

## THE STATE OF THE POPULATIONS OF *NECTAROSCORDUM BULGARICUM* IN THE STRICTLY PROTECTED ZONE OF THE “CODRII” RESERVE, REPUBLIC OF MOLDOVA

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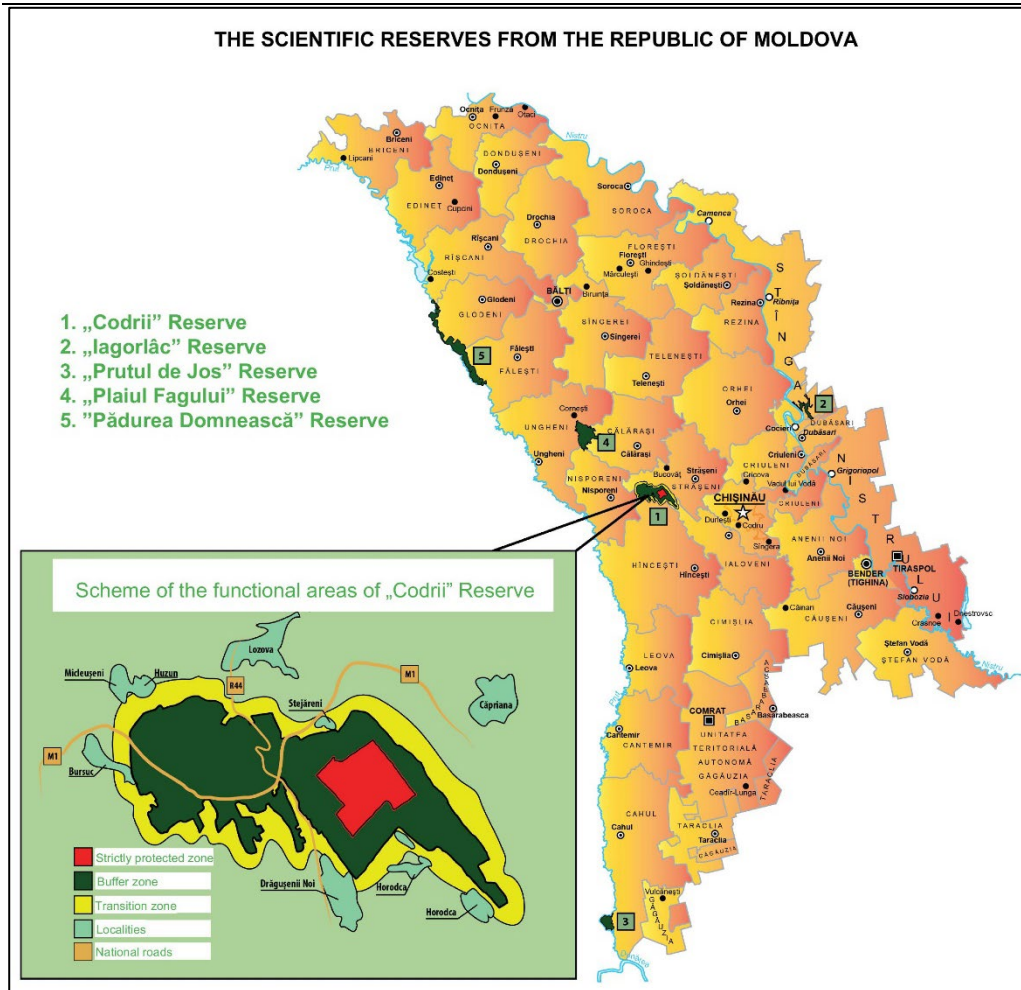
**Abstract:** *Nectaroscordum bulgaricum* – Honey garlic, a vulnerable species, included in the Red Book of the Republic of Moldova, is territorially protected in the “Codrii” Reserve. The aim of the study was to identify and describe the Honey garlic populations, as a result the trend of the species will be estimated. As a result, 11 populations were identified and described in subplots: 40E, F, K; 41B, J, K; 42H; 46A, E, D and 49E. The geographical coordinates were taken and the map with the location of the identified populations was developed. The state of the populations of Honey garlic in the strictly protected zone of the “Codrii” Reserve was evaluated.

**Keywords:** Honey garlic, population, protected area, rare species.

### Introduction

The „Codrii” Reserve occupies a special place among the protected areas of the Republic of Moldova and is the first reserve created with the status of a scientific research unit, by the Decision of the Council of Ministers of 27.09.1971, in order to preserve the most representative sectors of forests typical of the area of the Central Plateau of Codrii (Figure 1). The territory of the reserve has a special protection status, delimited into three functional zones: the strictly protected zone, the buffer zone and the transition zone.

The strictly protected area of the “Codrii” Reserve includes the sectors with the habitats of rare animal and plant species of universal value from a scientific and conservation point of view. It occupies an area of 723 ha and is intended for scientific research. The general character of the integral protection zone is determined by the presence of hills that follow each other in waves, and the general exposure determined by the relief and water drainage is south-east. The maximum altitude is 353 m, and the minimum 193 m. The territory of the integral protection zone is within the hydrological basin of the Botna River (tributary of the Dniester). The hydrographic network consists of multiple streams with seasonal flow - tributaries of the Botna, accumulating the surface runoff that forms after the rains. The soil, station and forest types are characteristic of the phytoclimatic floor – *Hilly oak forest with sessile oak and mixed forests on hills and beech forests of the inferior limit*. Light gray soils predominate. Mixed forests with sessile oaks on hills (51%) and sessile oak-mixed forests (19%) are representative for the forests of the integral protection zone [Forestry Research and Development Institute - Institutul de Cercetări și Amenajări Silvice (ICAS), 2020].



**Figure 1.** Location of the „Codrii” Reserve on the territory of the Republic of Moldova

The floristic inventory of the strictly protected area consists of 222 species of vascular plants, of which 32 are state protected plant species, which constitutes 53% of the total species protected by law on the territory of the “Codrii” Reserve [JARDAN, 2018]. Of these, 10 species are included in the Red Book of the Republic of Moldova (3<sup>rd</sup> edition): *Athyrium filix-femina* (L.) Roth, *Cephalanthera damasonium* (Mill.) Druce, *Cephalanthera longifolia* (L.) Fritsch, *Dryopteris filix-mas* (L.) Schott, *Epipactis purpurata* Sm., *Nectaroscordum bulgaricum* Janka, *Ornithogalum flavescens* Lam., *Polypodium vulgare* L., *Scopolia carniolica* Jacq. and *Thelypteris palustris* Schott [Red Book of Republic of Moldova, 2015].

Periodic assessment of the ecological status of rare plant populations is a necessity of major importance, in order to highlight the long-term trend of rare species. The purpose of the study was to identify and describe the populations of *Nectaroscordum bulgaricum* Janka in the strictly protected area of the “Codrii” Reserve.

*Nectaroscordum bulgaricum* is a Ponto-Balkan species, widespread in the Balkan Peninsula, Cyprus, Romania, Crimea, the Western Caucasus, Asia Minor [OMELICIUC-MEACUȘCO, 1979; STEARN, 1980]. In the Republic of Moldova it grows, at the northern limit of its Ponto-Balkan area, in the Telenești, Strășeni, Cîmislia, Leova, Hîncești and Cantemir districts [GHENDOV & CIOCÂRLAN, 2015].

*Nectaroscordum bulgaricum* Janka (honey garlic) – is a perennial, glabrous plant. Ovoid bulb, with a specific smell. Stem erect, unbranched, smooth. Loose inflorescence, consisting of 2-3 uniparous cymes, with 20-40 green-yellowish-violet flowers. Tepals or Perianth segments fleshy or thin, after flowering gathered in a cone. Fruit an ovoid capsule. Black seeds, relatively large, 3-edged. Blooms in May-June, fruits in June-July. Mesophilic, mesothermic, acid-neutrophilic species. Vulnerable species, included in the Red Book of the Republic of Moldova. Protected in the “Codrii” Reserve, in the landscape reserves “Hîncești”, “Căpriana-Scoreni”, “Cărbuna” and in the natural reserve of medicinal plants “Logănești” [CIUBOTARU & al. 2007; GHENDOV & CIOCÂRLAN, 2015].

### Materials and methods

The present study is based on the field researches carried out during the years 2022-2023, by following some itineraries that cover as representative as possible the strictly protected area within the “Codrii” Reserve.

The nomenclature of the species is presented according to fundamental works in the field [GHEIDEMAN, 1986]. In the population study of the species *Nectaroscordum bulgaricum*, the GPS coordinates were taken, the numerical effectivity of the populations, the ontogenetic stage of each individual, the vitality of the individuals as well as the populations, and the accompanying plant species were recorded. The population size has been determined by extrapolating the average density of individuals to the total area of the population. The average density of individuals was determined in sample areas of 1 m<sup>2</sup> (3-5 sample areas, depending on the population size). The geographic coordinates were taken over using the GPSMAP64s GPS device, GARMIN. The map regarding the location of *Nectaroscordum bulgaricum* populations in the strictly protected area of the reserve was developed using the application QGIS.

### Results and discussions

According to information from the literature, the presence of the species *Nectaroscordum bulgaricum* within the limits of the “Codrii” Reserve was reported in 1976 by GHEIDEMAN (1976). In 1984 it was indicated in plots 46, 48 and 49 of the strictly protected area, occupying areas of 2-3 m<sup>2</sup> [NIKOLAEVA, 1984; GHEIDEMAN & al. 1980]. To the inventory of the area with integral protection from 1993, STURZA & al. (1994) also reported the species in the plots 41 and 42.

As a result of our field research, in the strictly protected area of the “Codrii” Reserve, 11 populations of Honey garlic were identified in the subplots: 40E, F, K; 41B, J, K; 42H; 46A, E, D and 49E, type of station, *Hilly oak forest with sessile oak, mixed forests with sessile oak on plateaus, sunny and partly sunny slopes, with gray soils* [JARDAN, 2023]. The geographical coordinates were taken and the map with the location of the identified populations was drawn up (Figure 2).

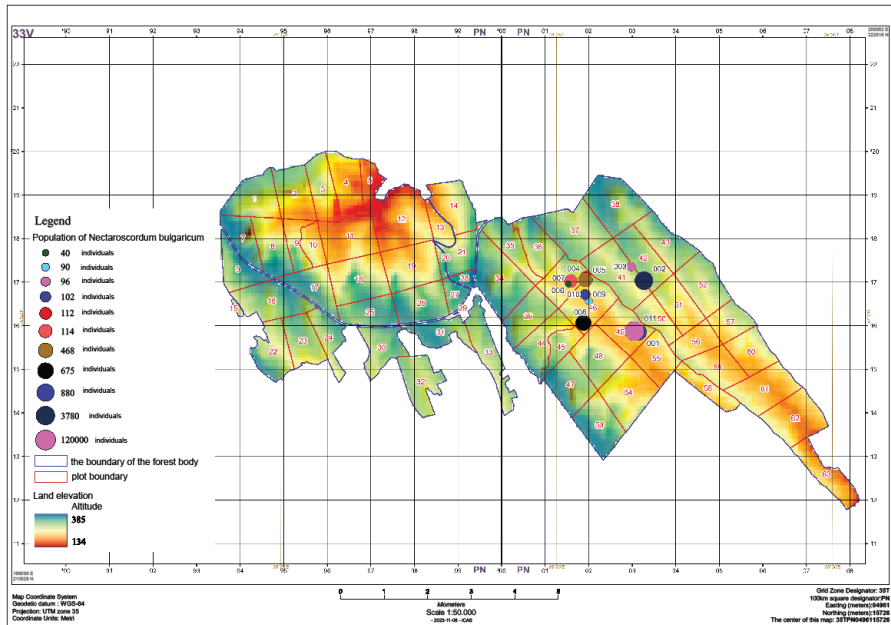


Figure 2. Map with the location of *Nectaroscordum bulgaricum* populations

The first recorded population of *Nectaroscordum bulgaricum* (on the date of 19.05.2022) in subplot 49E grows on an undulating slope with SW exposure, altitude 282 m, in a mixed forest with sessile oaks on hills – fundamental natural stand of superior productivity, consistency 0.8, age average 90 years. The upper floor of the trees consists of *Quercus petraea*, *Quercus robur*, the lower floor of *Fraxinus excelsior*, *Tilia cordata*, *Acer campestre*, *Carpinus betulus*, the layer of shrubs is represented by *Cornus mas*, *Crataegus monogyna*, *Corylus avellana*, *Viburnum lantana*. The herbaceous layer covers about 85% of the soil and includes: *Alliaria petiolata*, *Anemonoides ranunculoides*, *Arum orientale*, *Asparagus tenuifolius*, *Carex brevicollis*, *Carex pilosa*, *Carex sylvatica*, *Dentaria bulbifera*, *Fallopia dumetorum*, *Geum urbanum*, *Glechoma hirsuta*, *Lamium maculatum*, *Lapsana communis*, *Lunaria annua*, *Melica uniflora*, *Mycelis muralis*, *Polygonatum hirtum*, *Scutellaria altissima*, *Stellaria holostea*, *Stellaria media*, *Symphytum tauricum*, *Viola odorata*.

The population occupies an area of 220 m<sup>2</sup>, with a density of 4 specimens per m<sup>2</sup>. The share of juvenile individuals is 98% and generative ones – 2%.

The second population grows at the intersection of three subplots 41J, K and 42H (registered on 03.05.2023), on an upper undulating slope with SW and SE exposures, altitude 312 m, in a mixed forest with sessile oaks on hills and sessile oak-mixed forest - fundamental natural stand of superior productivity, consistency 0.8, average age 95 years. The upper layer of the trees is made up of *Quercus petraea*, the lower layer of *Fraxinus excelsior*, *Tilia cordata*, *Acer platanoides*, *Carpinus betulus*, the layer of shrubs is represented by *Cornus mas*. The grass cover covers the soil on about 80% of the surface and includes: *Allium ursinum*, *Anthriscus cerefolium*, *Asparagus tenuifolius*, *Carex sylvatica*, *Corydalis marschalliana*, *Dentaria bulbifera*, *Ficaria verna*, *Galium aparine*, *Geum urbanum*, *Glechoma hirsuta*, *Lamium*

*maculatum*, *Melica uniflora*, *Mercurialis perennis*, *Polygonatum hirtum*, *Pulmonaria officinalis*, *Stellaria media*, *Veronica hederifolia*, *Viola odorata*.

The given population occupies an area of 1260 m<sup>2</sup>, with a population density of 3 individuals per m<sup>2</sup>. Generative specimens predominate (97%), but juvenile ones constitute only 3%.

The third population grows in subplot 41B, on an undulating slope, with SW exposure, altitude 306 m, in sessile oak-mixed forest - fundamental natural stand of superior productivity, consistency 0.8, average age - 90 years. The upper floor is represented by *Quercus petraea* and *Fraxinus excelsior*, the lower one of *Tilia cordata*, *Acer campestre*, *Carpinus betulus*, the shrub layer is represented by *Cornus mas* and *Crataegus monogyna*. The herbaceous cover covers the soil on about 70% of the surface and includes: *Allium ursinum*, *Dentaria bulbifera*, *Ficaria verna*, *Galium aparine*, *Glechoma hirsuta*, *Lamium maculatum*, *Melica uniflora*, *Polygonatum hirtum*, *Stellaria holostea*, *Stellaria media*, *Veronica hederifolia*.

This population occupies an area of 56 m<sup>2</sup>, with a population density of 1.6 specimens/m<sup>2</sup>, predominating generative individuals with 75%, juvenile ones constitute 25%.

The fourth population was recorded in subplot 40F, on an upper undulating slope with SW exposure, altitude 307 m, in a mixed forest with sessile oaks on hills – total stand derived of superior productivity, consistency – 0.8, average age 95 years. The upper layer of the trees is made up of *Quercus petraea*, the lower layer of *Fraxinus excelsior*, *Tilia cordata*, *Acer campestre*, *Carpinus betulus*, the layer of shrubs is represented by *Cornus mas*. The grass cover covers the soil on about 70% of the surface and includes: *Alliaria petiolata*, *Anthriscus cerefolium*, *Asparagus tenuifolius*, *Corydalis marschalliana*, *Fallopia dumetorum*, *Galium aparine*, *Glechoma hirsuta*, *Lamium purpureum*, *Melica uniflora*, *Polygonatum hirtum*, *Stellaria holostea*, *Veronica hederifolia*.

The population covers an area of 153 m<sup>2</sup>, with a population density of 0.7 individuals/m<sup>2</sup>, predominating the generative specimens (97%).

The fifth population was identified in subplot 46E, on an upper undulating slope with SW exposure, altitude 289 m, in mixed forest with sessile oaks on hills – fundamental natural stand of superior productivity, consistency – 0.8, average age 100 years. The upper layer of the trees is made up of *Quercus petraea*, *Fraxinus excelsior*, the lower layer of *Acer campestre* and *Carpinus betulus*, the layer of shrubs is represented by *Cornus mas*. The grass cover covers approximately 75% of the soil from the surface and includes: *Alliaria petiolata*, *Anemonoides ranunculoides*, *Anthriscus cerefolium*, *Arum orientale*, *Asparagus tenuifolius*, *Corydalis marschalliana*, *Fallopia dumetorum*, *Galium aparine*, *Glechoma hirsuta*, *Lamium maculatum*, *Mycelis muralis*, *Polygonatum hirtum*, *Stellaria media*, *Veronica hederifolia*.

The population covers an area of 383 m<sup>2</sup>, with a population density of 1.2 individuals/m<sup>2</sup>, predominating the generative specimens (96%).

The sixth population of *Nectaroscordum bulgaricum* recorded in subplot 40E grows on a medium undulating slope with SW exposure, altitude 293 m, in sessile oak-mixed forest – fundamental natural stand of superior productivity, consistency – 0.8, average age 100 years. The tree layer is made up of *Quercus petraea*, *Fraxinus excelsior* and *Tilia tomentosa* on the upper floor, and the lower one from *Acer platanoides*, *Sorbus torminalis*, the shrub layer is represented by *Cornus mas*, *Viburnum lantana*, *Crataegus monogyna*. The herbaceous cover covers the ground on about 80% of the surface and includes: *Alliaria petiolata*, *Allium ursinum*, *Anemonoides ranunculoides*, *Corydalis marschalliana*, *Dentaria bulbifera*, *Galium aparine*, *Glechoma hirsuta*, *Mercurialis perennis*, *Polygonatum hirtum*, *Stellaria holostea*, *Veronica hederifolia*, *Viola hirta*.

The population extends over an area of 25 m<sup>2</sup>, with a population density of 3.8 individuals/m<sup>2</sup>, generative specimens predominating (97%), juveniles constituting 3%.

The seventh population was recorded in subplot 40K, on an undulating lower slope with SW exposure, altitude 276 m, in mixed forest with sessile and pedunculate oaks on hills – high productivity fundamental natural stand, almost full consistency – 0.9, average age 95 year old. The upper floor of the trees is made up of 135-year-old *Quercus robur*, the lower floor of *Quercus petraea*, *Fraxinus excelsior*, *Acer campestre* and *Carpinus betulus*, the layer of shrubs is represented by solitary specimens of *Cornus mas*. The herbaceous cover covers the ground on about 75% of the surface and includes: *Anthriscus cerefolium*, *Dentaria bulbifera*, *Ficaria verna*, *Galium aparine*, *Geum urbanum*, *Glechoma hirsuta*, *Lamium maculatum*, *Melica uniflora*, *Polygonatum hirtum*, *Stellaria holostea*, *Viola hirta*.

The population occupies an area of 14 m<sup>2</sup>, with a population density of 2 individuals/m<sup>2</sup>, generative specimens predominating (95%).

Population number eight was identified in subplot 46A, on an undulating lower slope with SE exposure, elevation 229 m, in mixed forest with sessile and pedunculate oaks on hills – partially derived stand, consistency – 0.8, average age 90 years. The upper floor of the trees consists of *Quercus robur*, *Quercus petraea* with 120 years old, the lower one – *Fraxinus excelsior*, *Acer campestre*, *Acer platanoides*, *Tilia tomentosa* and *Carpinus betulus*, the shrub layer is represented by *Viburnum lantana*, *Cornus mas*. The grass cover covers the soil on about 75% of the surface and includes: *Anthriscus cerefolium*, *Asparagus tenuifolius*, *Galium aparine*, *Geum urbanum*, *Glechoma hirsuta*, *Lamium maculatum*, *Polygonatum hirtum*, *Pulmonaria officinalis*, *Stellaria holostea*, *Stellaria media*, *Veronica hederifolia*, *Viola hirta*.

The population occupies an area of 222 m<sup>2</sup>, with a population density of 3 individuals/m<sup>2</sup>, generative specimens predominating (95%).

The ninth population of *Nectaroscordum bulgaricum* registered in subplot 46D grows on a flat lower slope with SW exposure, altitude 215 m, in oak-sessile oak-mixed forest - artificial stand of superior productivity, consistency – 0.9, average age 40 years. The layer of trees is composed of *Quercus robur* on the upper floor, and the lower layer of *Fraxinus excelsior*, *Tilia cordata*, *Carpinus betulus*, *Acer campestre*, the layer of shrubs is represented by *Crataegus monogyna*. The herbaceous cover covers the ground on about 80% of the surface and includes: *Ajuga reptans*, *Asarum europaeum*, *Dentaria bulbifera*, *Ficaria verna*, *Galium aparine*, *Galium odoratum*, *Geum urbanum*, *Glechoma hirsuta*, *Hedera helix*, *Polygonatum hirtum*, *Sanicula europaea*, *Stellaria holostea*, *Viola hirta*.

The population extends over an area of 24 m<sup>2</sup>, with a population density of 3 individuals/m<sup>2</sup>, with generative specimens predominating (99%), juveniles constituting only 1%.

Population number ten was recorded in subplot 46E, on an undulating slope with SW exposure, altitude 231 m, in mixed forest with sessile oaks on hills – high productivity fundamental natural stand, consistency – 0.8, average age 100 years. The upper floor of the trees is made up of *Quercus petraea*, the lower floor of *Fraxinus excelsior*, *Acer campestre*, *Tilia tomentosa* and *Carpinus betulus*, the layer of shrubs is represented by *Crataegus monogyna*, *Viburnum lantana*, *Cornus mas*. The grass cover covers the soil on about 70% of the surface and includes: *Aegopodium podagraria*, *Asparagus tenuifolius*, *Dentaria bulbifera*, *Ficaria verna*, *Hypericum hirsutum*, *Lamium purpureum*, *Mercurialis perennis*, *Stellaria holostea*, *Veronica hederifolia*.

The population consists of three clumps and occupies an area of 34 m<sup>2</sup>, with a population density of 3 individuals/m<sup>2</sup>, predominating the generative specimens (98%).



The 11<sup>th</sup> population of *Nectaroscordum bulgaricum* recorded in subplot 49E grows on an undulating slope with SW exposure, altitude 262 m, in mixed forest with sessile oaks on hills – fundamental natural stand of superior productivity, consistency – 0.8, average age 90 years. The layer of trees is made up of *Quercus petraea* on the upper floor, and the lower one of *Quercus robur*, *Fraxinus excelsior*, *Tilia cordata*, *Carpinus betulus*, *Acer campestre*, the shrub layer is represented by *Cornus mas*, *Viburnum lantana*, *Crataegus monogyna*. The herbaceous cover covers the soil on about 85% of the surface and includes: *Aegonichon purpureo-caeruleum*, *Alliaria petiolata*, *Allium ursinum*, *Anthriscus cerefolium*, *Asparagus tenuifolius*, *Carex brevicollis*, *Dactylis glomerata*, *Dentaria bulbifera*, *Fallopia dumetorum*, *Galium aparine*, *Glechoma hirsuta*, *Hedera helix*, *Lamium maculatum*, *Lapsana communis*, *Melica uniflora*, *Mercurialis perennis*, *Polygonatum hirtum*, *Pulmonaria officinalis*, *Stellaria holostea*, *Symphytum tauricum*, *Urtica dioica*, *Veronica hederifolia*, *Viola hirta*. The population extends over an area of 3 ha, with a population of 4 individuals/m<sup>2</sup>, with generative specimens predominating (98%), juveniles constituting only 2% (Figure 3).



**Figure 3.** The population of *Nectaroscordum bulgaricum* in subplot 49E

Phenological observations were made on the given species, recording the following phases: vegetative, budding, flowering, fruiting and senescence (Figure 4, Table 1).



Figure 4. The development phases of sp. *Nectaroscordum bulgaricum*

Table 1. Phenological phases of sp. *Nectaroscordum bulgaricum*

The characteristic of the phenological phases	Phenological phases				
	The beginning of vegetation	Budding	Flowering	The beginning of fruiting	Senescence
<b>2022</b>					
Date	14.02	16.05-20.05	20.05-06.06	01.06	16.05-04.07
Phase duration (days)		5	17		49
The sum of positive temperatures at the beginning of the phenological phases (°C)	25.8	700.0	758.4	965.5	700.0
<b>2023</b>					
Date	17.02	18.05-22.05	22.05-9.06	06.06	15.05-10.07
Phase duration (days)	-	4	17	-	56
The sum of positive temperatures at the beginning of the phenological phases (°C)	17.2	757.2	826.7	1089.7	704.3



The Honey garlic started its vegetative period on February in the territory of the reserve, when the sum of positive average temperatures reached 17-26°C. Budding lasted 4-5 days, after 90 days from the initiation of the vegetative phase. The beginning of the flowering period was recorded in the third decade of May, when the sum of positive temperatures exceeded 750°C and lasted for 17 days. The drying of the vegetative organs started during the formation of buds, on May, ending the vegetative phase on July with the complete drying of the plants.

As a result of the study, the state of the populations of Honey garlic species in the strictly protected area of the “Codrii” Reserve was evaluated. In the coming years, the monitoring of the populations will continue with the estimation of the long-term trend of the species *Nectaroscordum bulgaricum*.

### Conclusions

11 populations of *Nectaroscordum bulgaricum* Janka were identified and described in the strictly protected area of the “Codrii” Reserve with the location of the growth points on the map.

The presence of the Honey garlic in plot 40 was reported for the first time.

The largest population of *Nectaroscordum bulgaricum* in the strictly protected area extends over an area of 3 ha, with an effective of 4 individuals/m<sup>2</sup>.

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