

First record of *Cistus salviifolius* L. (Cistaceae) for the flora of North Macedonia

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Key words: Sageleaf Rockrose, new record, Macedonian flora, habitat, distribution, conservation status.

Ključne besede: kaduljelistni brškin, nove najdbe, flora Makedonije, habitat, razširjenost, ohranitveni status.

Abstract

The watershed of river Crn Drim in south-western parts of North Macedonia (Galičica and Jablanica mountains with the Ohrid valley in between) are under the influence of transitional mild continental to modified (sub)Mediterranean climate. These conditions support the development of rich flora and vegetation with presence of many relict and endemic species. Such is *Cistus salviifolius* L. (Sageleaf Rockrose) of the family Cistaceae, a species with Circum–Mediterranean distribution. This paper presents the first record of this species in North Macedonia, in the vicinity of Ohrid town (Trojani area), about 60km away from its nearest locality in Albania. The flora and vegetation associated with *Cistus salviifolius* in Trojani area are significantly different from the studied ones in which this species thrives in Northern Greece. Most of the recorded individuals develop on eroded regosols on silicate bedrock (phyllitic schists). Considering the small extent of occurrence in North Macedonia (62 ha), the threat status of *Cistus salviifolius* was assessed as Endangered [EN B1a+2a]. Future biogeographical studies supported by molecular analysis can explore distribution pathways, as well as past and present ecological conditions in the watershed of river Crn Drim.

Izveček

Razvodje reke Črni Drim v jugozahodnem delu Severne Makedonije (gorovji Galičica in Jablanica in Ohridska dolina med njima) je pod vplivom prehodne blage celinske do spremenjene (sub)mediteranske klime. V teh razmerah sta se razvili bogata flora in vegetacija s prisotnostjo številnih reliktnih in endemičnih vrst. Takšna vrsta je *Cistus salviifolius* L. (kaduljelistni brškin) iz družine Cistaceae, ki je razširjena v Sredozemlju. V prispevku predstavljamo prvi zapis o tej vrsti v Severni Makedoniji v bližini mesta Ohrid (območje Trojani), približno 60 km od njenega najbližjega nahajališča v Albaniji. Flora in vegetacija na najdišču vrste *Cistus salviifolius* na območju Trojani se bistveno razlikujeta od sedaj znanih v severni Grčiji. Večina primerkov uspeva na erodiranih regosolih na silikatni kamninski podlagi (filitni skrilavci). Glede na majhen obseg razširjenosti v Severni Makedoniji (62 ha) ocenjujemo status ogroženosti vrste *Cistus salviifolius* kot ogrožen [EN B1a+2a]. Prihodnje biogeografske raziskave, podprte z molekularno analizo, lahko razkrijejo smeri razširjanja vrste, pa tudi pretekle in sedanje ekološke razmere v porečju reke Črni Drim.

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Introduction

The genus *Cistus* contains 21 species, most of them with Mediterranean distribution or confined to Canary Islands (Guzmán et al., 2009). The highest diversity with 14 species occurs in the western Mediterranean: Iberian Peninsula and northwestern Africa (Guzmán & Vargas, 2005). In general, *Cistus* species are divided into two phylogenetic lineages: white-flowered species (12) which consist the subgenus and purple-flowered species (9). The groups of *Cistus salvifolius* (10 species) and *C. clusii* (2 species) make the white-flowered lineage (Guzmán et al., 2009). Sometimes these two groups are treated as subgenera *Leucocistus* Willk. and *Halimiodes* (Willk.) Demoly & P. Monts while purple-flowered species consist the third subgenus *Cistus* L. (Barrajón-Catalán et al., 2011; Lukas et al., 2021). Lately, *Halimium* (Dunal) Spach species were also included in the genus *Cistus* (von Raab-Straube, 2018) following the proven monophily of the *Cistus-Halimium* complex (Guzmán et al., 2009).

Cistus salvifolius radiated 0.82 ± 0.20 mya (million years ago) within the white-flowered *Cistus* lineage which started to appear 1.046 ± 0.25 mya and this diversification likely occurred after the development of Mediterranean climate 2.8 mya (Guzmán et al. 2009).

C. salvifolius is the most widespread species of *Cistus* genus and it is usually part of the understorey in forests and woodlands inhabiting many other habitats (Fernández-Mazuecos & Vargas, 2010). It spreads around the Mediterranean Basin, from Portugal to Greece, Turkey and Israel, extending to North Africa, though it may be locally disjunct and forming isolated population (Farley & McNeilly, 2004; Fernández-Mazuecos & Vargas, 2010). This species is insect-pollinated (entomophilous) (Moretti et al., 2020). The studies on the seed dispersal of *Cistus salvifolius* revealed no apparent mechanism of distant dispersal (Skourou & Arianoutsou, 2004; Tavsanoglu, 2010).

Cistus salvifolius has pharmaceutical, antifungal and antimicrobial properties (Demetzos et al., 2002; Rebaya et al., 2016) and lately it was used in phytostabilization and remediation of mine wastes (Abreu et al., 2012; Carvalho et al., 2020).

The genus *Cistus* was represented so far by only one taxon in the flora of North Macedonia – *Cistus creticus* L. ssp. *eriocephalus* (Viv.) Greuter & Burdet (= *Cistus tauricus* C. Presl.) which in the monograph of the flora of North Macedonia was presented sub. *C. incanus* L. (Micevski, 1995), a species with purple flowers. This taxon is distributed mostly in south-eastern parts of the country (Strumica, Dojran, Valandovo, Gevgelija and Demir Kapija) with additional occurrence in the areas of Mariovo, Pr-

ilep Kavadarci (Drenovo) and Jablanica (Micevski, 1995; Teofilovski, 2017). This species is also known from the Greek part of Prespa watershed (Strid et al., 2020). This species is characteristic and diagnostic of the association *Diantho-Cistetum incani* Micevski et Matevski ex Čarni, Matevski et Šilc, 2010 distributed in North Macedonia, Bulgaria and Greece (Čarni et al., 2010).

The presence of another *Cistus* species besides *C. creticus* ssp. *eriocephalus* in North Macedonia was expected when analysing the distribution maps of the other *Cistus* species in Albania and Greece (Barina et al., 2016; Strid, 2024). The aim of this paper is to present the first record of *Cistus salvifolius* in North Macedonia (Ohrid valley) as well as to describe its plant community, preference to geologic substrates and soils and discuss its conservation status.

Site description

The hills of Trojani are situated in the southwest part of North Macedonia, in the Ohrid valley, north of Lake Ohrid. It belongs to the Ohridsko Pole area -30834b according to the division of Melovski et al. (2013). Galičica mountain to the east and Jablanica mountain to the west surround the Ohrid valley.

The hilly massif of Trojani was named after a historic village Trojani that was situated above village Dolno Lakočerej. The highest peak is Gorenička Krasta also known as Bajrak (1203m). The lowest part of the Trojani hill massif is at altitude of 725 m which represents the floodplain formed by Lake Ohrid.

Lake sediments are present in the floodplain, while phylitic schists are dominant in the hilly area with smaller outcrops of alluvial or diluvial sediments, dolomites or marbled limestones (Dumurdzhanov & Ivanovski, 1972). The pedology is mainly represented by complex mix of cambisols, leptosols and regosols developing on phyllitic schists (MASIS, 2015).

The climate of Ohrid valley is influenced by its altitude (above 700 m), the presence of large Lake Ohrid and the corridor through created by the river Crn Drim. Rainfall in the Ohrid valley is determined by the Mediterranean pluviometric regime (Lazarevski, 1993).

Materials and Methods

Fieldwork at the locality Trojani (v. Dolno Lakočerej, Ohrid) was conducted on several short visits on 22.07.2023, 01.08.2023, 11.05.2024 and 18.05.2024. Photographs of the plants were taken by digital camera.

The composition of the plant community was noted during the fieldwork on 18.05.2024 and some specimens were collected and later on deposited in the Macedonian National Herbarium at the Institute of Biology, Faculty of Natural Sciences and Mathematics, Ss. Cyril and Methodius University, Skopje, North Macedonia (Index Herbariorum code: MKNH) with the following accession numbers: 071912, 071913, 071914, 071915 and 071916.

Nomenclature of the species follows Euro+Med Plant-Base (Euro+Med, 2006).

Results and Discussion

Species description

The following is description of the specimens from Trojani (Figure 1) which is in accordance to the description in different floras. Shrubs, up to 1m high, procumbent. Twigs and branches reddish. Leaves ovate to elliptical, flat and woolly when young, somewhat undulate when old; petioles furrowed on the upper side. Cymes with 1–2 flowers. Flowers 3–5 cm, with long pedicels; petals white; sepals 5, the two outer sepals cordate at base. All of the aboveground parts have stellate hairs; twigs and branches, both sides of the leaves, petioles, pedicels and sepals.



Figure 1: *Cistus salvifolius* L. (Sageleaf Rockrose), Trojani area. A – Habitus, B – Branch, C – Twig, D – leaves (upper side), E – leaf (lower side), F – Flowers, G – Flowers (side view), H – Flower with sepals, I – Fruit (from above), J – Fruit (side view), 22.02 & 01.08. 2023, 11.05. & 18.05.2024 (photos: S. Hristovski).

Slika 1: *Cistus salvifolius* L. (kaduljelistni brškin), območje Trojani. A – habitus, B – veja, C – vejica, D – listi (zgornja stran), E – list (spodnja stran), F – cvetovi, G – cvetovi (stranski pogled), H – cvet s čašnimi listi, I – plod (pogled od zgoraj), J – plod (stranski pogled), 22.02 & 01.08.2023, 11.05. & 18.05.2024 (fotografije: S. Hristovski).

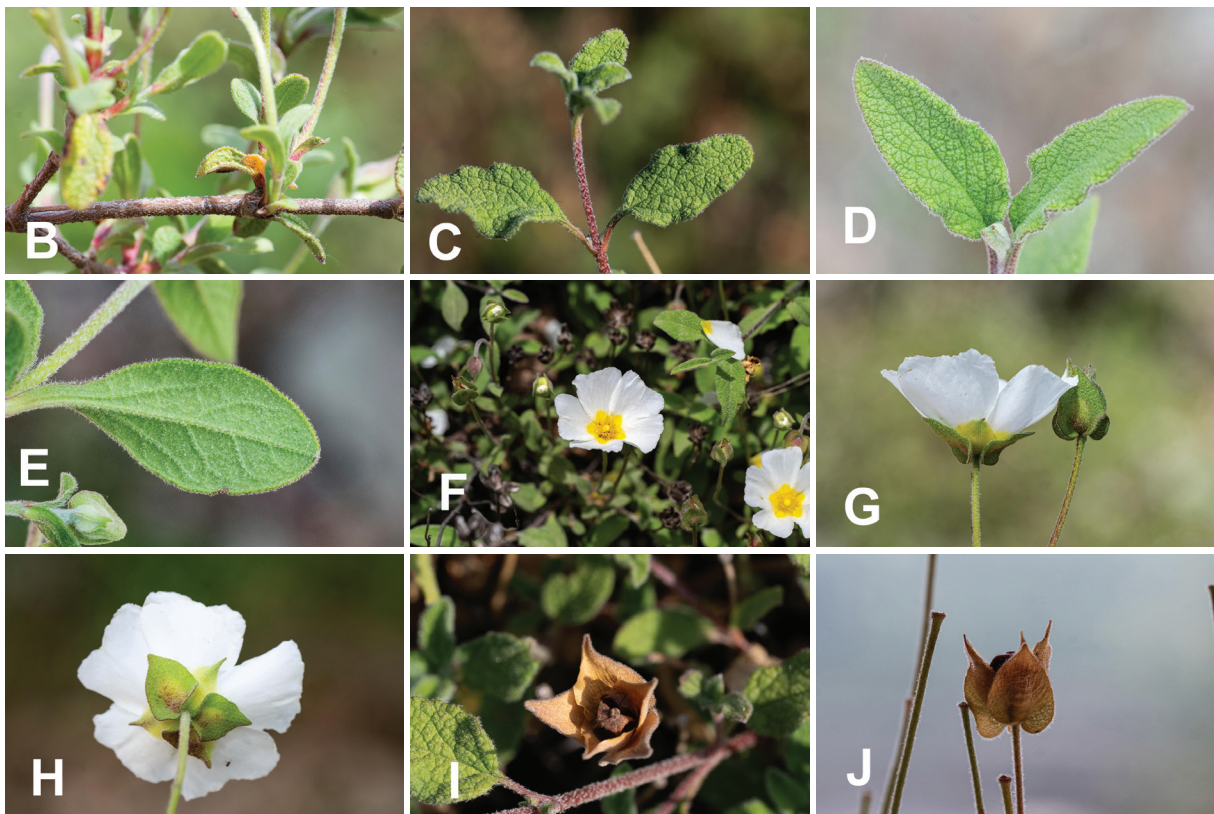




Figure 2: Distribution of *Cistus salvifolius* in North Macedonia (●).
Slika 2: Razširjenost vrste *Cistus salvifolius* v Severni Makedoniji (●).

Locality

Specimens of *Cistus salvifolius* were recorded during the field visits (Figure 2):

- Trojani, v. Dolno Lakočerej, Ohrid, N41.1618133°, E20.7922617°, 780 m a.s.l., Scrubland on eroded soil, 23.07.2023, leg. Slavčo Hristovski, Iskra Hristovska & Slobodan Hristovski.
- Trojani, v. Dolno Lakočerej, Ohrid, N41.1643833°, E20.79462°, 750 m a.s.l., degraded *Quercetum frainetto-cerridis*, 01.08.2023, leg. Slavčo Hristovski, Iskra Hristovska & Slobodan Hristovski.
- Trojani, v. Dolno Lakočerej, Ohrid, N41.1643931°, E20.785135°, 880 m a.s.l., degraded *Quercetum frainetto-cerridis*, 01.08.2023, leg. Slavčo Hristovski, Iskra Hristovska & Slobodan Hristovski.
- Trojani, v. Dolno Lakočerej, Ohrid, N41.167375°, E20.7770667°, 885 m a.s.l., degraded *Quercetum frainetto-cerridis*, 01.08.2023, leg. Slavčo Hristovski, Iskra Hristovska & Slobodan Hristovski.
- Trojani, v. Dolno Lakočerej, Ohrid, N41.1641233°, E20.7948917°, 745 m a.s.l., degraded *Quercetum frainetto-cerridis*, 11.05.2024, leg. Slavčo Hristovski & Slobodan Hristovski.
- Trojani, v. Dolno Lakočerej, Ohrid, N41.1622113°, E20.785548°, 745 m a.s.l., degraded *Quercetum frainetto-cerridis*, 11.05.2024, leg. leg. Slavčo Hristovski, Slobodan Hristovski, Marjan Komnenov, Renata Čušterevska, Vlado Matevski.
- Trojani, v. Dolno Lakočerej, Ohrid, N41.1643202°, E20.7852465°, 880 m a.s.l., degraded *Quercetum frainetto-cerridis*, 18.05.2024, leg. Slavčo Hristovski, Slobodan Hristovski, Marjan Komnenov, Renata Čušterevska, Vlado Matevski.

Plant community

The community of *Cistus salvifolius* develops on silicate bedrock i.e. the majority of records are on phyllitic schists (Figure 3). Actually, silicate bedrock is the ancestral soil type of *C. salvifolius* lineage. Nevertheless, *C. salvifolius* is also known as a calcicolous species (Guzmán et al., 2009).

Almost all of the records were on the soil complex of cambisols, leptosols and regosols according to the pedologic map of North Macedonia (MASIS, 2015). Actually, from the field visit we can conclude that the majority of *Cistus* individuals developed on eroded regosols (Figure 4).

Cistus salvifolius is a representative species of typical Mediterranean habitats as garrigues or open marquis (Mucina et al., 2016). It is a name giving taxon to numerous phytocoenoses, most recently described by (Hardy et al., 2024). Depending on the geological substrate on which they develop (silicate or limestone), the corresponding plant communities are syntaxonomically separated into different syntaxonomic categories (*Cisto-Lavanduletea stoechadis* Br.-Bl., *Ononido-Rosmarinetea* Br.-Bl. etc.) (Mucina et al., 2016).

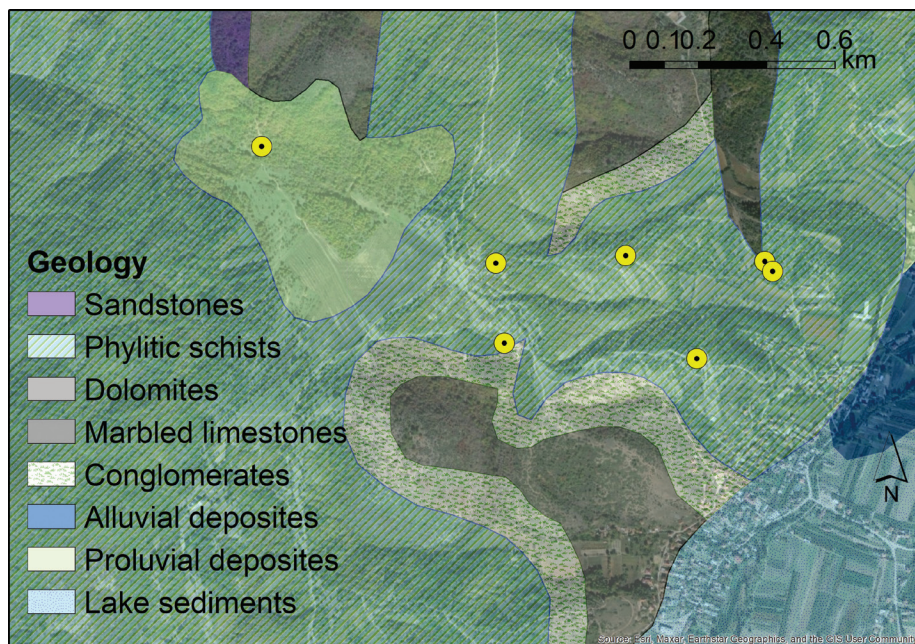


Figure 3: Distribution of *Cistus salvifolius* at locality Trojani and preference of geologic substrate.
Slika 3: Razširjenost vrste *Cistus salvifolius* na območju Trojani in prevladujoča geološka podlaga.

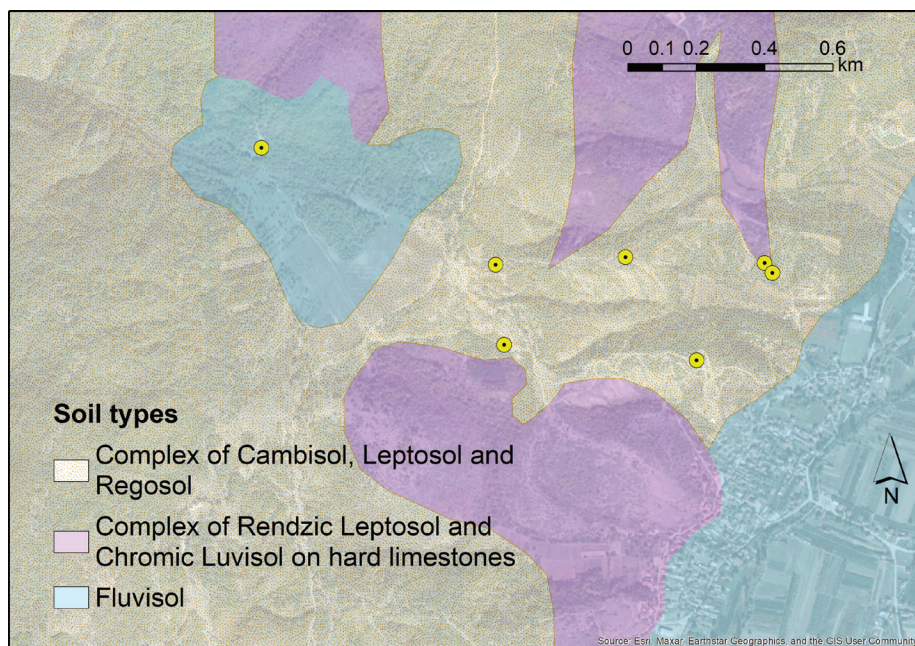


Figure 4: Distribution of *Cistus salvifolius* at locality Trojani and soil preference.
Slika 4: Razširjenost vrste *Cistus salvifolius* na območju Trojani in prevladujoči tip tal.

According to the research of Čarni et al. (2010), referring to the Mediterranean *Cistus creticus* subsp. *creticus* L. (= *Cistus incanus* subsp. *creticus* (L.) Heywood) – dominated community in Northern Greece (Palia Leptokaria, Krania, Halkidiki, Kavala), the species *Cistus salvifolius* is registered as a diagnostic species in the association *Calicotomo villosae-Cistetum cretici* [*Hyperico olympici-Cistion cretici* (Oberd. 1954) R. Jahn et Bergmeier in Mucina et al. 2009, *Cisto-Micromerietalia julianae* Oberd. 1954, *Ononido-Rosmarinetea* Br.-Bl. in A. Bolos y Vayreda 1950]. The

composition of the community is dominated by numerous Mediterranean, semi-shrubby and herbaceous plants such as *Calycotome villosa*, *Quercus coccifera*, *Cistus creticus* subsp. *creticus*, *Cytinus hypocystis* subsp. *clusii*, *Erica arboorea*, *Hymenocarpus circinnatus*, and others.

The flora and vegetation associated with *Cistus salvifolius* in the region of Ohrid (Trojani area), are significantly different from the flora and vegetation in which this species thrives in Northern Greece (Čarni et al., 2010). These are dry grasslands (all. *Trifolion cherleri*) that develop on



Figure 5: Community of *Cistus salvifolius* at locality Trojani, 30.07.2024 (photo: S. Hristovski).

Slika 5: Zdrúžba z vrsto *Cistus salvifolius* na območju Trojani, 30. 07. 2024 (fotografije: S. Hristovski).

a silicate substrate. They are in the process of being re-grown from the adjacent forest phytocoenosis dominated by *Quercus frainetto*, *Quercus pubescens*, *Carpinus orientalis*, *Juniperus deltooides*, *Ligustrum vulgare* and others. The following taxa were registered in the investigated *Cistus salvifolius* population: *Achillea coarctata*, *Agrostis castellana*, *Aira elegantissima*, *Carpinus orientalis*, *Centaurea grisebachii*, *Clinopodium alpinum* subsp. *hungaricum*, *Dorycnium pentaphyllum* subsp. *herbaceum*, *Eryngium campestre*, *Festuca valesiaca*, *Filago germanica*, *Fumana procumbens*, *Galium divaricatum*, *Hypericum olympicum*, *Hypericum perforatum*, *Juniperus deltooides*, *Lathyrus cicera*, *Lembotropis nigricans*, *Ligustrum vulgare*, *Linaria pelisseriana*, *Lonicera etrusca*, *Micropyrum tenellum*, *Myosotis stricta*, *Ornithopus compressus*, *Pilosella bauhini*, *Poa bulbosa*, *Psilurus incurvus*, *Quercus frainetto*, *Quercus pubescens*, *Rumex acetosella*, *Sanguisorba minor* subsp. *balearica*, *Sedum amplexicaule*, *Silene* sp., *Stachys angustifolia*, *Thymus longicaulis* subsp. *longicaulis* (= *Thymus rohlenae*), *Thymus sibthorpii*, *Trifolium arvense*, *Trifolium campestre*, *Trifolium hirtum*, *Veronica chamaedrys*, *Vicia lathyroides*, *Vicia villosa* aggr.

This region is influenced by a mild continental, i.e. modified (sub)Mediterranean climate which favours de-

velopment of a large number of Mediterranean and sub-Mediterranean plant species and plant communities (Em et al., 1985; Matevski & Kostadinovski, 1996). This is also the case with the finding of the species *Cistus salvifolius* in this area, which joins the large number of Mediterranean and sub-Mediterranean plant species in the wider area around lakes Ohrid and Prespa, such as *Asparagus acutifolius*, *Biarum tenuifolium*, *Buxus sempervirens*, *Clematis viticella*, *Convolvulus althaeoides* subsp. *tenuissimus*, *Hysosopus officinalis* var. *pilifer*, *Jasminum fruticans*, *Juniperus excelsa*, *Ephedra fragilis* subsp. *campylopoda*, *Phyllirea latifolia*, *Pistacia terebinthus*, *Sternbergia colchiciflora* and others (Matevski & Kostadinovski, 1996; Matevski et al., 2011).

Distribution

Cistus salvifolius shows low genetic differentiation with the same haplotype lineages in Europe and Africa, which is due to at least three intercontinental colonizations (even though the plant is apparently unable to spread over long distances). A recent (Pleistocene) European route of colonization between Iberia and Anatolia through France and Italy was proposed in order to explain the low haplotype diversity (Fernández-Mazuecos & Vargas, 2010). Moretti

et al. (2020) showed that marginal or peripheral populations of *Cistus salvifolius* have similar genetic diversity as central populations.

In Bulgaria, *Cistus salvifolius* is distributed only in Strandzha at the border with Turkiye (Stoyanov et al., 2021). From the Balkan countries it is absent from Serbia and Romania. In Albania the species is distributed along the Adriatic and Ionian coasts with few inland areas in the central and southern parts of the country, at altitudes between the sea level and 800 m (Barina et al., 2016). The two closest populations in Albania in west and southwest direction (Barina et al., 2016) are more than 60 km away from Trojani area.

Thus, the finding of the primarily Mediterranean species *Cistus salvifolius* in the Ohrid area is very intriguing. However, other species with (Sub)Mediterranean distribution are known to occur in the Ohrid valley i.e. the upper watershed of river Crn Drim in North Macedonia, such as *Moltkia petraea*, *Salvia officinalis*, *Cistus creticus ssp. eriocephalus*, etc. (Em et al., 1985; Matevski, 2013; Teofilovski, 2017). In fact, the area of river Crn Drim valley is part of the Ohrid-Prespa refugial region (Em et al., 1985). This region is under the influence of modified sub-Mediterranean climate (Melovski et al., 2013) which provides conditions for development of rich flora and vegetation with presence of many relict and endemic species (Micevski & Matevski, 1987; Matevski & Kostadinovski, 1996). It is obvious that new findings of rare species in the south-western parts of North Macedonia (Galičica and Jablanica mountains with the Ohrid valley in between) improve our knowledge of this flora with predominantly Eastern Mediterranean distribution (Aegean-Ionian-Adriatic part). Additional phytogeographical research combined with genetic approach will shed light on the pathways of distribution of these species such as river valley of Crn Drim as well as present and past ecological conditions (e.g. general climate, glaciation).

Conservation status

The area of Trojani has never been a subject of floristic investigation which explains why the species was not recorded so far in North Macedonia. The population of *Cistus salvifolius* in Trojani is obviously isolated from the main distribution of the species, but we believe it has natural origin.

In Albania and Greece, the species is not included in their respective red lists. However, in Bulgaria it was assessed as Endangered [EN B1ab(iii)+2ab(iii)] (Assyov & Denchev, 2015).

The population in Trojani area represents the only known locality in North Macedonia. Its extent of occurrence is about 62 ha (=0.62 km²). The main threat to

the species is probably the afforestation with non-native species, possible expansion of the agricultural land (vineyards) and construction of forest roads. Thus, its status can be assessed as Endangered [EN B1a+2a] according to the IUCN Red List categories and criteria (IUCN Species Survival Commission, 2012).

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