

INULA TAXA CONSERVED IN THE “ALEXANDRU BELDIE” HERBARIUM

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Received 22 February 2021; accepted 3 August 2021

ABSTRACT

This study offers insights into the inventory of the Inula genus stored in the „Al. Bedlie” Herbarium, as well as a short characterization of the most important taxa. 174 vouchers have been analyzed, resulting in 25 different taxa (17 accepted species, 2 intraspecific units, 2 hybrids and 4 non-validated taxa). Special attention should be given to I. bifrons a species with a rare distribution across the country. The most notable contribution in preserving this genus was made by the botanist C.C. Georgescu. All pressed plant specimens were in very well conservation conditions making them a possible subject for future studies.

KEY WORDS: *Inula, herbarium, voucher, conservation, Romania*

INTRODUCTION

Herbarium collections represent an important research source in documenting and evaluating biodiversity (Carine et al. 2018). One of the most relevant botanical collections in Romania is the „Alexandru Beldie” Herbarium. To date, it comprises approximately 40000 herbarium specimens that are stored in the headquarters of the National Institute of Research and Development in Forestry „Marin Drăcea”. The herbarium is recognized internationally being incorporated in the *Index Herbariorum* database system under the BUCF acronym (Dincă et al., 2018). The most recent inventories show a wide spectrum of species: *Alnus* (Dincă et al., 2019), *Asperula* (Pleșca et al., 2020), *Rubus* (Dincă et al., 2018), *Alyssum* (Cântar et al., 2018), *Cornus* (Vechiu et al., 2018), and *Bromus* (Tudor et al., 2019). These species are widespread in Romania (Bucegi-Crisan et al., 2020; Buzau-Crisan et al., 2020; former Vlasca County - Ciontu et al., 2019), as well as in other countries or territories (Balkans -Kachova et al., 2020; Moldavia -Vasile et al., 2019).

Inula genus (*Asterales*, *Asteraceae*) includes around 120 species (Akcin and Akcin 2017, Abu-Lafi et al., 2018) widespread in Europe (especially in the Mediterranean region), Asia and Africa (Toma et al. 2010).

Previously, 9 species and 5 hybrids were described in the flora of our country (Nyárády 1964). However, modern revisions recognize 10 species (Ciocârlan 2009) and 11 hybrids (Oprea 2005).

Recently studies on the taxonomy of the *Inula* genus have proposed the transfer of some of its species in the re-circumscribed *Pentanema* Cass. (Gutiérrez-Larruscain *et al.*, 2019). This revision is suggested for 25 species of the genus located on the territories of Hungary, Romania and Ukraine (Boiko *et al.* 2018). However, in Romania, these species haven't received *Pentanema* names.

The genus is characterized by solitary, corymb-shaped or paniculate anthodia. The involucre is hemispherical with nested leaflets, the inner ones with a colored tip, and the outer ones foliate. The disc flowers are hermaphroditic, tubular, and fertile. The female ones are situated on the edge, are ligulate, and yellow at the tip with 3-5 teeth. As for the receptacle, it is flat and naked. The base of the anthers has an extension. The fruit is represented by a cylindrical achene that may contain stripes.

In this study, we focused on the *Inula* genus preserved in the BUCF Herbarium, in order to create an updated database, as well as to provide a short description of its main representatives.

MATERIALS AND METHODS

All available vouchers from the *Inula* genus were centralized according to the information listed in the labels as showed in the following excerpt (table 1).

TABLE 1. *Inula* Inventory (partially from the database)

Drawer no.	Plate no.	Herbarium/ Botanic Collection/ Institution	Species Name	Harvesting Date	Harvesting Place	Collected/ Determined by:	Conservation degree (1..4)
197	4	Polytechnic's School Herbarium/Bucharest/Botanic Laboratory	<i>Inula bifrons</i> L.	1940.08.17	Piatra Cetei, 1250m. Alba County	C.C. Georgescu, T. Bunca	1
197	16	Flora Romaniae exsiccata/ Museum botanicum Universitatis Cluj	<i>Inula britannica</i> L.	1938.09.18	Făget Forest, Cluj County 600 m	E. Ghișa	1
197	40	Polytechnic's School Herbarium/Bucharest/Botanic Laboratory	<i>Inula britannica</i> var. <i>angustifolia</i> Marss	1936.08.02	Durastor District, Bobla Forest	Cretzoiu, Neuwirth	1
197	52	ICEF, Forestry Research and Experimentation Institute	<i>Inula conyza</i> (Grie ss.) DC.	1938.08.23	Liubcova, Caraș County	S. Pașcovschi	1
197	68	Polytechnic's School Herbarium/Bucharest/Botanic Laboratory	<i>Inula ensifolia</i> L.	1951.08.01	Bucegi, Jepii Mici	Al. Beldie	1
197	69	Polytechnic's School Herbarium/Bucharest/Botanic Laboratory	<i>Inula ensifolia</i> L. var. <i>lancifolia</i> Beck	1931.07.09	Hunedoara County, V. Vitalma	C.C. Georgescu, P. Cretzoiu	1
197	75	Polytechnic's School Herbarium/Bucharest/Botanic Laboratory	<i>Inula hybrida</i> Bau mg.	1853.01.01	-	Woeff	1

Drawer no.	Plate no.	Herbarium/ Botanic Collection/ Institution	Species Name	Harvesting Date	Harvesting Place	Collected/ Determined by:	Conservation degree (1..4)
197	81	Forestry Research Institute's Herbarium/ Agriculture and Silviculture Ministry	<i>Inula germanica</i> L.	1936.07.10	Lehliu	C.C. Georgescu	1
197	99	Editio Horti Botanici Imperialis Petropolitani N.A. Busch, B.B. Marcowicz, G.N. Woronow	<i>Inula orientalis</i> Lam.	1907.07.24	prov. Kuban	Elis. Busch., N. Busch	1
198	9	Forestry Research Institute's Herbarium/ Agriculture and Silviculture Ministry	<i>Inula hirta</i> L.	1934.07.13	Brătăsancea Forest, Brănești	Paul Cretzoiu	1
198	21	Flora Romaniae exsiccata/A Museo botanicum Universitatis Clusienensis Edita	<i>Inula helenium</i> L.	1940.06.23	Târnavă Mică District, Bazna 350 m	Al.Borza	1
198	47	Forestry Research Institute's Herbarium/ Agriculture and Silviculture Ministry	<i>Inula salicina</i> L.	1936.07.26	Eforie beach	I. Tatareanu	1
198	64	Flora exsiccata austro-hungarica	<i>Inula aspera</i> Poir.	1881.01.01	Budapest	Borbás	1

Additionally, we established the degree of conservation for each voucher by using the following scale: 1 = very well preserved plant, kept in its entirety and correctly attached to the voucher, 2 = plant detached from the voucher, with detached parts but still present, 3 = plant detached from the voucher, with missing parts and 4 = detached and fragmented plant, with over 50% of its parts missing (Vasile et al., 2019; Dincă et al., 2020).

Moreover, where necessary, the scientific names were updated following *The Plant List* international database (<http://theplantlist.org>).

Furthermore, a short chorological and morphological characterization of the most important taxa was realized.

RESULTS AND DISCUSSIONS

The final data set included 174 entries (vouchers) among which were found 17 species (*Inula aspera* Poir., *I. germanica* L., *I. hirta* L., *I. montana* L., *I. oculus-Christi* L., *I. spiraeifolia* L., *I. aschersoniana* Janka, *I. bifrons* L., *I. britannica* L., *I. conyza* (Griess.) DC., *I. ensifolia* L., *I. helenioides* DC., *I. orientalis* Lam., *I. salicina* L., *I. helenium* L., *I. candida* (L.) Cass. and *I. stricta* Tausch), 2 intraspecific units (*I. britannica* var. *angustifolia* Marss and *I. ensifolia* L. var. *lancifolia* Beck.), 2 hybrids (*I. hybrida* Baumg and *I. media* M.B.), and also 3 species (*I. denticulata* Borbás, *I. hirsuta* Vitman and *I. pseudosalicina* Simkov. ex

Beck) and 1 hybrid (*I. semiamplexicaulis* Reut.) that do not have a validated status yet.

The most frequently occurring recordings were registered for *I. britannica* (46 vouchers), *I. hirta* (23 vouchers), respectively *I. germanica* L. and *I. salicina* (both with 22 vouchers each) (figure 1). Together they cumulate 65% of the total number of vouchers.

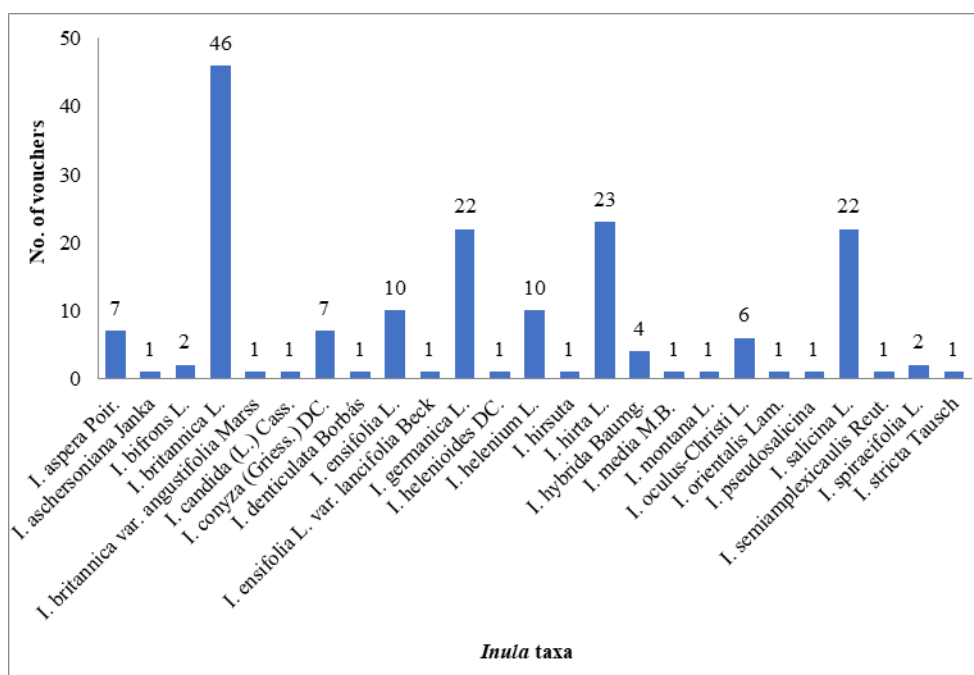


FIGURE 1. Distribution of vouchers number by taxa

Furthermore, we found 2 vouchers belonging to *I. bifrons*, a species classified as rare according to Oltean et al. (1994), but which is not mentioned any longer by Dihoru and Negrean (2009). The *I. bifrons* samples were harvested from Târnavelor Plateau (Oarba-Lechința forest, Mureș County) and from the Apuseni Mountains (Piatra Ceții Mountain, Alba County).

The majority of taxa represented only by 1-2 vouchers, come from exchanges with other botanical institutions and are not indigenous to our country (*I. aschersoniana*, *I. candida*, *I. denticulata*, *I. helenioides*, *I. hirsuta*, *I. montana*, *I. orientalis*, *I. pseudosalicina*, *I. semiamplexicaulis*, *I. stricta*).

Inula britannica L. (figure 2) is one of the most popular species of the genus, distributed mostly in Europe and Asia (Todorova et al. 2017). It has erect

stems and can reach 10-75 cm in height. The leaves are sessile, lanceolate to elliptical, sparsely pubescent to glabrate on the adaxial surface and densely villous on the abaxial surface. One particular characteristic is the absence of basal leaves during flowering. The flowers are yellow, solitary or grouped in clusters of two to three. The flowering time extends from July to September. It is commonly encountered through wet habitats, streams, meadows, roadsides and grasslands.

The species has a wide variability, having recorded a high number of intraspecific forms in the Romanian flora (Nyardy 1964), like: var. *vulgaris* Beck., f. *elliptica* Nyar, f. *viridis* Wahlbg., f. *subtomentosa* Schur., var. *angustifolia* Marss., var. *rupestris* Gris. et Sch., var. *monocephala* Schur and var. *discodea* Koch Syn.

Among its lower taxa, only var. *angustifolia* is present in the herbarium, being represented by a single specimen harvested from the Bobla forest (currently located on the territory of Bulgaria). In comparison with the typical form, *I. britannica* var. *angustifolia* has narrowly linear leaves and densely arranged capitula.

***Inula hirta* L.** (figure 3) is also a quite common perennial herb, having an ascending stem with rough hairs. The upper leaves are sessile, amplexicaul and have a lanceolate shape, while the lower ones are narrower and more elliptical. The flowers are grouped in a terminal, large anthodium (Afemei et al. 2011). The flowering takes place between June and September. The plant appears through dry meadows, pastures, forest edges and vineyards with calcium-rich soils (Raabová et al. 2011).



FIGURE 2. *Inula britannica*



FIGURE 3. *Inula hirta*

Inula germanica L. (figure 4) can be found in the central, southeastern and eastern parts of Europe as well as in the Caucasus and West Asia (Trejgell *et al.* 2018). In countries like Poland (Mirek *et al.* 2006) and Austria (Alder *et al.* 1994) it is listed as a critically endangered species. It usually grows up to 30-60 cm in height and has alternate, hairy, aromatic leaves. The anthodium is cylindrical and has almost 1 cm in diameter. The marginal flowers are ligulate, slightly longer than those of the disc. The flowering period lasts from July and August. It prefers sunny places and grows on dry grasslands.

Inula salicina L. is a perennial hemicryptophyte herb with a Eurasian distribution area (Pînzaru *et al.* 2020). The stem is 20-80 cm high, mostly glabrous. The leaves are glabrous, lanceolate, or narrowly lanceolate with a cordate base and an acute attenuated slow apex. The upper part presents a prominent reticulated nervation. During flowering (June to September) the anthodia can reach 2-5 cm in diameter. The species vegetates best on calcareous soils through meadows, glades and forest clearings.



FIGURE 4. *Inula germanica*



FIGURE 5. *Inula bifrons*

Inula bifrons L. (figure 5) is found rarely across the southern parts of Europe (de Medeiros *et al.* 2018), including Spain (central part), France (south-eastern part), Italy (northern part) and the Balkan Peninsula (Vincete 2010, Ivanova

et al. 2020). In Romania, according to the Red list of Superior plants (Olteanu et al. 1994), it is considered a rare species and was found predominantly in the central parts of the country (figure 6). It can be recognized by its decurrent leaves and small radiate ray-flowers (Anderberg 1991), which are always shorter than the internal involucre bracts (Gutiérrez-Larruscain et al. 2018). Additionally, it is entirely covered by glandular hairs. The flowers are odoriferous and bloom between July and August. It vegetates on sunny shores with bushes and forest edges.

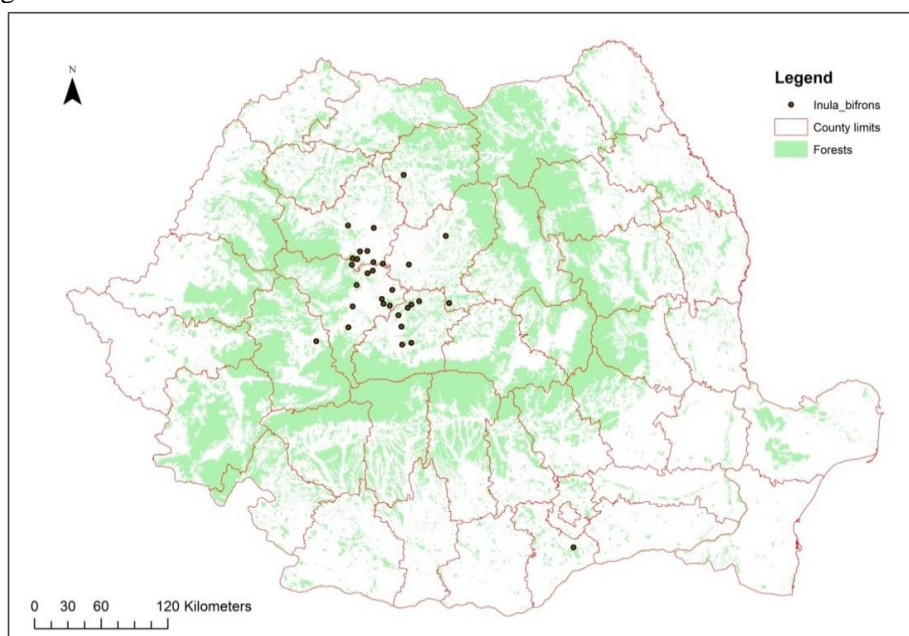


FIGURE 6. Known occurrences of *Inula bifrons* L. in Romania

Inula helenium L. is a hardy species native to Europe and East Asia (Konishi et al. 2002). It is a well-known species characterized by the following morphological features: thick root, pubescent stem up to 250 tall, large and elliptic leaves with thin hairs on the upper side and thick lanate on the underside, flowers with very broad and short involucre bracts. It is present from June to September through wet meadows, streamsides, and forests.

I. x hybrida Baumg. is a natural hybrid driven from *I. ensifolia* and *I. germanica*. The leaves have a narrow lanceolate shape, slightly acuminate which make it similar to *I. ensifolia*. The secondary nerves are obvious and almost parallel to the middle one. The involucre leaflets have a fairly obvious green appendix. The leaves are also wider, and short-acute, resembling *I. germanica*.

Abaxially, leaves are more or less pubescent. The anthodia are smaller. It is very common in grassy and sunny areas.

I. x media B.C. is a hybrid between *I. germanica* and *I. salicifolia*. It resembles *I. germanica* through its leaves that are not shiny, slightly acute with sparse hairs, and anthodia that are more numerous in number. On the other side, it is similar to *I. salicifolia* in anthodes which are larger, with small and green at the tip of the leaflets. The venation of the leaves is more accentuated. It can be found on sunny meadows in association with the species from which the hybridization resulted. Unlike the previous hybrid, it is rarer.

Conservation degree. After examining the conservation status, 164 vouchers (94%) contained very well-preserved plants, kept in their entirety and correctly attached to the voucher (figure 7). All vouchers which were scored with a second conservation degree are over 80 years old, this being a probable cause of their slight deterioration.

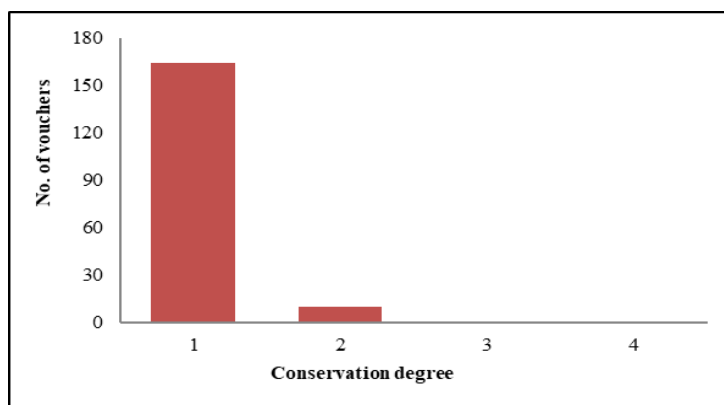


FIGURE 7. Conservation degree of *Inula* vouchers from “Al. Beldie” Herbarium

Harvesting periods. The interval in which the plants were harvested extends over 115 years, most samples being harvested between 1926-1950 (64%) (figure 8). The oldest voucher dates back to 1851 and contains an *I. pseudosalicina* specimen from the Polytechnic’s School Herbarium/Bucharest/Botanic Laboratory, collected and determined by the famous botanist Wolff. Another voucher exists from the same year, representing an *I. germanica* specimen, also collected by the previously-mentioned botanist and received as well through an exchange from the Polytechnic’s School Herbarium/Bucharest/Botanic Laboratory. On the other hand, the most recent specimen was harvested in 1993 from Oltenița Forest (Ilfov District) and represents an *I. conyza* exemplar which belongs to the original collection.

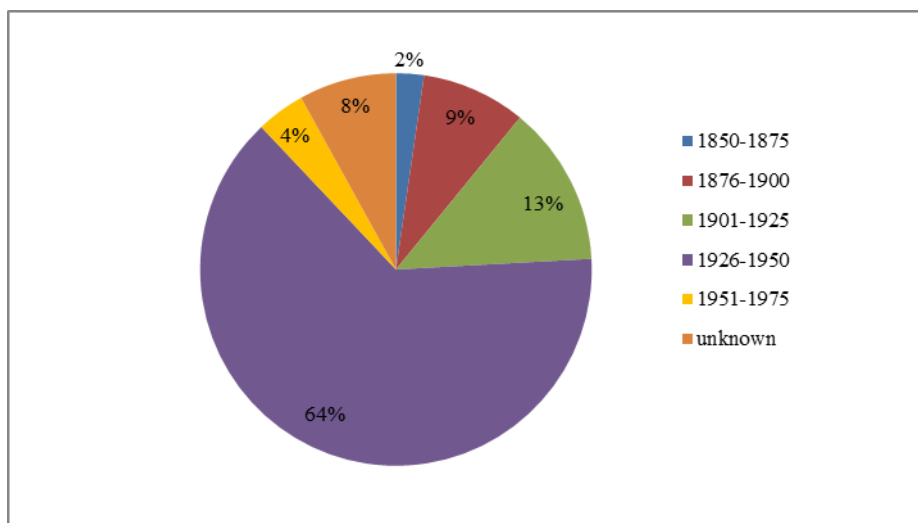


FIGURE 8. Harvesting periods of *Inula* plants preserved in “Al. Beldie” Herbarium

Most of the preserved *Inula* plants found in the collection are from Romania (80%) (figure 9).

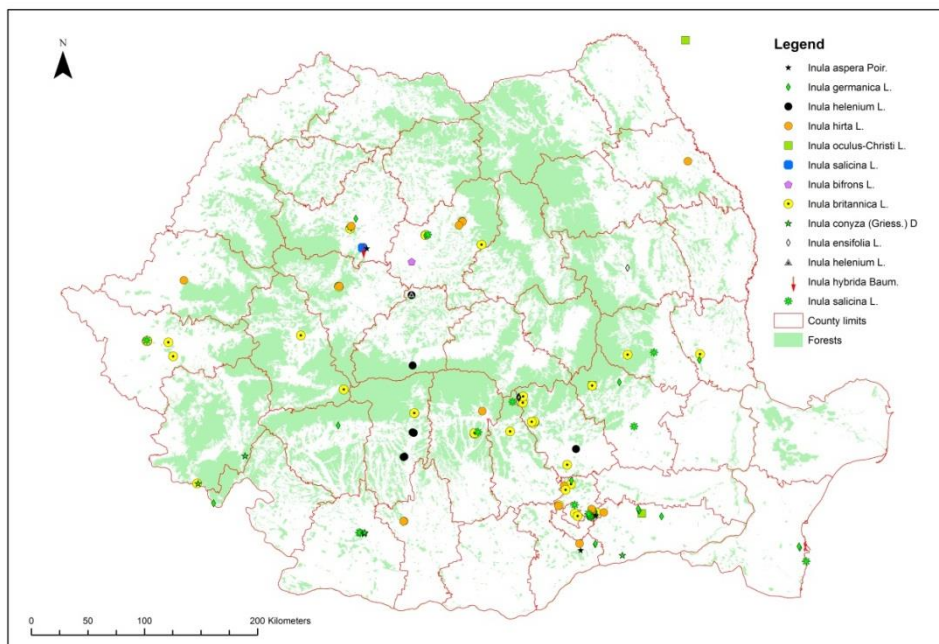


FIGURE 9. Harvesting places for *Inula* species in Romania

These are complemented by those collected from former territories that formed Romania in various historical periods (Bessarabia, Northern Bukovina and the Southern Dobruja - 8%). The place of collection is not mentioned for 8% of the preserved vouchers, Consequently, the places where the plants were collected are closely related to the activity of botanists who have contributed to the diversification of this collection. Among them we mention C.C. Georgescu with a number of 21 specimens collected, complemented by 15 specimens collected together with other colleagues (Morariu I., Onică M., Crețoiu P., Bunea T.), amounting to 21% of the total *Inula* specimens. Also, important contributions were made by At. Haralamb (14 vouchers), S. Pașcovshi (14 vouchers), Al. Beldie (6 vouchers) and Al. Borza (6 vouchers).

CONCLUSIONS

Inula L. genus stored in the “Al. Beldie” Herbarium includes up to 25 taxa, including independent species, varieties, hybrids and also taxa with unclear status. The most numerous recordings were registered for species that are native to our country. As expected, the non-native species are poorly represented in the collection, as they were obtained through collaborations with other specialized institutions. Donations and exchanges with different herbaria offered not only comparative materials but also have contributed to enlarge the collection with specimens from other parts of the European continent.

Apart from the botanical value, the collection also has a historical value, comprising specimens collected from the middle of the 19th century until the end of the 20th century, by famous botanical experts.

The entire *Inula* collection is preserved in very good conditions, so it can be considered as a scientific resource for future studies.

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PLEȘCA et al: Inula taxa conserved in the “Alexandru Beldie” Herbarium

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