Scientific Papers. Series A. Agronomy, Vol. LXVIII, No. 1, 2025
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

# SOME *Asteraceae* SPECIES (*Asteraceae Martinov*) IN THE COLLECTION OF "ALEXANDRU CIUBOTARU" NATIONAL BOTANICAL GARDEN (INSTITUTE) AS POTENTIAL HONEY PLANTS

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***Abstract***

*This article describes some plant species from the Asteraceae Martinov family, species with melliferous potential and multiple utility, from the collection of fodder, honey and energy plants of the "Alexandru Ciubotaru" National Botanical Garden, which includes a wide range of plants of various botanical families. Four species of non-traditional plants for the Republic of Moldova, belonging to the Asteraceae family, were selected as research subjects: Helianthus giganteus L., Silphium perfoliatum* L.*, Cynara cardunculus* L.*, Inula helenium L. These plants are known for their high potential as fodder, honey, medicinal and energy plants. They are characterized by longevity, early onset of vegetation, long and staggered generative period, attractive flowers for a wide spectrum of pollinating and honey-bearing insects. The researched species can significantly contribute to the diversification of the honey base, as an additional source of nectar and pollen for useful entomofauna as well as the beekeeping industry of the Republic of Moldova.*

***Key words****: Asteraceae Martinov, honey plants, development, flowering stages.*

## INTRODUCTION

The *Asteraceae Martinov* (*Compositae* Adans.) family encompasses 18000-20000 species, included in around 1300 genera. Evolution has produced in many directions and the principal developmental lines are summarized by grouping related genera into tribes (Benson, 1957). The family was classified in several different ways over the years. For example, Cassini (1816-1830) in his papers, described 19 tribes (King & Dawson, 1975). Later, the classification was modified and simplified. Bentham (1873) described 13 tribes: Vernoniaeae, Eupatoriacea, Asteroideae, Inuloideae, Helianthoideae, Helenioideae, Anthemideae, Senecionideae, Calendulaceae, Arctotideae, Cynaroideae, Mutisiaeae and Cichoriaceae (Bentham & Hooker, 1873). Asteraceae is an advanced and botanically highly specialized family of mainly herbaceous plants. They are widely distributed in the tropics and warm temperate regions of South, South-East an East-Asia, Africa including Madagascar and Central - South America (Sharma, 2004.)

In the spontaneous flora of Bessarabia, the family includes 70 genera with 244 species (Ionita, 2022). It includes herbaceous plants, annuals, perennials, sub-shrubs or exceptionally - trees. The stem is simple or branched. The inflorescence - solitary or numerous pseudanthia (flower heads) arranged in compound spike-like, panicle or corymb inflorescences, at the base of the flowers often with bract-like scales or setae. The flower heads consist of ray flowers and disc flowers. The androecium is pentamerous. The fruits - monospermous achenes (Comanici et al., 2022; Ionita, 2022). The flowers are grouped in what is the most notable characteristic of the family, the capitulum, a pseudanthium (i.e. an inflorescence that mimics a single flower) (Classenn -Bockhoff, 1990). It is the largest family in the phylum Magnoliophyta, consisting of food, technical, ornamental, medicinal plants, but also some harmful weeds (Comanici et al., 2022).

The Asteraceae family includes many species of major economic importance. Some of its representatives are well known sources of raw materials such as vegetable oil, sunflower seeds, lettuce, sweeteners, coffee alternatives and herbal teas, others are medicinal plants - calendula, tansy, chamomile, wormwood, arnica, coltsfoot, echinacea, elecampane, milk

thistle, chicory etc., there are also weeds like dandelion, ragwort, groundsel etc., and ornamental plants such as dahlia, zinnia, cosmos, aster, sunflowers, marigolds, chrysanthemums etc., and some are important ornamental crops for the cut flower industry. (Singh et al., 2015; Funk et al., 2009). The researched species (*Helianthus giganteus* L., *Inula helenium* L., *Silphium perfoliatum* L., *Cynara cardunculus* L.) are described in specialized literature as valuable plants with multiple uses - medicinal, fodder, honey, food, decorative, energetic (Koltowski, 2005; Mantineo et al., 2009; Bolohan et al., 2013).

Some species of the Asteraceae family are known for their high melliferous potential, and the mobilization of non-traditional ones for the Republic of Moldova can significantly contribute to broadening the range of nectar-pollen sources, ensuring maintenance harvesting and varied production during the active season for beekeeping. Researching the structure of the honey plant base and the succession of blooms is of major importance for beekeepers as it could provide for a continuous source of pollen and nectar to be collected by bees. Melliferous flora can also contribute to wild bee abundance and to crop yields through enhanced floral diversity (Hevia et al., 2016).

The goal of our research was to conduct a study on the biological aspects of the development of plant species of the Asteraceae family with multiple utility, particularly as honey plants, in order to enrich the assortment of species and varieties useful for the national economy.

## MATERIALS AND METHODS

The research was conducted within the "Alexandru Ciubotaru" National Botanical Garden (Institute), in the collection of forage, honey and energy plants, during the years 2022-2024, selecting for the current study plant species with melliferous potential, of the Asteraceae family, including less common plants for the Republic of Moldova. The selected species, according to their life form, are perennial plants with a long growing season, which can form a conveyor of flowers and food for the useful entomofauna, available from June to September. Finally, we selected as research subjects four species with high potential as honey, forage and energy crops: *Helianthus giganteus* L., *Inula helenium* L., *Silphium perfoliatum* L., *Cynara cardunculus* L. The germination capacity of the seeds of these species was determined in Petri dishes, seedlings were obtained in cell trays, under greenhouse conditions, and then the seedlings were transplanted outdoors, to the experimental sectors. The research was conducted according to the following techniques: Metodica izucenia fenologhii rastenii I rastitelinih soobscestv, Beideman, 1974.

Entomological surveys were carried out especially during the flowering stage (June - early September), at different times of the day, observations were made on the experimental sectors under various climatic conditions. The taxonomic affiliation of insects was determined using the species identification guidebook (Plaviliscicov, 1994).

The climatic conditions of the Republic of Moldova are characterized by mild winters and long, hot summers. The year 2023 was characterized by high temperature regime and a significant rainfall deficit during the August-October period. The year 2024 was also characterized by high temperature regime and rainfall deficit in the summer period, the annual amount of precipitation being 440-710 mm, and during the growing season it constituted 325-585 mm (meteo.md). According to the data from the Chisinau meteorological station, the average annual air temperature in 2024 was +13°C, that is, 3.2°C higher than normal, influencing the growth and development of agricultural crops.

## RESULTS AND DISCUSSIONS

In the collection of forage, honey and energy plants of the "Alexandru Ciubotaru" National Botanical Garden (Institute) of MSU (NBGI), there is a wide variety of plant species with multiple uses, traditional and non-traditional species for the Republic of Moldova, belonging to various botanical families. Broadening the spectrum of honey plants, with new valuable species, will significantly contribute to enriching the raw material necessary for the maintenance and development of bee colonies, capitalizing on the honey base, with the ultimate objective being to increase the productivity of beekeeping. As the impact of climate change on

biodiversity exacerbates, annual species are the most affected; in this case, non-traditional perennial honey and forage crops, in addition to providing the necessary natural food for animals, will also contribute to improving the health and productivity of bee colonies by providing new sources of nectar and pollen.
The research conducted was based on the study of the biological peculiarities of plant growth and development under the climatic conditions of the Republic of Moldova.

Table 1. Seed germination capacity

| Species | Germination capacity (%) | |
|---|---|---|
| | 2023 | 2024 |
| *H. giganteus* | 12.00±1.16 | 7,55±0,23 |
| *I. helenium* | 66.33±18.84 | 24.33±0.39 |
| *S. perfoliatum* | 40.00±12.52 | 23.75±0.72 |
| *C. cardunculus* | 61.33±11.25 | 32.00±3.46 |

The repeated determination of the germination capacity of the seeds collected from the experimental sectors of the Botanical Garden (Table 1) demonstrated that the seeds harvested in 2024 had lower germination capacity as compared with those harvested in 2023, the reason being the weather conditions recorded in the summer months, being 3.0-4.4°C higher than normal. High temperatures were also recorded in September, the average exceeding the norm with 2.5-4.5°C and with low amounts of precipitation. These phenomena negatively influence the development and formation of the seeds as well as their viability. These phenomena negatively influence the development and formation of the seeds as well as their viability. *H. giganteus* seeds have low germination capacity (year 2023 - 12.00±1.16; year 2024 - 7.55±0.23) but, from viable seeds, healthy and hardy planting material can be obtained.
The current collection includes the following species of the genus *Helianthus* L.: *H. annuus, H. tuberosus, H. mollis* and *H. giganteus*, which are species with a high degree of genetic variability, thrive on soils with medium fertility, with a long flowering stage (30-35 days), being able to provide a food conveyor for insects from June to October (Cîrlig, 2020). *H. giganteus* L. 1753. (syn.: *H. subtuberosus* Britton 1901) (Figure 1A) is known by the common name giant sunflower, chromosome number: 2n = 34 (diploid); native to Northeast USA, Southeast Canada; it is an ornamental in Central Europe; sometimes it can escape (Lajos Balogh, 2008). It is a species with long growing season and long flowering stage.



A B

Figure 1. *H. giganteus*: A - mature plant in the flowering stage, B - honeybee visiting a flower

The plants grown in the NBGI, starting with the second year of vegetation, go through the complete development cycle every year. The generative phenological stages occur in the period June-September. In the budding stage (end of June), the plants reach 160-182 cm in height, developing by 16-18 first-order shoots per plant, these shoots, in turn, developing by 6-8 second-order lateral shoots. On a first-order shoot, there are on average 47-52 leaves. The length of the leaves is 15-17 cm, and the width is 4 cm. The full flowering stage occurs from middle to late July, varying slightly depending on the weather conditions. During this period, the plants are visited by large numbers of insects, and are particularly attractive to one of the most important species of honey bees - *Apis mellifera* (Figure 1B). A bee collects nectar from a flower for 4-8 seconds. Representatives of the species *Eristalis tenax* are present on a flower for about 14 seconds. Many ants, in search of food, participate in the pollination of flowers.
*Inula helenium* L. plants, the cultivar 'ILEANA', registered in 2021 in the Catalog of Plant Varieties of the Republic of Moldova, were also studied. They are perennial plants, with the growing season beginning in early to mid-April (older plants - in late April). The flowering phase is staggered, occurring in July-August (sometimes early September) and lasting about 25-30 days, depending on the age of the plants and climatic conditions. Since the generative

phenological stages are staggered, at the same time (July 26) there can be, for example, 55 floral buds and 26 flowers on a plant. On another specimen there were 46 floral buds, 32 flowers and 2-6 wilted flowers with fruits at the stage of early ripening. During this period, the stem at the base turned brown. The flowers are yellow, with a diameter of 5-8 cm, attractive to insects (Figure 2A). The flowers were visited by insects from the families Apidae, Syrphidae, Coccinellidae, which are recognized as effective pollinators.



A B

Figure 2. A - Flowers of *I. helenium*;
B - Flowers of *S. perfoliatum*

According to the research conducted at NBGI, it has been demonstrated that the ontogenetic cycle of cup plant (*S. perfoliatum* 'Vigor', registered in the Catalogue of Plant Varieties of the Republic of Moldova (p. 37) and patented at the State Agency for Intellectual Property (AGEPI) in 2016 (Teleuță & Țîței, 2016), includes 4 life periods: latent, pregenerative, generative, postgenerative and six age stages: seed, seedling, immature, juvenile, virginal and senile. During the seedling and immature stages, plant development highly depends on climatic conditions (Cîrlig, 2022). The germination capacity of seeds depends on several factors. Viable seeds were selected and sown in cell trays to obtain seedlings, which were later transplanted in the experimental sectors. In the first year of vegetation, the plants completed only the vegetative phenological stages. Starting with the second year of vegetation, the *S. perfoliatum* plants went through the entire ontogenetic cycle characteristic of this species. The beginning of the growing season was recorded in mid- March. Since it was researched as a honey plant, particular interest was paid to the generative phase. The flowering stage (Figure 2B) of cup plant lasts for 51-63 days, occurring in the period June-August or July-September, depending on the air temperature and soil humidity. The honey bee is present on the cup plant flowers and collects pollen from one flower for about 20 seconds, then moves on to another flower on the same plant. *S. perfoliatum* is known as a plant with high melliferous potential (150-450-560 kg honey/ha) (Koltowski, 2005), the nectar productivity can vary, between 205.2 and 611.6 kg/ha, being closely related to the quality of the soil and the amount of mineral fertilizers applied (Savin & Gudimova, 2019). Previous research conducted at NBGI demonstrated the presence, on *S. perfoliatum* plants, of 10 insect species belonging to 4 orders (Hymenoptera, Diptera, Coleoptera, Lepidoptera) and 6 families (Apidae, Halictidae, Syrphidae, Sarcophagidae, Cerambycidae, Satyridae) (Cîrlig, 2022).



A B

Figure 3. *C. cardunculus*: A - plants in the budding stage; B - flowers visited by insects

The species *Cynara cardunculus* L. (Figure 3), common names - cardoon or artichoke, under the climatic conditions of the Republic of Moldova, shows high tolerance to climatic factors, but temperatures below 0°C in spring can affect young plants, which easily recover once positive temperatures are recorded. In 2024, an experimental plot of *C. cardunculus* was obtained from seedlings started indoors, in cell trays. When the plants were 12-16 cm tall, they were transplanted to open ground, in late April, when the weather conditions were favorable for plants (the temperature recorded in April was +13°C…+15°C). At this stage, 5-6 leaves were developed, with a length of 12-14 cm and width of 3-4 cm. In the first year of vegetation, the plants developed only the rosette of basal leaves, which reached about 25-35 cm in height. In *C. cardunculus* plants, in the first

year of vegetation, the green leaves persisted till November.

Starting in the second year, the plants develop erect stems with alternate stem leaves and go through the full cycle of vegetative and generative phases. The flowering stage in artichokes occurs in July and lasts about 20 days. The number of inflorescences per plant at the beginning of July is on average 3.50±0.22. The inflorescence is a solitary terminal flower head, with purple-violet flowers. During this period, the flowers are abundantly visited by insects, the plants being described in the specialized literature as potential honey plants, with a productivity of 150-400 kg/honey/ha (https://www.apiterapie.ro/). The production potential of honey plants differs from year to year and directly depends on the weather conditions recorded in that year.

The phenological spectrum was determined by field surveys made at 2-4 day intervals. During the growing season, plants manage to go through the entire cycle of vegetative and generative phenological stages. In the current study, the generative phenological stages were highlighted - budding, flowering and fruiting (Table 2). The beginning of the growing season varies from one species to another and takes place between late March, for *C. cardunculus* (17.03.2023/20.03.2024) and late April, for *H. giganteus* (20.04). The full flowering stage was recorded in mid-July, but the periods of fruit formation and development were more diverse, depending on the duration of the flowering stage of each species. In the species *H. giganteus* and *S. perfoliatum* the fruit development stage was recorded in early to mid-September. The end of the growing season (beginning of dormancy), regardless of the species and age of the plants, took place in autumn, in October-November, when freezing temperatures were recorded at night (-2°C-4°C). The dry leaves fell from the shoot, only dry and browned seeds remained on the stems.

Table 2. The phenological spectrum of the studied species

| Year | 2022 | | | | 2023 | | | | 2024 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | S | B | Fl | Fr | S | B | Fl | Fr | S | B | Fl | Fr |
| *H. giganteus* | 20.04 | 07.09 | 28.09 | 15.10 | 08.04 | 25.06 | 20.07 | 18.09 | 4.04 | 28.06 | 28.07 | 13.09 |
| *I. helenium* | 12.04 | 08.06 | 14.07 | 06.08 | 11.04 | 12.06 | 18.07 | 15.08 | 10.04 | 12.06 | 06.07 | 16.07 |
| *S. perfoliatum* | 04.04 | 22.06 | 11.07 | 04.09 | 03.04 | 22.06 | 18.07 | 06.09 | 02.04 | 21.06 | 08.07 | 02.09 |
| *C. cardunculus* | 01.04 | 13.06 | 20.07 | 16.08 | 17.03 | 20.06 | 23.07 | 18.08 | 20.03 | 16.06 | 15.07 | 20.08 |

Note: S - sprouting; B - budding; Fl - flowering; Fr - fruit development.

The flowering stage of the researched species is long, staggered, they can form a food conveyor for useful entomofauna during the months of July-September, which also demonstrates the presence of a wide spectrum of insects in the flowering stage, insects that actively participate in the pollination process. The flowers are visited by insects throughout the day, from early morning until evening. Representatives of the Apidae family, which includes bumblebees, solitary bees, stingless bees and honey bees, are present in large numbers on flowers. There are approximately 700 species of bees in Central Europe, and the honey bee is the only pollinator species that lives in perennial societies (Kunast et al, 2023). From an ecological point of view, bees are considered biological resources that play an essential role in the perpetuation and survival of numerous plant species on Earth, being a true biometer of ecological balance (Lazăr & Vornicul, 2007).

Most bees depend on a diversity of plant species, requiring a constant supply of nectar and pollen. In addition to Apidae species, recognized as the most basic pollinators (*Apis mellifera, Bombus* species), individuals of the *Eristalis tenax* species, Coccinelide species, and ants were detected on the researched plants. The species *Cetonia aurata* and *Epicometis hirta* are often found on artichoke flowers. The insects are active throughout the day, but between 12:00 and 14:00, their number is lower on the plants, the air temperature during this period reaching its maximum in July and August.

## CONCLUSIONS

The results of the research carried out at the "Alexandru Ciubotaru" National Botanical Garden (Institute) on plants from the Asteraceae family (*Helianthus giganteus* L., *Inula helenium* L., *Silphium perfoliatum* L., *Cynara*

*cardunculus* L.) have demonstrated the melliferous potential of the studied species, which would help broadening the spectrum of honey plants available in the Republic of Moldova, for the possibility of organizing an uninterrupted honey conveyor for a long period. Phenological and entomofaunistic research has demonstrated that the plants studied have honey value, through their long flowering period (*S. perfoliatum* 51-63 days, *H. giganteus* 30-35 days) as well as the presence in large numbers of *Apis mellifera* specimens on flowers throughout the flowering phase of the plants. The researched species can serve as alternative honey plants for the Republic of Moldova, by extending the honey season to August-September. Besides, they are valuable plants to support the useful entomofauna, along with other species of traditional honey plants. These species are characterized by long growing season and staggered flowering stage, which corresponds to the period of June-September. The germination capacity of seeds varies from year to year, being influenced by temperature and the amount of humidity. All the plants come out of dormancy in early spring, in 2024 - *C. cardunculus* on 20.03; *S. perfoliatum* - 02.04; *H. giganteus* 04.04 and *I. helenium* - 10.04.

The plants provide food for a wide range of insects, especially representatives of the Apidae family: *Apis mellifera*, *Bombus* species, known as honey producing insects and active pollinators. The honey bee collects pollen and nectar from a *H. giganteus* flower for 4-8 seconds, from a *S. perfoliatum* flower for about 20 seconds.

## ACKNOWLEDGEMENTS

This research has been supported by the subprogram no. 01.01.02 "*Identification of valuable forms of plant resources with multiple uses for the circular economy*".

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