

## HISTORICAL RESEARCH OF *LIGULARIA* GENUS – OVERVIEW

Andreea Natalia Matei<sup>1\*</sup>

<sup>1</sup> University of Pitești, Faculty of Sciences, Physical Education and Informatics,  
Târgu din Vale St. 1, 110040, Pitești, Romania

### Abstract

*The viability of the rare plant species populations, including also the relict species, indicates a population decline due to the independent or simultaneous action of several factors such as: habitat quality, population size and genetic diversity.*

*This paper aims to synthesize the studies conducted over time both on *Ligularia sibirica* species and *Ligularia* genus. The main objective of the paper is to identify the following research steps necessary for the optimal characterization, monitoring and conservation of the studied species and of its related populations.*

*Ligularia* genus includes species adapted to different climatic and environmental conditions from the European and Asian continent. Following the collected scientific material which holds data about *L. sibirica*, the author found a total of 166 bibliographic sources, of which 107 belong to Romania. The number of scientific materials found in Romania is correlated with the distribution of the *L. sibirica* species in the country. At European and Asian level, have been carried out phytosociology, genetics, biochemistry, biotechnology and phytopathology studies on *Ligularia*, while in our country taxonomic studies predominate, being part of some floristic surveys, monographs, etc., which need to be updated and completed. It can be noticed that biochemical and cytotoxic studies could bring new perspectives on *L. sibirica* benefits.

*Keywords: Historical research, Ligularia, Ligularia sibirica*

### 1. INTRODUCTION

Starting with Darwin, the evolutionary history of populations and the phylogenetic interpretation of the relationships between organisms, served to elucidate the natural system (Andrersson-Kottö and Gairdner, 1931; Mettler and Greg, 1974; Onete, 2008).

The paleoclimatic changes produced during the geological eras have led to the migration of a very large number of plant species (Bănărescu et al., 1973). The species considered to be geographic or phylogenetic relics is a real source of information on identifying the possible characters that allowed their survival from Holocene or Paleocene to nowadays (Graham, et al., 2006; Carnaval et al., 2009; Murienne et al., 2009; Grandcolas et al., 2011; Grandcolas et al., 2014).

Annually, many species and their populations are at risk of extinction, which is reflected in the decline of biodiversity (Primack et al., 2008). Numerous rare plant species, including relict species, are currently showing a population decline as a result of factors such as habitat quality, population size and genetic diversity. These factors, through their independent or simultaneous action, affect the viability of existing populations (Fischer et Matthies 1998; Oostermeijer et al. 1998; Vergeer et al. 2003; Lienert 2004; Heinken-Šmídová, 2012).

Monitoring of threatened species has recently been closely linked to national commitments under the European Union Habitats Directive and closely linked to the concept of "favorable conservation status" (Pakalne et al., 2005). Through the Convention on Biological Diversity (CBD), many countries have agreed to reduce biodiversity losses by pursuing three main objectives: preserving biological diversity, sustainable use of biological diversity components and fair and equitable sharing of benefits from the use of genetic resources (<https://www.cbd.int/intro/default.shtml>).

## 2. MATERIALS AND METHODS

The elaboration of the present paper aimed to synthesize the studies performed on *Ligularia sibirica* species, but also on *Ligularia* genus. The main objective of the paper is to identify the following research steps necessary for the optimal characterization, monitoring and conservation of the studied species. For a better structure and a better highlighting of the degree of knowledge and therewith the characterization of relict species, two distinct studies were carried out, one at national level and one study at international level. The scientific material needed to complete the database was obtained through various bibliographic sources such as: registries, monitoring programs, databases (*Global Compositae Checklist*, *Flora Europaea*, *The Plant List*, *Euro+Med Plant Base*, *Google Scholar*, etc.), scientific articles and specialized books (*Flora Republicii Populare/Socialiste Române*, *Flora Ilustrată a României. Pteridophyta et Spermatophyta*, *Plante Vasculare din România. Determinator ilustrat de teren*, *Flora of the U.S.S.R*, *Flora of China*, etc.).

## 3. RESULTS AND DISCUSSIONS

### *Ligularia* Genus

*Ligularia*, is a Latin name, "ligula" = tongue, the name comes from the specific ligules encountered at the edge of calathium (Sârbu et al., 2013).

The *Ligularia* genus, according to *Flora of China*, *The Plant List*, *Flora Europaea* and according to *The Botanic Garden and Botanical Museum Berlin BGBM* data, includes about 150 species, distributed in the temperate areas of central and eastern Asia as well as in Europe. There are six species throughout Europe territory: *L. sibirica* (L.) Cass., *L. glauca* (L.) O. Hoffm., *L. carpathica* (Schott) Pojark., *L. dentata* (A. Gray) H. Hara, *L. hodgsonii* Hook., *L. przewalskii* (Maxim.) Diels și *L. stenocephala* (Maxim.) Matsum. & Koidz.. The species are found under different categories: introduced, introduced – naturalized, introduced – occasionally adventitious, native species, doubtless native, cultivated – ornamental (Table 1.).

The area of *Ligularia* varies according to the resort, on the river banks, on the lakes banks, in the eutrophic marshes, in the wetlands, wet meadows and marshes sometimes in the wet forests, forest edges, forest meadows, rocky slopes and grooves in the alpine area. The altitude of the species ranges from 100 m in North Asia to 4800 m in the rest of the continent. The habitats occupied by the studied species, develop into the alpine area, in arid places on the high mountains screes, such as the Hengduan Mountains or alpine meadows such as those in Tibet. Both ecological conditions and altitude cause an increased variability in the species height, ranging from 5 cm on the rocky slopes and reaching up to 200 cm high on the grooves in the alpine area, in the river valleys, in eutrophic marshes, meadows, etc. (Komarov et al., 1961; Tzvelev et al., 2002; Slavík, 2004; Wu et al., 2011). China is the state with most species belonging to the *Ligularia* genus, of which 89 from 123 are endemic (Wu et al., 2011). On the other hand, Russia comprises 38 *Ligularia* species throughout its territory. Most often they occupy habitats similar to those from China (Komarov et al., 1961).

According to the main botanical publications which describe Romania flora, (*Flora ilustrată a României. Pteridophyta et Spermatophyta*, *Plante vasculare din România. Determinator ilustrat de*

teren, *Flora mică ilustrată a Republicii Populare Române, Plante Vasculare din România*) on our country territory, there are only two species belonging to *Ligularia* genus, respectively: *Ligularia sibirica* (L.) Cass. and *Ligularia glauca* (L.) Hoffm.

**Table 1. The *Ligularia* genus distribution in Europe**

**Introduced (I), Introduced – naturalized (IN), Introduced – occasionally adventitious (IAO), Native (N), Doubtless native (ÎN), Cultivated – Ornamental (C)**

Nr.	<i>Ligularia</i> sp.	Sinonim	Europa	Categorie
1	<i>L. sibirica</i> (L.) Cass.	<i>Othona sibirica</i> L. (non <i>Senecio sibiricus</i> L.f. 1782); <i>S. cacaliifolius</i> Sch. Bip., nom. nov.	Bulgaria Belarus Czech Republic Croatia Estonia France Hungary Latvia Russia Romania Slovakia Turkey Ukraine	N
			Austria	ÎN
			Italy	C
2	<i>L. carpathica</i> (Schott) Pojark.	<i>Senecillis carpathica</i> Schott	Romania Bulgaria Ukraine Slovakia	N
3	<i>L. dentata</i> (A. Gray) H. Hara	<i>Erythrochaete dentata</i> A. Gray <i>Ligularia clivorum</i> Maxim.	United Kingdom Czech Republic Germany Sweden	IN IAO IAO IAO
4	<i>L. hodgsonii</i> Hook.	-	Sweden	IAO
5	<i>L. przewalskii</i> (Maxim.) Diels	<i>Senecio przewalskii</i> Maxim.	United Kingdom Austria	I
6	<i>L. stenocephala</i> (Maxim.) Matsum. & koidz.	<i>Senecio stenocephalus</i> Maxim.	Sweden	IAO

The *Ligularia* Cass. genus belonging to the *Asteraceae* family, the *Senecioneae* tribe and the *Tussilagininae* subtribes, its a highly diverse genus, many species being located in the Qinghai-Tibet Eastern plain and its surroundings; *L. dentata* and *L. hodgsonii* are considered some of the less evolved species (Jeffrey et al., 1984). This region is considered the center of origin and diversity of the *Ligularia* genus (Liu, 1989; Liu et al., 1994). Some of the identified species, more than half of them (60), are considered to be endemic to the area. All species belonging to the *Ligularia* genus in that area have the same number of chromosomes  $2n = 58$ , a similar karyotype  $2A$  and  $x = 29$  representing the base number. The number of chromosomes  $x = 30$  is mainly found in Europe and north Asia, far away from the center of origin and diversity of the *Ligularia* genus. If the number is derived from  $x=29$  through a secondary aneuploid event, then this can be one of the reversal chromosomal evolution situations (Liu, 2004).

The *Ligularia* genus has been extensively studied in the recent years from the phytochemical compounds point of view, with significant results useful in traditional medicine, in the treatment of bronchitis, asthma, tuberculosis, arthritis, cough, inflammation, jaundice, scarlet fever, and in relieving liver pain (Li et al., 2008; Xie et al., 2010). Species belonging to the *Ligularia* genus possess many properties in terms of biological activity, such as: antibacterial properties, cytotoxic, tyrosine phosphatase inhibitory activity, insecticidal properties, antihepatotoxicity, antioxidant properties, as well as antithrombotic and anticoagulant activities. Pharmaceutical and chemical studies conducted on *Ligularia* species show the presence of specific constituents such as sesquiterpenes (Wu et al., 2016).

The *L. sibirica* species has not been studied much from the biochemically or cytotoxicity point of view either, however it should be noted that the species can be used in the treatment of excessive phlegm and cough reduction (Liao et al., 2002; Tori et al., 2008; Yuan et al., 2013).

### ***Ligularia sibirica* (L.) Cass.**

*Ligularia sibirica* (Linnaeus) Cassini (Cuvier, 1823) is a polymorphous, perennial species, sometimes green, with purple tint, which can reach heights from 15 cm up to 150 cm (Chater, 1976).

- In soil, the species has a short rhizome, densely covered with thick or thin adventive roots, and in the upper part covered with fibrous debris of dead leaves (Komarov, 1961; Tzvelev, 2002).

- The stem is erect, thick, streaked-striated, greenish or reddish-violet, completely glabrous, pubescent or hairy up to inflorescence (Komarov, 1961; Tzvelev, 2002).

- The basal leaves are green on the top, with dimensions ranging between: 3 / 10-25 and 3 / 7-20 cm. These may be triangular-reniform to sagittal, dentate, more or less glabra, to dense hair on the lower or upper surface along the ribs, rarely being entirely hairy. The petiole usually can be of 2-2.5 / 3 times longer than the blade (Komarov, 1961; Chater, 1976; Tzvelev, 2002). The blades have different shapes, with dimensions ranging from: 5.5 / 9-24 cm long and 7-22 cm wide, cordate or ovate-cordate, sometimes deltoid, sinuous-toothed with deltoid teeth longer and shorter (Komarov, 1961; Chater, 1976; Tzvelev, 2002).

- The cauline leaves are of two types: inferior and superior. The lower ones have shorter blade and petiole, narrowed at the base in a longer sheath. On the upper cauline leaves the blade is deltoid or deltoid-cordate and delicate-toothed, with a short petiole, much of which is modified in a large sheath. At the same time, one can notice that the last leaf is brown or red, amplexicaul, in the form of a scale or a lower bracteal leaf (Komarov, 1961; Chater, 1976).

- The inflorescence is simple, racemose, more oblong, with a length of more than 12 cm, consisting of 5 / 10-52 heads with a diameter of 2.5-4.5 cm, lateral oblique bent (Komarov, 1961; Tzvelev, 2002). The involucre is campanulate or campanulate-turbinate, glabra or arachnoid-hairy and is based on 11-12 hairy bracts on the outer face. The lower bracts are ovate-lanceolate, carinated and long-acuminate, with a length of 2.5-6 cm, occasionally with the upper part toothed. The upper bracts are ovate-lanceolate, even linear. The lower and upper peduncle are thick, the lower ones are 5-10 cm long with 1 or 2 capitulas, and the upper ones measure 5-12 cm, with brown / white arachnoid hair (Komarov, 1961; Tzvelev, 2002).

- Capitulas are made up of two types of flowers: 7-8 / 11 ligulated flowers and 18 / 23-32 tubular flowers. The external ligulate flowers are yellow, oblong-ovate with a tube of 5-6 mm long, the ligules are crossed by 4-9 ribs, while the central flowers are campanulate-turbinate, with a narrow limb and tube with 1-1.5 mm length. At the stamen level the anthers have an oval-lanceolate apical appendix, the basal one being short and obtuse. The gynoecium has the style branched, the

branches are covered with short and thin hairs, on top being slightly flattened in a short, obtuse appendix (Komarov, 1961; Tzvelev, 2002).



Figure 1. *Ligularia sibirica* (L.) Cass. – Härman Marsh (Original)

- Achenes size is between 4-6 mm length, the pappus being longer or equal to achene with a white-dirty colour (Komarov, 1961; Chater, 1976; Tzvelev, 2002).

At Härman Marsh it can be seen *L. sibirica* var. *araneosa* (DC) or *L. sibirica* f. *araneosa* (DC) (Nyárády E. I., 1964; *The Plant List*) – the plant is sublanted with white-haired pedicles.

### ***Ligularia glauca* (L.) Hoffm.**

The main morphological differences between *L. sibirica* (L.) Cass. and *L. glauca* (L.) Hoffm. species, can be noticed at the level of vegetative organs and at the fruit level. Thus, the basal leaves are narrowed or slightly cordate at the base (Nyárády, 1964; Sârbu et al., 2013), being more or less suddenly attenuated in the petiole. From the shape point of view, the leaves are ovate-elliptical or elliptical, glabrous, with an entire edge or small denticulate (Komarov, 1961; Nyárády, 1964; Tzvelev, 2002; Ciocârlan, 2009). The pappus can be very short (Ciocârlan, 2009), shorter than achene or in some cases even absent (Nyárády, 1964; Sârbu et al., 2013).

### ***Ligularia bucovinensis* (L.) Nakai**

Various botanical specialists from both Romania and from countries such as Ukraine, Slovakia, Czech Republic and Poland have tried to get the most conclusive results on the dichotomy between *L. sibirica* and *L. bucovinensis* species. Thus, from the results obtained through extensive taxonomic studies carried out in recent years, it can be mentioned that *L. bucovinensis* was accepted in taxonomic bases as *The Plant List* or *Global Compositae Checklist*. However, many specialists claim that those slightly variable characters of *L. bucovinensis* such as plant height of 70-75 cm, thin stems and small inflorescences with a maximum of 15 capitulas (Komarov, 1961), would be better suited in order to determinate a subspecies or variety. (Nyárády, 1964; Ciocârlan, 2009; Sârbu et al., 2013)

### ***Ligularia carpathica* (Schott, Nyman et Kotschy) Pojark.**



The main morphological characters that differentiate *L. carpathica* species from *L. glauca* species include: the sinuated-toothed edges of all the leaves or just for the lower ones, the narrower limb of the tubular flowers and the peripheral flowers ligules crossed by about 6-10 ribs (Pojarkova, 1961). Currently *L. carpathica* is accepted as a species by taxonomic bases such as: *The Plant List* and *Euro+Med Plantbase*, the species being recognized by the field vascular plant check list "Plantele vasculare din România. Determinator ilustrat de teren" (Sârbu et al., 2013). However, Nyárády (1964), Sanda (2004) and Ciocârlan (2009) and considers *L. carpathica* species as a synonym of the *L. glauca* species.

### History of worldwide research (Table 2.)

First in-depth studies on the *Ligularia* genus begin in France in 1816, where the botanist and naturalist Alexandre Henri Gabriel de Cassini (1781-1832), specialized in the *Asteraceae* family, names and frames *Ligularia* genus. Swedish botanist, physicist and zoologist Carl Linnaeus (1707 – 1778), considered being the "father of the modern taxonomy" that has developed the binomial nomenclature system, which is now used internationally by the *International Code of Nomenclature for algae, fungi, and plants* (ICN), described for the first time *Ligularia sibirica* species, which Cassini in 1823 has reclassified it in the botanical system used today. Later on, through the development of botanical research at European level, the relict species was mentioned in several Flora volumes from 11 countries: Russia, Estonia, Latvia, Poland, Slovakia, Croatia, Austria, Romania, Bulgaria, France and Ukraine.

Due to climate threats, decrease of nutrients and soil eutrophication, maintaining biodiversity and preserving flora and vegetation, it is a current problem at European level. *L. sibirica* is considered to be a species of Community importance, and the Habitats Directive seeks to preserve it through various monitoring projects. In Poland, besides adopting the necessary conservation measures, the species was included in the endangered plant seed bank.

From the genetic point of view, the specialized literature provides information regarding the uniformity of the karyotype, the genetic diversity at the population level and the endopolyploidy of the *L. sibirica* species. Thus, in 2004 Liu JQ. et al. carried out a comprehensive study on the uniformity of *Ligularia* genotypes, concluding that the variation of the karyotype structure at diploid level may be characteristic of chromosome evolution.

Genetic research continued with the study realised by Šmídová A. et al. in 2012, a paper that reveals that the studied populations of *L. sibirica* from the Czech Republic and Slovakia, maintain a high level of genetic diversity, not yet threatened by genetic factors. Krasņevska N. et al. have studied in 2017 the endopolyploidy of *Ligularia sibirica* species in several distinct populations from Poland, with the aim of developing the necessary measures for the protection of endangered species. The study concluded that the type of nutrient contamination is not the only factor that affects endopolyploidy in young *L. sibirica* leaves.

Two PhD theses from Europe were studying the *L. sibirica* relict from different points of view. The first work carried out by Heinken-Šmídová A. in 2012, "Study of factors influencing population dynamics of the plant species *Ligularia sibirica* (L.) Cass." has followed objectives such as: genetic diversity estimation and of the main habitat conditions requirements in the studied localities, as well as the identification of the optimum population size needed for the *L. sibirica* dynamics in the Czech Republic and Slovakia.

Table 2. *Ligularia sibirica* (L.) Cass. – History of worldwide research

Nr. Crt.	Year	Author	Title	Journal / Book / Publication
1	1823	Cuvier F.	<i>Ligularia sibirica</i> (Linnaeus) Cassini	Dict. Sci. Nat.
2	1878	Timbal-Lagrave E. et al.	Du <i>Ligularia sibirica</i> Cass. Dans Les Pyrénées, Bulletin de la Société Botanique de France	Bull. Soc. bot. Fr.
3	1892	Franchet M. A.	Les Genres <i>Ligularia</i> , <i>Senecillis</i> , <i>Cremanthodium</i> , Et Leurs Espèces Dans L'asie Centrale Et Orientale	Bulletin de la Société Botanique de France
4	1936	Mattauch F.	Über die <i>Ligularia sibirica</i> (L.) Cass.	Natur Heimat
5	1950	Kneblová V.	Reservace u Rečkova a <i>Ligularia sibirica</i> (L.) Cass.	Čes. Bot. Listy
6	1953 - 1957	Ohwi J.	Flora of Japan (in Engleza)	National Science Museum
7	1965	Ishii H. et al.	Studies on sesquiterpenoids. Structure of ligularol and ligularone from <i>Ligularia sibirica</i> Cass.	Tetrahedron
8	1968	Tanahashi Y. et al.	Ligularenolide. A new sesquiterpene lactone of eremophilane type	Tetrahedron Letters
9	1976	Baudiere A. & Serve L.	Les groupements à <i>Ligularia sibirica</i> Cass. du Capcir (haute vallée de l'Aude, Pyrénées-Orientales)	Bulletin de la Société Botanique de France
10	1976	Chater A.O.	<i>Plantaginaceae</i> to <i>Compositae</i> (and <i>Rubiaceae</i> ) Flora Europaea	-
11	1984	Jeffrey C. & Chen YL.	Taxonomic studies on the tribe <i>Senecioneae</i> ( <i>Compositae</i> ) of eastern Asia,	Kew Bulletin
12	1988	Broz E & Przemyski A.	Stanowisko <i>Ligularia sibirica</i> (L.) Cass. na obszarze Niecki Włoszczowskiej. (The locality of <i>Ligularia sibirica</i> (L.) Cass. in the Włoszczowska Trough (Central Poland))	Flor. Geobot
13	1989	Liu SW.	<i>Compositae-Senecioneae</i> . Flora Reipublicae Popularis Sinicae	-
14	1990	Šegulja N. & Krga M.	<i>Ligularia sibirica</i> (L.) Cass. – Eine neue art der Jugoslawischen flora	Acta. Bot. Croat., Zagreb
15	1991	Vane-Wright R.I. et al.	What to protect? Systematics and the agony of choice	Biol. Conserv.,
16	1994	Liu SW. et al.	Origin, evolution and distribution of <i>Ligularia</i> Cass. ( <i>Compositae</i> )	Acta Phytotaxonomica Sinica
17	1998	Huang T-C.	Flora of Taiwan 2 <sup>nd</sup> edition, Angiosperms – Dicotyledons,	Editorial Committee of the Flora of Taiwan
18	1999	Kukk Ü.	Eesti kaitstavad taimeliigid / Protected plants of Estonia	-
19	1999	Procházka F. & Pivničková M.	<i>Ligularia sibirica</i> (L.) Cass., Červená kniha ohrožených a vzácných druhov rastlín a živočíchov SR a ČR	-
20	2000	Mühlenberg M. et al.	The conservation value of West-Khentei, North Mongolia: Evaluation of plant and butterfly communities	Fragm. Flor. Geobot.,
21	2000	Poiarkova A.I.	<i>Ligularia</i> Cass. în Flora of the U.S.S.R.,	Smthsonian Insitution Libraries, Whashington D.C.

22	2001	Sammul M.	Harilik kobarpea. Kaitsekorralduskava	-
23	2001	Ocakverdi H.	The Flora of the Mount Kisir (Kars and Ardahan) and Nearest Environs	Turk. J. Bot.
24	2002	Bensettiti F. et al.	«Cahiers d'habitats» Natura 2000. Connaissance et gestion des habitats et des espèces d'intérêt communautaire	-
25	2002	Gaudillat V. & Haury J. (eds.)	Habitats humides, Cahiers d'habitats	
26	2002	Tzvelev N.N. & Andrej A. Fedorov	Flora of Russia. The European part and bordering regions	-
27	2002	Uniyal V.P.	Nanda Devi Expedition (Report).	Wildlife Institute of India
28	2003	Kukk Ü.	The distribution of <i>Ligularia sibirica</i> (L.) Cass. in Estonia and changes in its population	Biul Ogródów Bot
29	2003	Ryttäri T. et al.	Monitoring of threatened vascular plants in Estonia and Finland—methods and experiences,	The Finnish Environment
30	2003	Wiedenfeld H. et al.	Pyrolizidine Alkaloids from <i>Ligularia sibirica</i> Cass. and <i>Tephrosia integrifolia</i> L.	Sci. Pharm.
31	2003	Hendrych R.	Poznatky o druhu <i>Ligularia sibirica</i> v Čechách (On the occurrence of <i>Ligularia sibirica</i> in Bohemia)	Preslia
32	2003	Witkowski Z. J. et al.	Carpathian List of Endangered Species	-
33	2004	Slavík B.	<i>Ligularia</i> Cass.	Slavík B, Štěpánková J (eds) Květena České republiky, 7 (Flora of the Czech Republic, 7)
34	2004	Kļaviņa D. et al.	Tissue culture technology in conservation of threatened plant species of Latvia	Acta Universitatis Latviensis,
35	2004	Liu JQ.	Uniformity of karyotypes in <i>Ligularia</i> ( <i>Asteraceae: Senecioneae</i> ), a highly diversified genus of the eastern Qinghai–Tibet Plateau highlands and adjacent areas	Botanical Journal of the Linnean Society
36	2005	Kobiv Y.	<i>Ligularia sibirica</i> (L.) Cass. ( <i>Asteraceae</i> ) in the Chornohora mountains (Ukrainian Carpathians): population-ontogenetic parameters, morphology, taxonomy and conservation.	Ukrainian Bot. Jour.
37	2005	Pakalne M. & Kalnina L.	Mire ecosystems in Latvia, Stapfia 85, zugleich Kataloge der OÖ	Landesuseen Neue Serie 35, Biologiezentrum Linz
38	2005	Minayeva T. et al.	Mongolian Mires: from taiga to desert	Stapfia 85, zugleich Kataloge der OÖ
39	2006	Mirek Z. & Piękoś-Mirkowa H.	Występowanie języczki syberyjskiej <i>Ligularia sibirica</i> (L.) Cass. w Polsce—zagrożenia i problemy ochrony	Chrońmy Przyrodę Ojczyzną
40	2008	Kull T. et al.	Necessity and reality of monitoring threatened European vascular plants	Biodiversity and Conservation
41	2009	Petrova A. & Vladimirov V. (eds)	Red List of Bulgarian vascular plants,	Phytologia Balcanica
42	2011	Bilz M. et al.	European Red List of Vascular Plants	-
43	2011	Šmídová A. et al.	Genetic diversity of a relict plant species,	Flora



			<i>Ligularia sibirica</i> (L.) Cass. (Asteraceae),	
44	2011	Wang Y. et al.	Growth and Physiologic characteristics of <i>Ligularia sibirica</i> under livestock wastewater treatment	Journal of Nuclear Agricultural Sciences
45	2011	Wu Z. Y. et al.	Flora of China	Science Press (Beijing) & Missouri Botanical Garden Press
46	2011	Yang JL et al.	Phytochemicals and bioogical activity of <i>Ligularia</i> species	Nat Prod Bioprospect
47	2011	Zhang J. et al.	Purification Effect of <i>Ligularia sibirica</i> on Livestock Wastewater	Journal of Sichuan Agricultural University
48	2012	Wróblewska A. & Stawiarz E.	Flowering abundance and páollen productivity of <i>Ligularia clivorum</i> Maxim. and <i>Ligularia przewalskii</i> Maxim.	Acta Sci. Pol
49	2012	Heinken-Šmídová A.	Study of factors influencing population dynamics of the plant species <i>Ligularia sibirica</i> (L.) Cass., PhD. thesis	-
50	2012	Heinken-Šmídová A. & Münzbergová Z.	Population dynamics of the endangered, long-lived perennial species, <i>Ligularia sibirica</i> ,	Folia Geobotanica
51	2012	Joosten H. et al.	Peatlands - Guidance for Climate Change Mitigation Through Conservation, Rehabilitation and Sustainable Use.	-
52	2014	Kadlečík J.	Carpathian Red List of Forest Habitats and Species, Carpathian List of Invasive Alien Species (draft).	The State Nature Conservancy of Slovak Republic
53	2014	Lanno K. & Sammul M.	The survival of transplants of rare <i>Ligularia sibirica</i> is enhanced by neighbouring plants	Folia Geobotanica
54	2014	Puchalski J. et al.	Seed banking of Polish endangered plants – the FlorNatur Project	Biodiversity Research and Conservation
55	2015	Horsák M. et al.	European glacial relict snails and plants: environmental context of their modern refugial occurrence in southern Siberia,	Boreas
56	2016	Zahariev D.	Biodiversity of relict vascular plants in Bulgaria	Int. Jour. of Res. St. in Biosc.
57	2017	Chytrý M. et al.	Flora and vegetation of the Czech Republic	-
58	2017	Krasņevska N. et al.	Endopolyploidy of Endangered Plant Species <i>Ligularia sibirica</i> in Different Environments	Proceedings of the 11th International Scientific and Practical Conference
59			Flora of Pakistan	<a href="http://www.tropicos.org/Name/2701004">http://www.tropicos.org/Name/2701004</a>

The second paper, written by Kaire Lanno in 2014, "*Long-term changes in the Estonian flora and measures for conservation*", wishes to find answers to some questions regarding the conservation of the studied species: what is the persistence of the studied species in different types of habitats in Estonia, to what extent the species is dependent on habitat characteristics and whether the decline of species in alluvial meadows is related to site quality.

The genus *Ligularia*, due to its intense biological activity and numerous biochemical compounds, has attracted the interest of scientists from China, Japan and Mongolia over the years. The *L. sibirica* species has been part of studies such as: "*Phytochemicals and biological activity of Ligularia species*", "*Ligularenolide. A new sesquiterpene lactone of eremophilane type*", "*Studies*

on sesquiterpenoids. Structure of ligularol and ligularone from *Ligularia sibirica* Cass.” and „Pyrrolizidine Alkaloids from *Ligularia sibirica* Cass. and *Tephroses integrifolia* L.”.

Due to their habitus, *Ligularia* species are also suitable for landscape architectural services in cultivars such as: „*Britt Marie Crawford*”, „*Gregynog Gold*”, „*The Rocket*”, „*Zepter*”. These cultivars were included in the list of species with optimum growth performance in the United Kingdom in 2017, being awarded by *The Award of Garden Merit* (AGM), contest organized annually by *British Royal Horticultural Society* (RHS).

Due to the presence of *Ligularia* species in wet habitats, it is important to know the diseases that can affect the conservation of relict species. In 2010 in China, You C-J. et al., have conducted studies on the *Coleosporium ligulariae* Thüm. species, identified in a first step on a *Ligularia sibirica* specimen and subsequently on another 10 species of *Ligularia*. Wang Y. et al. and Zhang J. et al., have demonstrated in 2011 that *L. sibirica* can be used in different applications of the modern biotechnology, both because of its excellent adaptation capacity and resistance to waste water pollution as well as its ability to purify wastewater from the livestock sector.

### History of research in Romania (Table 3.)

In Romania research on *L. sibirica* species begins in 1796, when the naturalist Franz von Waldstein and the botanist Pál Kitaibel quotes the species for the first time as *Cineraria sibirica* identified in the Gutâi Mountains, Tăul lui Dumitru and Căvnic. Subsequently, the research continued in 1802, when Johann Christian Baumgarten mentioned the relict species to which he added other localities in Harghita County.

The botanist Philipp Johann Ferdinand Schur mentions the species in 1865: *Senecillis glauca* Gaertn. and *Senecillis carpathica* Schott, which have been found in Corongiș Mountain - Rodna Mountains and Pietra Secuiului - Rimetea, being mentioned the next locations with *L. sibirica* from Puturosu Mountain, Turia (Covasna) and Borsec. Michael Fuss in 1866 describes for the first time in a Romanian publication, *Transsilvaniae excursoria*, *L. sibirica* and *L. carpathica* taxa.

Florian Porcius in 1881, criticizes the few characters that Schur utilized to distinguish the species *Senecillis (Ligularia) glauca* and *Senecillis (Ligularia) carpathica*. At the same time, Porcius fits *L. sibirica* species in *Hoppea* genus.

The academician Nyárády E.I. brought in 1964 a very large contribution to the description of the *Ligularia* genus and also of the *L. sibirica* species in the *Flora Republicii Socialiste Române*.

Contributions to the study of *L. sibirica* species in Romanian peat bogs are also brought by academician Emil Pop through numerous publications, but also through the synthesis of the researches conducted in the country, in *Mlaștinile de Turbă din Republica Populară Română*, published in 1960.

Botanical research has continued to nowadays, to which had contributed reference names in the field as: Grecescu D., Resmeriță I., Morariu I., Beldie Al., Boșcaiu N., Drăghici Bibica, Coldea Gh., Kovács J. A., Stoicovici Lucia, Gergely I., Rațiu Flavia, Alexiu V., Drăgulescu C., Stancu Daniela Ileana, Neblea Monica, Cristea V., Răduțoiu D., etc.

The Convention on Biological Diversity (CBD) is today the most important international instrument in coordinating global policies and strategies on biodiversity conservation. Romania ratified the CBD through the Law nr. 58/1994. *L. sibirica* is one of the community important species in Romania, being mentioned in the Habitats Directive through the Annexes Iib, IVb and in OUG 57/2007 - Annexes 3, 4A. Nowadays, the size of the population is unrated, holding the conservation status as Data Deficient (DD). Three reference papers present the status of the species in Romania: „*Lista roșie a plantelor superioare din România*”, „*Arii speciale pentru protecția și conservarea*

*plantelor în România” and ”Ghidul de monitorizare a speciilor de plante de interes comunitar din România”.*

**Table 3. *Ligularia sibirica* (L.) Cass. – History of research in Romania**

Nr. Crt.	Year	Author	Title	Journal / Book / Publication
1	1796	Pál Kitaibel și Franz von Waldstein	<i>Cineraria sibirica</i>	Mlaștinile de turba din R.P.R. (Pop. E.)
2	1802	Johann Christian Gottlob Baumgarten	-	Enumeratio stirpium in Magno Transsilvaniae principatui
3	1857	Rațiu Flavia & Gergely I.	O nouă asociație vegetală pentru țara noastră: <i>Calamagrostetum neglectae</i> Tengwal 20	Studia Univ. ”Babeș-Bolyai” Seria Biologie
4	1865	Philipp Johann Ferdinand Schur	-	Enumeratio plantarum Transsilvaniae
5	1866	Michael Fuss	-	Flora Transsilvaniae excursoria
6	1881	Florian Porcius	Flora phanerogama din fostulu Districtu alu Naseudului	Transilvania
7	1886	Lajos Simonkai	-	Enumeratio florae transsilvanicae vesculosae critica
8	1898	Dimitrie Grecescu	-	Conspectul Florei României
9	1932	Papp C.	O dare de samă asupra excursiei a 6-a fitogeografică internațională (I.P.E.) în munții Moldovei	Rev. St. ”V. Adamachi”
10	1939	Chirilei H.	Considerații fitosociologice și biologice asupra unei noi turbării din jud. Câmpulung	Rev. Șt. ”V. Adamachi”
11	1948	Burduja C.	Contribution floristique et chorologique relative a la Moldovie	Bull, de l’Ecole Polytechnique de Jassy,
12	1954	Pop E.	Studii botanice in mlaștinile noastre de turbă	Bul. St., Acad. R.P.R., Secț. Șt. Biol., Agron., Geol., Geogr.
13	1958	Papp C.	Contribuțiuni la cunoașterea florei și vegetației și în special Archegoniatele dintre văile râurilor Oituz și Uz, din reg. Bacău	An. Șt. Univ. ” Al. I. Cuza” Iași, Ser. Nouă
14	1958	Pop E.	Regiunea de mlaștini eutrofe Drăgoiasa-Bilbor-Borsec și importanța ei fitogeografică	Ocr. nat.
15	1958	Kristó A.	Plante rare și relice ce trebuie ocrotite în mlaștinile de la Sâncrăieni „Borsáros”	Ocr. nat.
16	1960	Pop E.	Mlaștinile de turba din R.P.R.	Ed. Acad. Rep. Pop. Ro.
17	1960	Resmeriță I. et al.	Contribuții la cunoașterea florei din Regiunea Baia – Mare	Com. Acad. R.P.R.
18	1961	Prodan I. & Buia Al.	Flora mică ilustrată a Republicii Populare Romîne	Ed. Agro-silvică
19	1962	Pop I. et al.	Vegetația din Valea Morii – Cluj, conservatoare de relice glaciare	Contrib. Bot. Cluj,
20	1963	Șerbănescu M.	Contribuții la studiul florei și vegetației algelor din mlaștinile eutrofe Hărman-Prejmer (Reg. Brașov)	St. cerc. Biol., Ser. Bot.
21	1964	Nyárady E.I.	Flora R. S. România,	Flora Republicii Populare Române

22	1964	Borza Al.	Contribuții la cunoașterea molinițelor din Regiunea Oaș-Maramureș	Contrib. Bot. Cluj
23	1964	Boșcaiu N., colab.	Contribuții la cunoașterea molinițelor din Regiunea Oaș-Maramureș	Contrib. Bot. Cluj, pp. 241–248.
24	1964	Morariu I.	Aspecte din vegetația rezervației de mlaștină de la Hărman	Ocr. nat.
25	1965	Pop E.	Problema relictelor glaciare în mlaștinile de turbă din România	St. și Cerc. Biol. seria Botanică
26	1966	Morariu I. et al.	Sfatul popular al regiunii. Brașov	Consiliul regional pentru ocrotirea naturii
27	1966	Morariu I.	Mlaștinile de la Prejmer conservatoare de relice floristice	Ocr. nat.
28	1967	Beldie Al.	Flora și vegetația Munților Bucegi	Ed. Acad. R.S.R.
29	1968	Drăghici Bibica	Flora și vegetația Văii Dâmbovicioara și a versantului estic al Pietrii Craiului	Teză de doctorat
30	1969	Coldea Gh. & Kovács J. A.	Ceretări fitocenologice în Munții Nemirei	St. și Cerc. Biol. Seria Botanică
31	1970	Ștefureac Tr.	Relicte și endemisme în flora rezervațiilor naturale din Bucovina	St. Com. Ocr. Nat.
32	1970	Morariu I. & Hortensia N.	<i>Saxifraga mutata</i> L. și <i>Virga strigosa</i> (Willd.) Holub noi în flora României	St. Cerc. Biol., Ser. Bot.
33	1971	Păun M.M. & Popescu G.	<i>Ligularia sibirica</i> (L.) Cass. în Oltenia. ( <i>Ligularia sibirica</i> (L.) Cass. en Oltenie).	Comun. Bot.
34	1971	Ularu P.	Specii relice din mlaștina eutrofă de la Dumbrăvița (jud. Brașov)	Ocr. nat. med. înconj.
35	1972	Danciu M.	Asociațiile de rogoz din Mlaștina de la Ozunca	St. Și Cerc. Biol. Seria Botanică
36	1972	Lungu L.	Importanța fitogeografică a mlaștinii turboase din lunca Negrei Brostenilor de la Cristișor (Județul Suceava)	St. Com. Ocr. Nat.
37	1972	Rațiu Flavia	Asociații de rogozuri înalte din mlaștinile eutrofe ale Depresiunii Giurgeului	Contrib. Bot., Cluj-Napoca
38	1973	Heltmann H.	Contribuții la studiul florei Țării Bârsei	St. Com., Muz. Șt. Nat. Brukenthal
39	1974	Rațiu Flavia	Considerații generale asupra florei relictare a mlaștinilor eutrofe din Depresiunea Giurgeului	Ocr. Nat.,
40	1977	Stoicovici Lucia	Stațiuni cu <i>Ligularia sibirica</i> (L.) Cass. f. <i>araneosa</i> DC. În bazinele Dornei și Bilborului, considerații fitocenologice și ecologice	St. Cerc. Biol., Ser. Biol. Veget.
41	1979	Danciu M. & Kovács S.	Flora și vegetația mlaștinilor de la Comandău (Jud. Covasna)	Contrib. Bot.
42	1980	Morariu I. & Drăghici B.	Contribuții la flora Masivului Piatra Craiului	Studii și Cercet. De Biologie, seria Biologie Vegetală
43	1981	Rațiu Flavia & Gergely I.	Fitocenoze caracteristice mlaștinilor eutrofe din bazinul inferior al Ciucului	Contrib. bot. Univ. Babeș-Bolyai
44	1981	Seghedin G. et al.	Fânațele cu <i>Ligularia glauca</i> (L.) O. Hoffm. de la Calafindești (Jud. Suceava)	St. Com. Ocr. Nat.
45	1982	Stoicovici Lucia	Rapidirea populațiilor relictare de <i>Ligularia sibirica</i> (L.) Cass. în R.S. Romania	Stud. Cerc. Biol., Biol. Veg.
46	1984	Moldovan I. et al.	List of rare, endemic and threatened plants in Romania, Notulae Botanicae	Horti Agrobotanici,
47	1986	Mititelu D. et al.	Flora Munților Călimani	An. St. Univ. "Al. I. Cuza"

48	1986	Buz Zoe	Semnificația fitogeografică și fitoistorică a complexului mlăștinos de la Fântâna Brazilor (Jud. Harghita)	Ocr. nat. med. Înconj.
49	1989	Gergely I. et al.	Flora și vegetația mlaștinii "Răbufnitoarea" (Munții Turiei – Județul Covasna)	Contrib. Bot. Cluj,
50	1992	Rațiu Flavia	Mlaștina eutrofă "Dumbrava Harghitei"	Oct. nat. med. înconj.
51	1993	Mititelu D. et al.	Contribuții noi la cunoașterea florei și vegetației județului Bacău	St. Com. Muz. Șt. Nat. Bacău
52	1994	Oltean M. et al.	Lista roșie a plantelor superioare din România	St., Sint., Doc. Ecol., Acad. Română - Inst. de Biologie
53	1995	Alexiu V. et al.	Propunere de rezervație pe baza unui studiu fitocenologic în complexul de chei al Dâmboviței	Naturalia, St. Cerc. Muz. Jud.
54	1996	Seghedin T. G.	Cercetări privind flora și vegetația Carpaților din Bucovina Istorică	-
55	1997	Țibu Dominica	Rezervația naturală de la Rezervația naturală de la Stejari – Horaiț	Analele Bucovinei
56	1997	Beres I. et al.	Propuneri pentru înființarea unor noi rezervații naturale în județul Maramureș	Ocr. Nat. Med. Inconj.
57	1998	Jakab G.	Contributions to the knowledge of the bryophyte flora of the SE Carpathians (Romania)	Studia bot. Hung
58	1999	Drăgulescu C.	The hydrophilous and hygrophilous flora and vegetation from the upper and middle Olt river valley	Transylv. Rev. Syst. Ecol. Res.
59	2001	Mihăilescu S.	Flora și vegetația Masivului Piatra Craiului, PhD thesis	-
60	2002	Csergő A.- M.	The problem of the refugia of certain preglacial and glacial relict populations from the calciphilous flora of the Apuseni Mountains (Romania)	Contr. Bot. Cluj
61	2003	Alexiu V. & Stancu D.I.	<i>Carici remotae-Calthetum laetae</i> Coldea (1972) 1978 <i>ligularietosum sibiricae</i> nova subass. in the Brusturet Gorges (Piatra Craiului)	Research in Piatra Craiului National Park, I,
62	2003	Neblea Monica. & Alexiu V.	Aspects of vegetation from Zănoaga and Tătaru Gorges (The Bucegi Mountains)	Rev. Roum. Biol. – Biol Végét.
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64	2004	Alexiu V.	La végétation des gorges du bassin supérieur de Dambovitsa. Étude comparative	Colloques Phytosociologiques Végétation postglaciaire... E. Schweizerbart'sche verlagsbuchhandlung Stuttgart, Gebrüder Borntraeger Verlagsbuchhandlung Berlin-Stuttgart
65	2004	Dumitru M.	Contribuții la studiul florei și vegetației munților Parâng (Județul Gorj)	An. Univ. Din Craiova, Fac. Hort.
66	2004	Sanda V., Biță D.C., Barabaș N	Flora cormofitelor spontane și cultivate din România	Ed. Ion Borcea,
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68	2006	Mardari C.	The historical of botanical researches realized in Neagra Broștenilor river basin	Buletinul Grădinii Botanice
69	2007	Neblea Monica	Vegetația megaforbietelor din Valea Ialomiței (Munții Bucegi)	Ecos, 19
70	2007	Sârbu Anca et al.	Arii speciale pentru protecția și conservarea plantelor în România	-
71	2008	Alexiu V.	Fitotaxoni amenințați la nivel global, european și național, identificați în județul Argeș	ECOS
72	2008	Alexiu V.	The main zoological categories of the Argeș county	Contribuții Botanice,, Grădina Botanică "Alexandru Borza"
73	2008	Chorney I. et al.	Rare, Endangered and endemic species of plants of the Chyvychny/Civcin Mountains (Carpathians)	Transylvanian Review of Systematical and Ecological Research
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77	2009	Neblea Monica	Phytosociological researches concerning habitats with <i>Ligularia sibirica</i> (L.) Cass From Meridional Carpathians	Analele Științifice ale Universității "Al. I. Cuza" din Iași: Biologie Vegetală
78	2009	Speta F.	Betrachtungen zu den Floren Siebenbürgens aus Anlass der Neuerscheinung des Bildbandes „Wildpflanzen Siebenbürgens“ von E. Speta & L. Rákósy im Jänner 2010	Schriften Verein zur Verbreitung naturwissenschaftlicher Kenntnisse
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80	2010	Oprea A. & Sîrbu C.	Phytocoenotic surveys on some mesotrophic-eutrophic marshes in Eastern Romania	J. Plant Develop
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86	2013	Brînzan T. et al.	Catalogul habitatelor, speciilor și siturilor Natura 2000 în România	-
87	2013	Matei Andreea Natalia	The importance of conservation of Bilbor swamps	Argesis Studii și Comunicări Seria Științele Naturii
88	2013	Sârbu I. et al.	Plante vasculare din România. Determinator	Victor B Victor

			ilustrat de teren	
89	2013	Mânzu C. et al.	Current and future potential distribution of glacial relict <i>Ligularia sibirica</i> (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
90	2013	Neblea Monica et al.	Data concerning forestry habitats from Buila-Vânturarița National Park	Journal of Horticulture, Forestry and Biotechnology
91	2014	Andreea Natalia Matei	Phytosociological study concerning associations with <i>Ligularia sibirica</i> (L.) Cass. in Romania	Current Trends in Natural Sciences
92	2014	Andreea Natalia Matei	Vulnerable flora species in Natural Park Bucegi	Marisia. Studii și Materiale. Științele Naturii
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96	2014	Andreea Natalia Matei	Phytosociological study concerning habitats with <i>Ligularia sibirica</i> (L.) Cass. from Harman Marsh	Annals of the University of Craiova
97	2014	Andreea Natalia Matei	Florist relicts from Harman Marsh, Argesis.	Studii și Comunicari Seria Științele Naturii
98	2015	Andreea Natalia Matei	Phytosociological study concerning habitats with <i>Ligularia sibirica</i> (L.) Cass. and <i>Cladium mariscus</i> (L.) Pohl from Hărman Marsh	Contribuții Botanice vol. L, Grădina Botanică "Alexandru Borza"
99	2015	Andreea Natalia Matei	<i>Ligularia sibirica</i> (L.) Cass. chorology in Romania and Europe, along with worldwide chorology of genus <i>Ligularia</i> .	Marisia. Studii și materiale, Științele Naturii
100	2015	Andreea Natalia Matei	Studies on <i>Ligularia sibirica</i> (L.) Cass. in to its southern point in Romania, Brusturețului Gorges, Argeș County	Current Trends in Natural Sciences
101	2015	Andreea Natalia Matei	Floristic study of Dobreanului Stream Marsh, Harghita county	Drobeta seria Științele Naturii
102	2015	Andreea Natalia Matei	Studies on <i>Ligularia sibirica</i> (L.) Cass. in its southern point in Romania, Brusturețului Gorges, Argeș county	Current Trends in Natural Sciences
103	2015	Mihăilescu S.	Ghidul de monitorizare a speciilor de plante de interes comunitar din România	Institutul de Biologie București – Academia Română
104	2016	Andreea Natalia Matei	Phytosociological study of <i>Ligularia sibirica</i> (L.) Cass. Habitats from Zănoagei Gorges (Bucegi Mountains) Romania	Marisia. Studii și Materiale, Științele Naturii,
105	2016	Matei Andreea Natalia et al.	Responses to Drought and Salinity in the Endangered Species <i>Ligularia sibirica</i> (L.) Cass.	Bulletin of University of Agricultural Sciences and Veterinary Medicine
106	2017	Ursu T. M. et al.	Review of Habitat distribution, conservation status and human impact: the case of one Natura 2000 site in the Eastern Carpathians (Romania)	Contribuții Botanice, Grădina Botanică "Alexandru Borza" LII, Cluj Napoca
107	2017	Marelena & Radu Pușcarciuc	<i>Ligularia sibirica</i> & <i>glauca</i>	Munte și flori <a href="http://www.muntesiflori.ro/li-gularia-sibirica-glauca/">http://www.muntesiflori.ro/li-gularia-sibirica-glauca/</a>

Conservation measures have been taken since 1995, when Alexiu V. et al. come with a reservation proposal on the basis of a phytocenological study in the Dâmboviței Gorges Complex, where the *L. sibirica* species was found.

Kapás A. et al. conducted in 2009, the first study in Romania aimed to identify the bioactive compounds of the *L. sibirica* species, "Obtaining and identification of bioactive compounds from *Ligularia sibirica* (L.) Cass."

In 2013 Ciprian Mânzu et al., presents a potential distribution of the *L. sibirica* species correlated with the possible climatic changes in the "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". The authors concluded that following climate changes will not affect the distribution of the species in the coming years. At the same time, they mentioned that the effectiveness of Natura 2000 system in Romania is below the optimum level.

Climate changes and the anthropic activities affect the conservation and distribution of numerous plant species, especially relict ones year by year. In order to find the response to abiotic stress caused by lack of water or soil salinization on *L. sibirica* species, Matei A.N. et al. have achieved the study in 2016, "Responses to Drought and Salinity in the Endangered Species *Ligularia sibirica* (L.) Cass.". The authors concluded that both water stress and salt stress have negative effects on the studied species.

#### 4. CONCLUSIONS

The *Ligularia* genus includes species adapted to different climatic and environmental conditions on the European and Asian continent. Following the collected scientific material containing data of *L. sibirica*, the author found a total of 166 bibliographic sources, of which 107 belong to Romania. The number of scientific materials found in Romania is closely correlated with the distribution of the *L. sibirica* species in the country.

At the European and Asian level, studies of phytosociology, genetics, biochemistry, biotechnology and phytopathology were conducted on the studied species. In our country predominant taxonomic studies have been effectuated, being part of some floral works, monographs, etc., which need to be updated.

Up to now there are just few ecological studies of *L. sibirica* species populations in addition the species has not been studied much either from biochemically or cytotoxically point of view.

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