarer *F. meleagris* has 8,997 georeferenced occurrences and the Natura 2000 species *Marsilea quadrifolia* L. has 2,926 georeferenced occurrences. This bias in collection of herbarium specimens and data gathering in general could have visible consequences in today's big data analyses used for various environmental surveys. In recent years the number of studies actively using the herbarium specimens in a variety of research themes has increased. Together with traditional taxonomic research and numerous phylogenetic studies (e.g. Kolanowska et al. 2016), herbarium specimens have been used in the development of inventories of the spatial and temporal distributions of species (e.g. Fuentes et al. 2013, Grass et al. 2014), studies of phylogeographic structure of invasive plants (e.g. Martin et al. 2014), or for studying past pathogens or ancient alleles contained in herbarium specimens (Besnard et al. 2014, Yoshida et al. 2014). A larger number of herbarium specimens, often

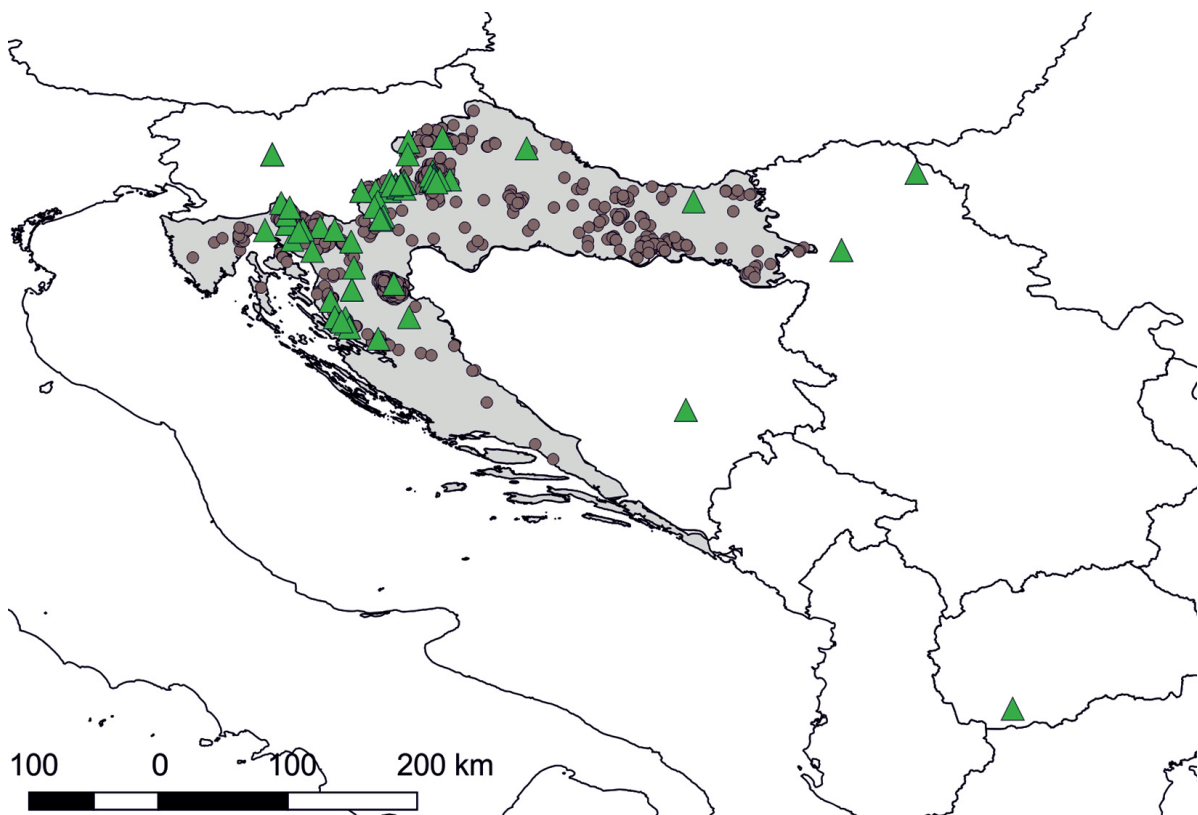
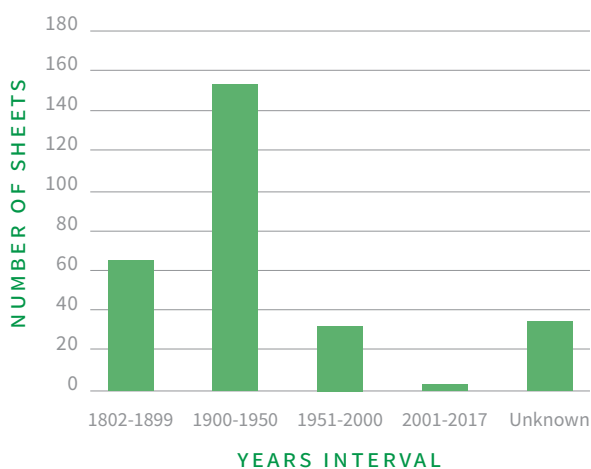


Figure 4. Distribution map of *Sanicula europaea* from Croatia and neighbouring countries. Green triangles represent the localities from herbarium specimens of ZA and ZAHO collections, brown dots represent the literature, field and other observation data stored in FCD.

Table 1. The number of herbarium sheets for each taxon across the studied collections.

| | ZA | ZAHO | total |
|--|------------|------------|------------|
| <i>Fagus sylvatica</i> L. | 41 | 46 | 87 |
| <i>Aposeris foetida</i> (L.) Less. | 35 | 7 | 42 |
| <i>Hacquetia epipactis</i> (Scop.) DC. | 47 | 49 | 96 |
| <i>Sanicula europaea</i> L. | 44 | 19 | 63 |
| total | 167 | 121 | 288 |

from different vegetation periods and from the same locations, is needed to address questions of phenological shifts from both regional and phylogenetic perspectives (see review by Willis et al. 2017) and in modelling the effects of environmental changes on biodiversity (e.g. Beaman & Cellinese 2012). For studies like these the absence of herbarium material is a crucial limiting factor and even when it exists it is usually burdened with sampling bias. The survey of large scale digitalization of Australian, South African and USA New England regional floras identified numerous shared biases, such as: collection of specimens close to roads

**Figure 5.** Temporal distribution of the herbarium specimens from ZA and ZAHO based on collection periods.

and herbaria, more frequent collection during biological spring and summer, threatened species collected less frequently, specimens of close relatives collected in similar numbers, and finally, the large percentage of specimens collected by very few botanists who with their associated preferences and idiosyncrasies shaped patterns of collections bias via “founder effect” (Daru et al. 2018).

Despite the potential illustrated by previous studies for herbarium specimens to vastly expand our understanding of plant biology (Lavoie 2013), the collections are threatened by constraints in funding, staff and space. The lack of storage space is occurring in ZA and ZAHO collections as well as in the majority of Balkan herbaria (Jogan 2018) and has directly influenced the intensity of collecting new specimens in recent decades. Nevertheless, in order to ensure that herbaria continue to be vital centres for research, the herbarium staff and collectors should focus on underrepresented taxa and sampling sites as well as to maintain the consistent temporal and spatial specimen gathering of all regional floras. The collection of plant specimens, and even of the most common taxa, in collaboration with digitization and technological breakthroughs in molecular biology, will facilitate the research opportunities not yet imagined.

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