NAT. CROAT. | VOL. 12 | No 1 | 9–18 | ZAGREB | March 31, 2003

ISSN 1330-0520 original scientific paper / izvorni znanstveni rad

CRESSA CRETICA L. (*CONVOLVULACEAE*) IN THE FLORA OF CROATIA

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Milović, M. & Marković, Lj.: *Cressa cretica* L. (*Convolvulaceae*) in the flora of Croatia. Nat. Croat., Vol. 12, No. 1., 9–18, 2003, Zagreb.

According to VISIANI (1826: XVIII–XIX) *Cressa cretica* was found in the area of Dalmatia around the middle of the 16th century by Luigi Anguillara. Since later explorers of the flora of Dalmatia did not confirm this finding it only has a historical significance.

This thermo-cosmopolitan halophilous species from *Convolvulaceae* family was found in the salt marsh area of Blato by the Solaris hotels near Šibenik in June 1996. Observations that were made in period from 1997 to 2002 show that it is an annual plant with a short life cycle that continues in the summer period when the salt marsh area drains. It grows as a part of halophitic vegetation, mostly with the species *Suaeda maritima*, *Salicornia europaea*, *Salsola soda*, *Limonium vulgare* subsp. *serotinum* and *Crypsis aculeata*. With the exception of the locality of Blato by Solaris, *Cressa cretica* has not been found on any other locality in the wider area of Šibenik.

Key words: *Cressa cretica* (*Convolvulaceae*), Solaris (Šibenik), Croatia

Milović, M. & Marković, Lj.: *Cressa cretica* L. (*Convolvulaceae*) u flori Hrvatske. Nat. Croat., Vol. 12, No. 1., 9–18, 2003, Zagreb.

Prema Visianiju (1826: XVIII–XIX) vrstu *Cressa cretica* sredinom 16. stoljeća navodi Luigi Anguillara za područje Dalmacije. Kasniji istraživači dalmatinske flore nisu potvrdili ovaj nalaz pa on ima samo povijesno značenje.

Ova termokozmopolitska halofitna vrsta iz porodice *Convolvulaceae* pronađena je u lipnju 1996. godine na slanom močvarnom području Blato, uz hotelsko naselje Solaris u blizini Šibenika. Promatranja u razdoblju 1997.–2002. pokazuju da se radi o jednogodišnjoj biljci s kratkim životnim ciklusom koji se odvija tijekom sušnog ljetnog razdoblja kada slano močvarno područje presušuje. Raste u sastavu halofilne vegetacije najčešće s vrstama *Suaeda maritima*, *Salicornia europaea*, *Salsola soda*, *Limonium vulgare* subsp. *serotinum* i *Crypsis aculeata*. Za sada nije pronađena na drugim lokalitetima na širem šibenskom području.

Ključne riječi: *Cressa cretica* (*Convolvulaceae*), Solaris (Šibenik), Hrvatska

INTRODUCTION

During floristic investigations of the Šibenik area (central part of the Adriatic Coast, Croatia), in June 1996 the first author collected an interesting unknown plant species near the Solaris hotels (Fig. 1). The herbarium specimens of this species were defined later by the second author as *Cressa cretica* L. from *Convolvulaceae* family (Fig. 2).

The only note about the presence of *Cressa cretica* in the area of Croatia can be found in Visiani´s »*Stirpium dalmaticarum specimen*« (1826: XVIII). In the chapter »*De*

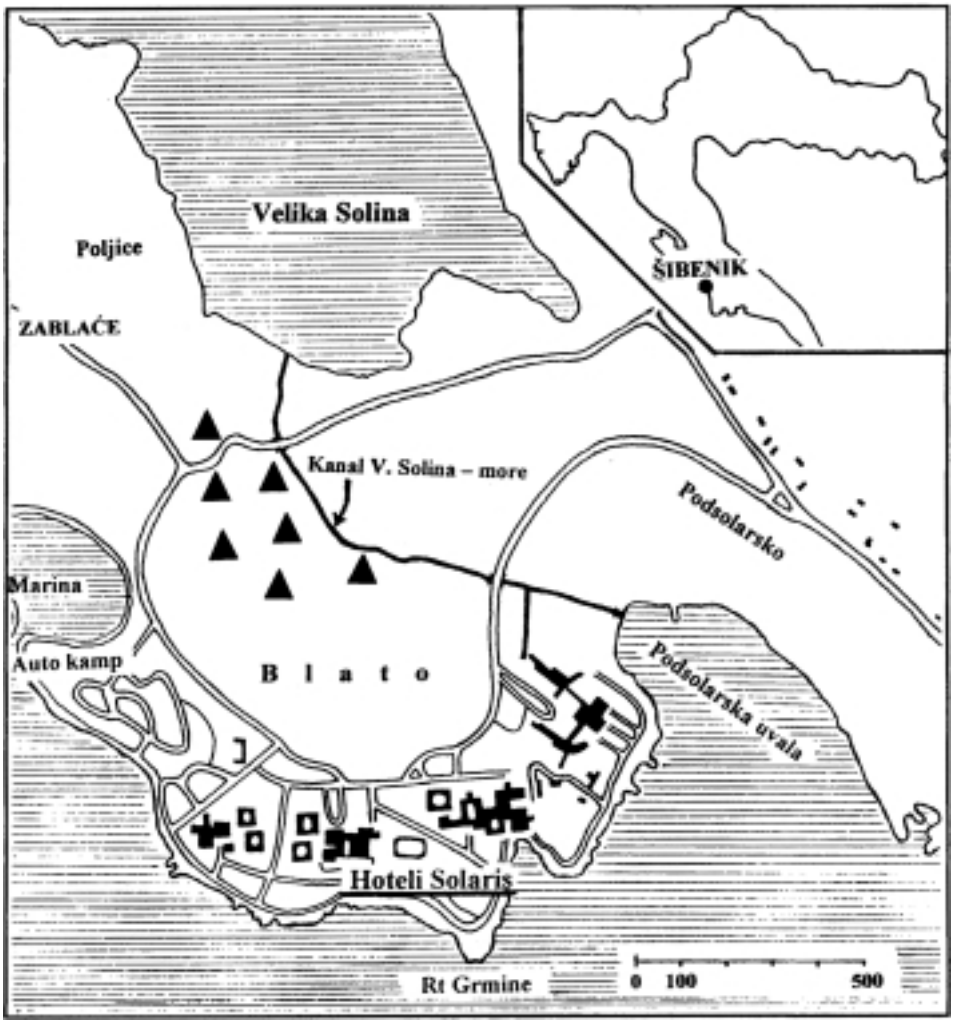

Fig. 1. Location of the salt marsh area of Blato with marked places (▲) where *Cressa cretica* was found.

Fig. 2. *Cressa cretica*, the upper part of flowering plant (20 August, 2002).

Dalmatia ejusque vegetatione« Visiani gives a survey of earlier researches into Dalmatian flora and mentions the botanist Luigi Anguillara, who recorded about 700 species of Dalmatian plants in his work »*Semplici*« (Venice 1561). According to Anguillara´s description and Croatian names and Sprengel´s work »*Rei herbariae historia*«, Visiani managed to establish Linne´s synonyms only for the minor number of plants. He considers Anguillara´s plant named *Anthillide I* and Linne´s species *Cressa cretica* as the same species (VISIANI, 1826: XVIII; »*Anthillide I* p. 237. – *Cressa cretica* (juxta Spr.)«). According to this Visiani quotation we can assume that *Cressa cretica* was present in Dalmatian flora around the middle of the 16th century. Later explorers of the Dalmatian flora did not confirm findings of this species and it is not mentioned either in the older or in recent literature concerning Croatia (VISIANI, 1847:227–230; SCHLOSSER & VUKOTINOVIĆ, 1869:627–630; HAYEK, 1928:41; DOMAC, 1994:256–257; HULINA, 1997:120–121). For this reason it could be considered lost for the Croatian flora.

According to PIGNATTI (1982:385), *C. cretica* is a thermo-cosmopolitan halophilous species. With exception of the Crimean Peninsula and former Yugoslavia (of which Croatia was a constituent until 1991) it is distributed in all parts of the Mediterranean region (GREUTER *et al.*, 1986:8). The range of *C. cretica* also occupies: Caucasus, South West and Central Asia, Africa and Australia (BONNIER, 1924:129; KUZMANOV, 1982:444).

Recently AL-TURKI (1997:268) has noted *C. cretica* as a new species for the Quasim region in Saudi Arabia: »Al-Awshazayah, c. 15 km E of Unayzah, saline sandy soil near edges of salt flat and road«.

C. cretica usually grows in sandy or muddy saline habitats along the sea coast (BONNIER, 1924:129; STACE, 1972:78; KUZMANOV, 1982: 444; PIGNATTI, 1982:385) or by inland salt marshes (EL-GHANI, 2000; ASRI & GHORBANLI, 1997) where it occurs in diferent halophilous plant communities (OBERDORFER, 1952:340, table 7; ASRI & GHORBANLI, 1997:158, table 1).

According to the available literature data the most important edaphic factors affecting the distribution and structure of *C. cretica* communities are salinity, moisture content and fine fractions (EL-GHANI, 2000) while the growth and reproduction of this plant were significantly inhibited by potassium (K) and nitrogen (N) deficiency in the soil (KHAN, 1998).

In some parts of its range *C. cretica* is a very common species (TÄCKHOLM, 1974:435) while in the other parts it is rare or very rare (BONNIER 1924:129; KUZMANOV, 1982:444; PIGNATTI, 1982:385). In the greater part of the Mediterranean region the saline coastal wetlands with halophilous species are endangered as a result of strong and long lasting human influences: draining of wetlands, trampling of vegetation, excessive tourism, contamination of the beaches and contamination of the soils, and so on. For these reasons, *Cressa cretica* is classified as an endangered species in several countries (VELČEV (ed.), 1984; OLIVIER *et al.*, 1995; CONTI *et al.*, 1997).

In neighbouring Italy, in *Liste Rosse Regionali delle Piante d´Italia*, *Cressa cretica* is classified as an endangered species at the national level and at the lower, regional level as a rare (Lazio, Basilicata), endangered (Calabria) and vulnerable species (Sicily) (CONTI *et al.*, 1997:44).

METHODS

In the period from 1997 to 2002 the first author did more detailed research into the conditions of the habitat and life cycle of *C. cretica* and the plant communities in which it appears in the area of Blato by the Solaris hotels near Šibenik. The fieldwork and observations were the most intensive in the period from June to September each year.

Vegetation records were made by the standard phytosociological method (BRAUN-BLANQUET, 1964; MUELLER-DOMBOIS & ELLENBERG, 1974). The plant names in this paper are made to comply with TUTIN *et al.*, eds. (1968–1980, 1993).

The specimens of *C. cretica* collected during this research are stored in the Herbarium of the Department of Biology, Faculty of Science, University of Zagreb (ZA).

RESULTS AND DISCUSSION

Cressa cretica was found in the Blato area by the Solaris hotels (UTM, WJ 74), 5km from the town of Šibenik (Fig. 1), in June 1996.

Blato is a small salt marsh area (ca 800m x 200m) about 250 m distant from the sea (Podsolarsko Bay). It is a shallow depression of the sandy and muddy soil with a clay ingredient. For most of the year the soil has a high moisture content or is in-

undated with about 5–10 cm of water (Fig. 3). Only in some deeper ditches and hollows is the water layer higher, about 40–50 cm. The excess water is led away by a drainage channel passing by Blato area and connecting the small salt lake Velika Solina to the sea in the Bay of Podsolarsko (Fig. 1). During the summer period, the salt marsh area of Blato gradually drains because of precipitation deficiency and high evaporation. The soil drains, cracking in some places while its surface whitens by salt crystallisation. The deeper parts of the soil retain some of the moisture even in the most dry period from July to August because of the presence of the groundwater.

This salt marsh area is overgrown by halophytic vegetation (Fig. 3). The composition of the vegetation formations is heterogeneous and their distribution in the area depends on the moisture content in the soil, period of inundation and depth of water layer. The shallowest parts of the area, with the shortest time of inundation, are densely overgrown with vegetation in which these perennial halophilous species dominate: *Arthrocnemum fruticosum* (L.) Moq., *A. macrostachyum* (Moric.) C. Koch, *Artemisia caerulescens* L., *Limonium vulgare* Miller subsp. *serotinum* (Reichenb.) Gams, *L. bellidifolium* (Gouan) Dumort, *Halimione portulacoides* (L.) Aellen, *Elymus elongatus* (Host) Runemark, *Elymus pycnanthus* (Godron) Melderis, *Juncus maritimus* Lam., *Juncus acutus* L., *Carex extensa* Good., *Typha latifolia* L. etc. Species like *Scirpus maritimus* L. subsp. *maritimus* and hydrophilous plants like *Ruppia maritima* L. and some algae grow in the deeper parts of the area like ditches and hollows. In summer, these ditches and hollows gradually drain, the hydrophilous plants in them wither and their dried remains finally cover all the surface of the soil. Annual halophilous species like *Salicornia europaea* s. l., *Suaeda maritima* (L.) Dumort, *Salsola*

Tab. 1. The vegetation records of the plant communities with *Cressa cretica* in the area of Blato (Solaris, Šibenik)

No. of records	1	2	3
Area (m^2)	12	8	5
Plant cover (%)	60	90	30
Date		20 July, 2002	
No. of species	8	4	7
Cressa cretica L.	2.3	2.3	1.2
Suaeda maritima (L.) Dumort	2.2	1.1	–
Salicornia europaea s.l.	1.1	–	1.2
Crypsis aculeata (L.) Aiton	1.3	4.4	–
Limonium vulgare Miller subsp. *serotinum* (Reichenb.) Gams	1.2	–	+.1
Arthrocnemum macrostachyum (Moric.) C. Koch	+.2	–	+.2
Salsola soda L.	+.1	+.1	–
Arthrocnemum fruticosum (L.) Moq.	+	–	+
Puccinellia festuciformis (Host) Parl.	–	–	+
Limonium bellidifolium (Gouan) Dumort	–	–	+

Fig. 3. The salt marsh area of Blato by the Solaris hotels in the period of inundation (16 March, 2002).

soda L., *Crypsis aculeata* (L.) Aiton. and *Cressa cretica* L. appear in these drained ditches and hollows in the summer period (Fig. 4, 5).

The life cycle of *C. cretica* endures in the summer period. Its population was not regularly distributed on the whole area. It occurs here and there in smaller or greater clumps mostly in open and sunny positions. In open spaces it grows individually or in small patches within the basic halophytic vegetation cover. The most numerous populations with the highest density grow in dry ditches and hollows (Fig. 4, 5) where there is higher content of moisture in the soil. As a heliophilous plant, *Cressa cretica* does not occur in salt marsh stands where the surface is completely overgrown by the perennial halophilous plants.

Three vegetation records, in the different stands where *C. cretica* grows, were made in the area of Blato and the results are given in Tab. 1.

Rec. 1. A dry hollow (max. depth about 30 cm); soil with some moisture, its surface is covered with withered remains of *Ruppia maritima* and algae, whitened by salt crystallisation; *C. cretica* specimens occur in greater clumps (Fig. 5).

Rec. 2. A broad shallow ditch (max. depth ca 30–40 cm); the soil with some moisture, its surface is covered with withered remains of *Ruppia maritima* and some algae, whitened by salt crystallisation and overgrown with patches of *Crypsis aculeata*; *C. cretica* specimens occurs in greater clumps.

Rec. 3. Flat area, the soil with clay ingredient; *Arthrocnemum macrostachyum* and A. *fruticosum* shrubs dominating in the plant cover; parts of the surface without

Fig. 4. *Cressa cretica* mostly occurs in clumps in dry hollows (July, 1999).

Fig. 5. *Cressa cretica* community with *Suaeda maritima*, *Salicornia europaea*, *Salsola soda* and *Crypsis aculeata* (25 August, 2002).

plant cover are dry, here and there cracking and whitening by salt crystallisation; *C. cretica* specimens grow individually or in smaller clumps in the open spaces.

It is obvious from these vegetation records that *C. cretica* mostly grows in clumps within formations composed of annual halophilous species like: *Suaeda maritima*, *Salicornia europaea*, *Salsola soda* and *Crypsis aculeata*.

The specimens of *C. cretica* start to shoot in the beginning of June. The smallest adult specimens are about 5–6 cm high while the highest ones are about 20 cm. Most of the specimens in the area of Blato are about 10 cm high. Flowering and fruiting time is from the end of June to the end of August, which coincides with the literature data (PIGNATTI, 1982:385). During September the plant gradually withers. The end of the life cycle, in the end of September and beginning of October, coincides with the opening days of more abundant and higher quantum of precipitation, when the moisture content in the soil increases and finally the whole area becomes inundated again. The seeds of *C. cretica* remain dormant in the inundated soil until June of the next year.

It is obvious from the results of observations in the Blato area that *C. cretica* is an annual plant (*Therophyta*) with a very short life cycle, which depends closely on the conditions of the habitat, mostly on the pause in inundation and the beginning of soil drainage, resulting in increased salinity.

While in Blato *Cressa cretica* grows only as an annual plant, it occurs more often as a perennial herb (HAYEK, 1928:41; STACE, 1972:77; KUZMANOV, 1982:444; TÄCKHOLM, 1974:435) or as dwarf shrub (PIGNATTI, 1982: 385) in the greater part of its area of distribution.

During the period of the observation (1997–2002) *C. cretica* became adapted and somewhat wider distributed in appropriate habitats in the whole area of Blato. Now the total population is larger, most of the specimens are well developed and with good fertility which indicates that its survival is not directly endangered on this locality.

Except at the locality of Blato near the Solaris hotels, *C. cretica* has not been found in any other localities to date, although the first author has looked for it in similar salt marsh habitats in several localities in the wider area of Šibenik (Velika and Mala Solina near Zablaće, Morinje Bay, Prokljan Lake, Grebaštica, Jezera etc.).

CONCLUSION

The results of this research indicate that *Cressa cretica* was spread and naturalised in the salt marsh area on locality of Blato near the Solaris hotels where it was found in June 1996.

Although it mostly grows as a perennial herb or as dwarf shrub in other parts of its range, in the area of Blato it is an annual plant with a short life cycle. It endures from the beginning of June to the end of September or beginning of October, in the period when the salt marsh area drains and moisture content in the soil decreases while salinity increases.

The most numerous and the most dense populations are observed in drainage ditches and hollows where soil retains considerable moisture content but also during the driest summer period. It mostly grows within plant communities composed of annual halophilous species like: *Suaeda maritima*, *Salicornia europaea*, *Salsola soda* and *Crypsis aculeata*.

The population large in number and well developed and fertile specimens indicate that its survival at the locality of Blato is not endangered. It has not been found at other localities.

After the unconfirmed finding by Anguillara from the middle of the 16th century which has more historical than scientific significance, the finding of *Cressa cretica* in Solaris near Šibenik is the first certain evidence of its presence in the area of Croatia. The appearance and presence of *C. cretica* in Croatia is especially interesting because it has recently become a rarer and more endangered species in several countries in the Mediterranean region.

Received October 2, 2002

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SAŽETAK

Cressa cretica L. (*Convolvulaceae*) u flori Hrvatske

M. Milović & Lj. Marković

Cressa cretica L. je termokozmopolitska halofitna vrsta iz porodice *Convolvulaceae* za čiju prisutnost na području Hrvatske nije bilo sigurnih podataka. Prema VISIANIJU (1826: XVIII–XIX), Luigi Anguillara ju je sredinom 16. stoljeća zabilježio na području Dalmacije. Kako kasniji istraživači dalmatinske flore nisu potvrdili ovaj nalaz, on ima samo povijesno značenje.

Vrsta *Cressa cretica* je pronađena u lipnju 1996. na slanom močvarnom području Blato uz hotelsko naselje Solaris, 5 km udaljeno od Šibenika.

Iako u drugim dijelovima svoga areala češće dolazi kao zeljasta trajnica ili polugrm, na području Blata *C. cretica* raste kao jednogodišnja biljka s vrlo kratkim životnim ciklusom koji započinje krajem lipnja, a završava krajem rujna, tj.u razdoblju kada slano močvarno područje presušuje, količina vlage u tlu se smanjuje, a koncentracija soli povećava.

Najbrojnije i najgušće populacije rastu u presušenim udubljenjima i plitkim jarcima, najčešće u zajednici s jednogodišnjim halofilnim vrstama *Suaeda maritima, Salicornia europaea, Salsola soda* i *Crypsis aculeata*.

Kako je ukupna populacija razmjerno brojna, a većina jedinki su dobro razvijene i plodne može se zaključiti da opstanak vrste *C. cretica* na području Blata nije neposredno ugrožen. Za sada nije zapažena na drugim lokalitetima na širem šibenskom području.

Pojava vrste *C. cretica* u Hrvatskoj je posebno zanimljiva zbog činjenice da na području Sredozemlja, zbog uništavanja staništa, postaje sve rjeđa i ugroženija.

Fig. 1. *Sporobolus pungens* (Schreber) Kunth

there were no other plant species. It is quite possible that the whole population is a clone because of the vegetative propagation with widely creeping rhizomes. From floristic composition of the surrounding vegetation (Tab. 1) it can be concluded that it belongs to the association *Echinophoro-Elymetum farcti* Gehu 1987.

For *S. pungens* the status of endangered species as proposed by ILIJANIĆ & TOPIĆ (2000) can be confirmed. To date, only four localities of this species in have been noted Croatia: the islet of Veli Lukavac near the island of Hvar, seashore sands near Lumbarda and a sandy beach in Prižba on the island of Korčula, the island of Biševo, and the new locality Blaca Bay on the island of Mljet. However, the locality