THE SERIES OF PLANTS FROM EQUISETUM GENUS PRESERVED IN "ALEXANDRU BELDIE " HERBARIUM, ROMANIA

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Abstract. *The collection of vascular plants from Equisetum Genus, contains approximatively 19th different taxa, with distinct appearance, belonging of Pteridophyta division, Equisetopsida class. As such, the goal of the present article is to understanding the modality of preserving these species into the "Alexandru Beldie" Herbarium. The current state of the article in the field of research, highlights the botanical values from the past, with implications in present through the ways of promoting the interests of national patrimony. As materials, it was used 88 vouchers harvested in period 1852-1993, mainly from Southern Carpathians, Bucegi Mountains group. The adopted methods were focused on the determination of conservation degree, period of harvesting and so on. The degree of novelty is represented by the multitude of vouchers collected from the entire Europe, by the famous botanists during the interbellic period. The results are based on the inventory of plants from Equisetum Genus preserved in "Al. Beldie" Herbarium, 19 species were identified, namely in order: Equisetum arvense L., Equisetum heleocharis Ehrh., Equisetum hyemale L., Equisetum limosum L., Equisetum maximum Lam., Equisetum palustre L., Equisetum pratense L., Equisetum ramosissimum Desf., Equisetum scirpoides Michx., Equisetum sylvaticum L.., Equisetum telmateia Ehrh., Equisetum trachyodon A. Br, and Equisetum variegatum Schleich. The most number of recordings were found for Equisetum arvense (19 vouchers) and Equisetum hyemale (17 vouchers), followed by Equisetum paluste L. (9 vouchers), Equisetum sylvaticum (9 vouchers), Equisetum linosum L. (5 vouchers) and Equisetum maximum Lam. (4 vouchers). The research limitations are conditioned by the identification of the habitats and the lack of Equisetum species from the Romanian flora which not reflect the possibility to discover the new taxa and how to protect them by damages. It's important to have knowledge in recognising the species, for further research studies which are not implemented yet.*

Keywords*: conservation degree, Equisetum genus, taxa, vascular plant, voucher.*

INTRODUCTION

Equisetum Genus belongs to the *PTERIDOPHYTA* Phylum that includes approximately 15 species. In addition, this is the only existant of *Equisetopsida* Class. *Equisetum* Genus is the only representative of this vascular plant subdivision, becoming of great interest to botanists (HAUKE, 1979). They have focused on understanding the evolution of these vascular plants, especially for interpreting *Equisetophytina* fossils (*Sphenopsida*). Furthermore, other botanists have studied the capacity of these plants to deposit silicon (HAUKE, 1979). Numerous researches on some species of the genus Equisetum (*Equisetum arvense* L., *Equisetum telmateia* Ehrh) have captured the storage capacity of flavonoids, phenolic acids, antioxidant capacity and histo-anatomical characteristics (PALLAG *ET AL*., 2016). The sculptural silicon elements differ based on their measure, location and location of the peak and stem and branch internodes (FEOKTISTOV AND GUREYEVA, 2016). Plants have a distinct appearance, growing in dense clusters. The stems are sometimes ramified, with branches that appear on the articulations between segments. For example, *Equisetum arvense* L. has very small leaves named microphils, that are usually non-photosynthetic and hard to detect at some species. The stem internodes contain an empty slime surrounded by small empty canals called vallecular and carinal canals, strongly connected to xylem and phloem (KNOWLTON, 2012). The circulation occurs through the trachea canals

(perfect wood vessel) and through tracheae (liberian vases or winnows tubes). The sporophyte or diploid life cycle phase is predominant for *Equisetum* Genus and is represented by the herbaceous stems described above. The strobili structures from the peak of fertile sprouts host developing haploid spores (KNOWLTON, 2012). „Marin Drăcea" National Institute for Forest Research and Development from Bucharest hosts a herbarium created in 1929, "Alexandru Beldie" Herbarium. Inscribed in Index Herbariorum and having the international BUCF code, the herbarium contains approximately 40.000 vouchers (DINCĂ *ET AL*., 2018; VASILE *ET AL*., 2019; CIONTU AND DINCĂ, 2019; KACHOVA *ET AL*., 2020). From the species presented in this herbarium we mention: the 42 species of *Alnus* genus (DINCĂ AND PETICILĂ, 2019), 33 *Orobanche* (SCĂRLĂTESCU *ET AL.*, 2017), the 25 species of *Asperula* genus (PLEȘCA *ET AL*., 2020), the 65 species of *Rubus* genus (DINCĂ *ET AL*., 2018), 29 *Allysum* species (CÂNTAR *ET AL.*, 2018), the 58 species of *Cornus* genus (VECHIU AND DINCĂ, 2019), the 130 species of *Campanula* genus (DINCĂ AND VECHIU, 2020), and the 36 species of *Bromus* genus (TUDOR AND DINCĂ, 2019).

MATERIAL AND METHODS

The study material was comprised of 88 vouchers belonging to the *Equisetum* Genus. The first stage was to identify each voucher based on the information contained on each label and then create an electronic data base that allows for further interpretations. At the same time, the conservation degree of each species was evaluated on a scale from 1 to 4, based on the following criteria: well conserved plant, entire, correctly attached to the voucher =1, plant detached from the voucher, with detached parts but present =2, plat detached from the voucher, with missing parts = 3, or detached and fragmented plant, with over 50% parts missing = 4 (VASILE *ET AL*., 2017). Subsequently, the scientific name was compared with international data bases and updated according to *The Plant List* (http://www.theplantlist.org/). A data base was obtained as an end result, with the following recordings: drawer number, voucher number, scientific name, collection to which it belongs, harvesting place, the name of the collector/person who has identified the plant and the conservation degree (*Table 1*). The bibliographic study was used as a study method, followed by the analysis of conserved specimens.

Table 1

Equisetum Genus Inventory (excerpt from the data base)

Drawer number	Voucher number	Herbarium/ Botanical Collection/ Institution	Species name	Harvesting Date	Harvesting Place	Collected/ Determined by:	Conservation Degree (1-4)
153	82	Al. Beldie, Herbarium București	*Equisetum arvense L.*	1947.08.02.	Glove of the Goat	Al. Beldie	1
153	50	Bucharest's Polytechnics School Herbarium/ Botanic Laboratory	*Equisetum heleocharis Ehrh.*	1937.05.26.	Maramureș Middle Vișeu	A. Coman	2
153	53	Forestry Research Institute's Herbarium / Agriculture and Forestry Ministry	*Equisetum hyemale L.*	1955.09.02.	Bucegi, Jepii Mici	Al. Beldie	2
153	46	Al. Beldie Herbarium, București	*Equisetum limosum L.*	1948.11.30.	Bucegi, V. Râșnoavei	Al. Beldie	1

153	6	Al. Beldie Herbarium, București	*Equisetum maximum Lam.*	1948.06.20.	Bucegi: V. Dorului Source	Al. Beldie	2
153	34	ICEF, Forestry Research and Experimentation Institute	*Equisetum palustre L.*	1954.06.12.	Sinaia	Al. Beldie	1
153	33	Bucharest's Polytechnics School Herbarium/ Botanic Laboratory	*Equisetum pratense Ehrh.*	1949.08.11.	Bucegi	Al. Beldie	1
153	35	Bucharest's Polytechnics School Herbarium/ Botanic Laboratory	*Equisetum pratense L.*	1946.08.01.	Bucegi, Jepii Mici	Al. Beldie	2
153	28	Museum Botanicum Universitatis, Cluj / Flora Romaniae exsiccata	*Equisetum ramosissimum Desf.*	1923.008.11.	Transilvania, distr. Târnava Mică	Al. Borza, I. Pop	2
153	22	Dr. C. Baenitz, Herbarium Europaeum	*Equisetum scirpoides Michx. V. Decumbens B.*	1992.08.04.	Kongsvold	C. Baenitz	3
153	12	Al. Beldie Herbarium, București	*Equisetum sylvaticum L.*	1947.08.04.	Bucegi, V. Râșnoavei	Al. Beldie	3
153	11	Bucharest's Polytechnics School Herbarium/ Botanic Laboratory	*Equisetum telmateia Ehrh.*	1937.02.19.	Vălenii de Munte	Al. Beldie	2
153	5	Al. Beldie Herbarium, București	*Equisetum variegatum Schleich.*	1948.05.24.	Bucegi, V. Râșnoavei	Al. Beldie	1

RESULTS AND DISCUSSIONS

Based on the inventory of *Equisetum* conserved in "Al. Beldie" Herbarium, 19 species were identified, namely: *Equisetum arvense* L., *Equisetum heleocharis* Ehrh., *Equisetum hyemale* L., *Equisetum limosum* L., *Equisetum maximum* Lam., *Equisetum palustre* L., *Equisetum pratense* L., *Equisetum ramosissimum* Desf., *Equisetum scirpoides* Michx., *Equisetum sylvaticum* L.., *Equisetum telmateia* Ehrh., *Equisetum trachyodon* A. Br, *and Equisetum variegatum* Schleich. The most number of recordings were found for *Equisetum arvense* (19 vouchers) and *Equisetum hyemale* (17 vouchers), followed by *Equisetum paluste L.* (9 vouchers), *Equisetum sylvaticum* (9 vouchers), *Equisetum linosum* L. (5 vouchers) and *Equisetum maximum* Lam. (4 vouchers).

Equisetum pratense Ehrh. (figure 1) is a species with a rhizome root that has tubercles, firstly described in the Miocene, at Luhe, Yunnan Province from South-West China. It can usually be found in forests with tall trees or very dense foliage that can offer shadow (LING *et. al*., 2006). In addition, it tends to grow closer to rivers or ponds. The rhizomes are represented by a multitude of nodes and internodes on which one up to four tubercles can grow in clusters. Through their presence, the tubercles rhizomes indicate that their inhumation took place during

late autumn or winter. As such, species from this category and their fossils showcase climatic tolerance and similar phonologic characteristics (LING *ET. AL*., 2006). *Equisetum pratense* Ehrh. was also used in obtaining hybrids such as: *Equisetum* × *sergijevskianum* (*E. palustre* L. × *E. pratense* Ehrh.) or *Equisetum x mildeanum* Rothm. (*E. pratense* Ehrh.x *E. sylvaticum* L.) etc.

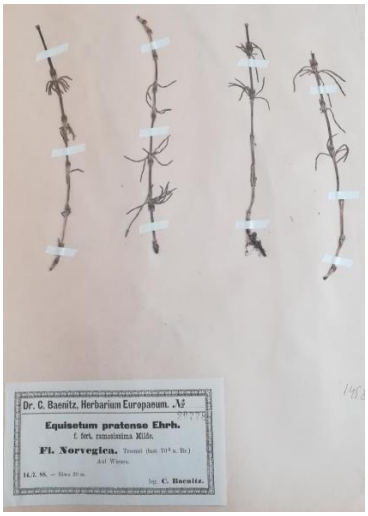

Figure 1. *Equisetum pratense* Ehrh.

Figure 2. *Equisetum limosum* L.

Equisetum limosum L. (figure 2) is a species that was studied and analysed for a long-time due to its capacities for growing in water. The plant was associated with *Equisetum fluviatile* L., as it has the same type of root (rhizome) and the same habitat. However, after a more profound study it was established that the two species have different functions, especially through their formation mode: ramified and non-ramified. In 1836, F. W. Meyer proposed to reduce *E.limosum* L. to its varietal state (FERNALD AND WEATHERBY, 1921).

In regard to its development, *Equisetum limosum* L. develops well in water, erect. The roots are persistent and soften in the mud from the water's bottom even though it has an oxygen deficit. During the hot summer months, it develops aerial sprouts that can reach one meter in height (BARBER, 1961) As such, the oxygen concentration from the sprouts progressively decreases from the stem to the root's rhizomes, allowing them to survive despite their oxygen deficit (BARBER, 1961).

Equisetum hyemale L.(figure 3) is a vascular plant that prefers sheltered valleys and river bends where it can grow up to the altitude of 535 meters. It has a sporadic presence in Europe and even rare in the Mediterranean region (CLAPHAM *ET AL*., 1987). The stems, measuring 30-100 cm, are erect, with a 4-6 mm diameter, green, simple and persistent during winter; they have slightly inflated internodes. Abrupt and angular indentation can be present, as well as two rows regulated by visible tubercles; 10-30 canals can exist, being moderate; the sheaths have a depth of 3-9 mm, are large and can become white, with a black strip on the upper and lower parts (CLAPHAM *ET AL*., 1987).

Fig.3. *Equisetum hyemale* L.

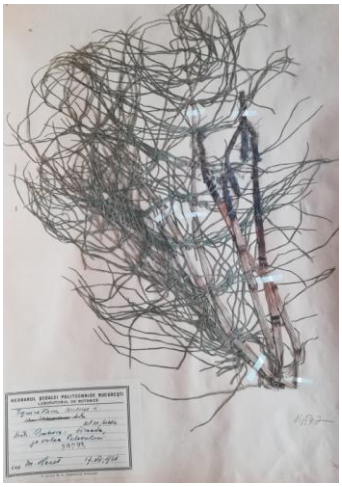

Fig.4. *Equisetum arvense* L.

Equisetum arvense L. (figure 4) can be found in plains, hills and the desert, reaching over 900 meters altitude areas. It predominates in North America, Greenland, Europe and China (CLAPHAM *ET AL.*, 1987). The rhizome is pubescent, with oval tubercles. The stem is erect, green and slightly hard, can reach 20-80 cm in height, and has a diameter of 3-5 mm. It presents splines with a depth of 6-19 cm. The tunic has a depth of 3-8 mm and is green. The empty centre is smaller than ½ of the stem's diameter. The branches are numerous, usually simple, solid, regular, with prominent narrow peaks. The shank is fertile, can reach 10-25 cm, is simple and brown. The sheath is also brown, having 6-12 darker ivories, while the thorns can reach 1-4 cm in length (CLAPHAM *ET AL.*, 1987).

The harvesting periods of the plants. The species present in the herbarium were harvested between 1852-1993 while the oldest *Equisetum* taxon is an *Equisetum sylvaticum* L. sample.

The majority of vouchers date previous to the year 1900 and were obtained from other institutions (e.g. Flora Bavariae, Flora Romaniae Exsiccata, Flora Oltaniae Exsiccata etc.). The first two vouchers with plants harvested from Romania date back to 1852, containing *E. sylvaticum* L species and originate from the Botanic Laboratory from King Carol II Polytechnic School from Bucharest. After the year 1900, the number of recordings vary from one period to the other, with most plants being harvested between 1940-1949 (figure 5). These vouchers, cumulated with the one from 1930-1939 represent half of the total number of vouchers.

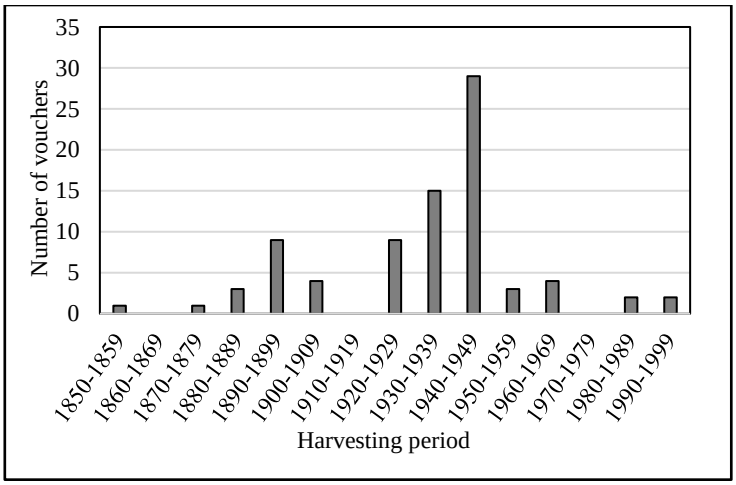

Figure 5. Harvesting periods of *Equisetum* plants from "Alexandru Beldie" Herbarium

From the entire collection, 72% of the plants were harvested from our country (figure 6), with a focus on mountain regions from Argeș, Bistrița-Năsăud, Brașov, Buzău, Constanța, Cluj, Dâmbovița, Gorj, Hunedoara, Maramureș, Prahova, Vâlcea and Vrancea Counties. The most number of vouchers (14) were gathered from different areas of Bucegi Mountains (C.Cerbului, Barbeș's Fangs, Bear Keys, Cărpenișu Peak, Ialomița Valley, Jepilor Valley, Source of Dorului Valley, Râșnoavei Peak etc.).

The difference of 28% contains different species or taxonomic subunits harvested from abroad, from high altitude areas belonging to certain mountain chains (Alps, Pyrenees, Carpathians etc.). The main contribution to the creation of *Equisetum* collection was offered by Al. Beldie who has collected and determined over 20 vouchers. An important contribution was also offered by other experts such as: A. Haralamb (9 vouchers), M. Onică (8 vouchers), T. Bunea (5 vouchers), A. Coman (4 vouchers), C.C. Georgescu (3 vouchers), Golescu (2 vouchers), I. Morariu (2 vouchers), M. Păun (2 vouchers), Gh. Popescu (2 vouchers), and M. Haret (1 voucher). Amongst the foreign specialists we mention Wolff who owns 7 vouchers with different species.

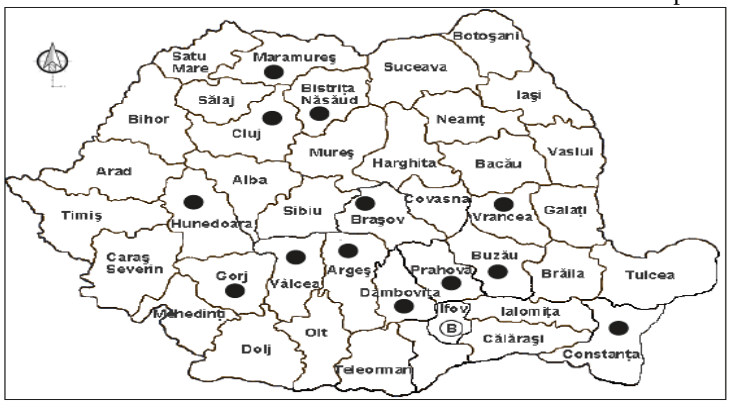

Figure 6. Place of harvest for *Equisetum* genus in Romania

Besides its own collection (20 vouchers), "Al. Beldie" Herbarium was also enriched through exchanges and donations with other herbarium and institutions. As such, a considerable number of vouchers originate from Polytechnic's Herbarium from Bucharest (20 vouchers), ICEF, the Forestry Research and Experimentation Institute (15 vouchers) or from Museum Botanicum Universitatis from Cluj/Flora Romaniae Exsiccata (7 vouchers). In addition, vouchers were obtained from international institutions from Austria, Estonia, Norway, Switzerland, Germany or France.

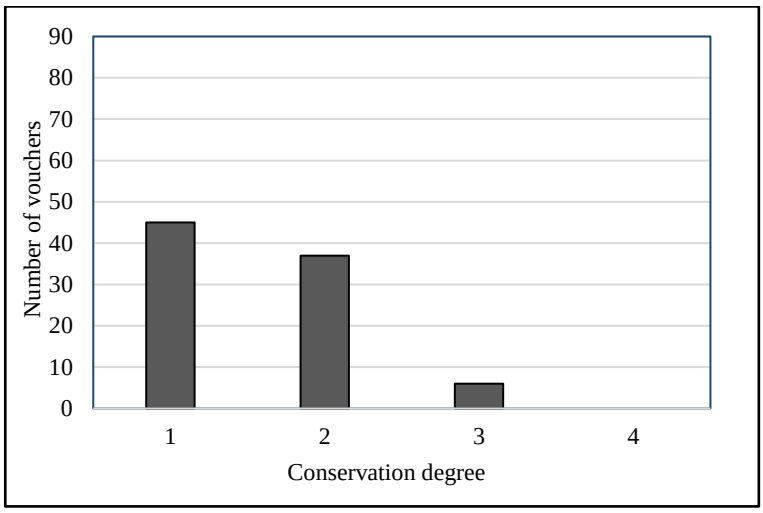

Figure 7. Conservation degree of plants from "Alexandru Beldie" Herbarium

With a few exceptions, *Equisetum* species are very well preserved, a fact illustrated in Figure number 7 where the high number of vouchers situated in the first and second conservation categories can be observed. The voucher that has obtained the third degree of conservation dates back to the XIXth century, a fact that influences its conservation degree.

CONCLUSIONS

The *Equisetum* inventory from "Al. Beldie" Herbarium has emphasized a total number of 19 taxa, from which only 7 taxa are independent species, without intra-specific units. Amongst them, *E. arvense* L. (19 vouchers) and *E. hyemale* (17 vouchers) hold less than one third of the total number of vouchers. In addition, the representatives include six taxa included on the *Red List* on superior plants from Romania, namely: *Equisetum telmteia* L. *Equisetum sylvaticum* L. *Equisetum fluviatile* L. *Equisetum ramosissimum* *Equisetum hyemale* L. *Equisetum variegatum* Schleich. The vouchers were harvested between 1852-1993, mainly from our country, with the most prolific period being 1940-1949. The majority of vouchers were harvested by Al. Beldie (20), A. Haralamb (9) and M. Onică (8), with material harvested from Bucegi Mountains. Substantial contributions were obtained through exchanges with different national and international institutions. The conservation conditions from the herbarium are amongst the best, a fact that has allows and encourages further studies.

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