

**PHENOLOGICAL, AUTECOLOGICAL AND PHYTOCOENOLOGICAL
CHARACTERISTICS OF A *Sedum caespitosum* Cav (CRASSULACEAE) POPULATION
FROM CENTRAL DOBROGEA (SE ROMANIA), LESSONS FOR BROADER,
MORE EFFECTIVE CONSERVATION**

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Abstract. *Sedum caespitosum* is a small 5(4)-merous and haplostemonous ephemeral Crassulacean, precociously inhabiting inhospitable habitats a few weeks in spring, vanishing before competitors progress in their lifecycles. As phenological shifts are responses to climate changes, and because the Dobrogean populations show phenological, autecological and phytocoenological characteristics differing from halophyllous South-Eastern Central European populations, I report herein data about a population located near Gura Dobrogei in Central Romanian Dobrogea. The phenology of *Sedum caespitosum* is typical for ephemeral therophytes, with overwintering seeds (resting propagules). The active phase of the lifecycle begins in March and lasts about two months, as by June the plants are completely dry with ripe seeds. Particularly unusually though, *S. caespitosum* population studied shows a distinct, second blooming-phase, sometimes succeeding a brief apparent vegetative arrest/death of leaves and shoot parts which bloomed in the first blooming period, indicating the existence of two meristem subsets with anthesis decouple by brief endodormancy. If true, this hypothesis would be a highly unusual case in an annual plant, similar to some sort of condensed polycarpy (as Bărcă V suggested in personal communication). The ecological and phytocoenological data reported here show that *Sedum caespitosum* grows in Dobrogea in clearly non-halophyllous plant associations developed on shallow topsoil covering the superficial limestone bedrock, and supporting the hypothesis that it is at most an opportunistic halophyte being just a salt-tolerant species exploiting ecological niches inaccessible for other plants, thus avoiding the competition which it is unable to withstand. Another explanation of the observed autecological and phytocoenological inconsistent preferences exhibited by *Sedum caespitosum*, is that the halophyllous populations from South-Eastern Central Europe indeed belong to a distinct taxon, specialised in exploiting salt-rich flatlands and salt pans, as claimed by Simonkai when describing *Sedum deserti-hungarici* Simonkai (1890) based on specimens from one of those halophyllous populations.

Keywords: *Sedum caespitosum*, phenology, autecology, conservation, Dobrogea.

Rezumat. Caracteristici fenologice, autecologice și fitocenologice ale unei populații de *Sedum caespitosum* Cav (Crassulaceae) din Dobrogea Centrală (SE România), învățăminte pentru o mai largă și mai eficientă conservare. *Sedum caespitosum* este o Crassulacee mică, 5(4)-meră și haplostemonă care ocupă precoce habitate neospitaliere câteva săptămâni primăvara, dispărând înaintea progresiei competitorilor prin ciclul lor de viață. Întrucât decalajele fenologice sunt adesea răspunsuri la modificări climatice, și deoarece populațiile dobrogene au caracteristici fenologice, autecologice și fitocenologice diferite de cele ale populațiilor halofile Sud-Est-Central Europene, prezint aici date despre o populație localizată lângă Gura Dobrogei în Dobrogea Centrală Română. Fenologia *Sedum caespitosum* e tipică therofitelor efemere, care ierneză prin semințe (propagulele de repaus). Faza activă a ciclului de viață începe în martie și durează cam două luni, încât prin iunie plantele sunt complet uscate, cu semințe mature. Foarte neobișnuit totuși, populația de *S. caespitosum* studiată prezintă o a doua fază de înflorire distinctă, uneori succedând unei perioade de scurtă întrerupere vegetativă aparentă sau de moarte a frunzelor sau a unor părți din lăstarii care înfloriseră în prima perioadă de înflorire, indicând existența a două subseturi de meristeme cu antheza decuplată de scurte perioade de endo-dormanță. Dacă e adevărată această ipoteză ar fi un caz foarte neobișnuit la o plantă anuală, similar unui tip de policarpie condensată (așa cum sugerează Bărcă V. într-o comunicare personală). Datele ecologice și fitocenologice prezentate aici arată că *Sedum caespitosum* crește în Dobrogea în asociații vegetale clar nehalofile pe cuverturi subțiri de sol acoperind superficial substrate calcaroase, și susținând ipoteza că este cel mult o halofită oportunistă fiind de fapt doar o specie halo-tolerantă exploatănd nișe ecologice inaccesibile pentru alte plante, astfel evitând competiția pe care e incapabilă să o suporte. Altă explicație a neconcordanțelor observate în preferințele ecologice și fitocenologice arătate de *Sedum caespitosum*, e aceea că populațiile halofile Sud-Est-Central Europene aparțin într-adevăr unui taxon distinct, specializat în exploatarea sărăturilor joase, cum susține Simonkai descriind *Sedum deserti-hungarici* Simonkai (1890) pe baza unor exemplare din aceste populații halofile.

Cuvinte cheie: *Sedum caespitosum*, fenologie, autecologie, conservare, Dobrogea.

INTRODUCTION

Sedum caespitosum (Cav.) D.C. is a small ephemeral Crassulacean described initially 1791 by CAVANILLES (1791), as *Crassula caespitosa*, it was described again some 40 years later by de Candolle under *Sedum caespitosum* in 1828: 405.

In my experience from Romanian habitats, it strikingly distinguishes itself by the peculiar short life-cycle specialized for avoiding competition by occupying the niche of inhospitable habitats for a few weeks in spring, vanishing before its competitors are early in their lifecycles.

Taxonomically it was a disputed species, with relatively many synonyms, of which I mention the ones which are more prevalently used: *Aithales caespitosa* (Cav.) Webb & Berth., *Crassula diffusa* Lam., *Crassula magnolii* DC., *Crassula verticillaris* Linné, *Procrassula caespitosa* (Cav.) Fourr., *Procrassula magnolii* (DC.) Griseb., *Sedum*

caespitosum Boiss., *Sedum erythrocarpum* Pau, *Sedum rubrum* (L.) Thell., *Tillaea rubra* L. (Marhold 2011); *Sedum rubro* (L.) Thell., (ICN), (HART 1991). An interesting name for this species, now synonymized, is *Sedum deserti-hungarici* Simonkai which was given to plants from populations located near to the population in western Romania, which are relatively close to the one I studied.

Morphologically, (see also BĂRCĂ 2018b, NICULAE 2018b, where the morphological characteristics of the exact population studied here are detailed), it is characterized by some distinctive characters which together are of diagnostic importance: *S. caespitosum* has a small habitus, with erect, straight, un-branched or slightly branched glabrous stems about 5-8cm tall, growing in dense populations but without giving the appearance of dense mats like *S. hispanicum* or *S. sexangulare*. It is characterized by 5(4)-merous and haplostemonous flowers which usually have white to pinkish petals, with sometimes a reddish longitudinal medial vein.

Biogeographically, it has a wider circum-mediterranean distribution extending from Portugal and Morocco to Asia Minor, Syria, Israel and Iran. It develops best in the Mediterranean and sub-Mediterranean climatic zones, but its range stretches Northwards into Poland where it is adventive, via European Turkey and the Balkans into Romania, Hungary and Czech republic and Slovakia (but also see LIPPERT, 1995, JALAS et al, 1999).

In Romania, *Sedum caespitosum* (Cav.) D.C. is rare and localized, and relatively neglected in the recent years; unlike other Crassulacean species which were better studied both regarding their chorology (BĂRCĂ & NICULAE 2005, 2006, BĂRCĂ 2016a, NICULAE, 2018a, NICULAE & BĂRCĂ, 2005; 2006), and their morphology (BĂRCĂ & NICULAE, 2008; BĂRCĂ 2018b) their general biology (BĂRCĂ & NICULAE, 2011, BĂRCĂ et al., 2011), their ethnobotanical and medicinal properties (STANCIU et al., 2009); BĂRCĂ, 2015, 2018a; BĂRCĂ & NICULAE, 2018) zoological aspects (ARBUNE et al., 2009), producing even taxonomical surprises (BĂRCĂ, 2016b).

In the case of *Sedum caespitosum* (Cav.) D.C., from Romania despite it being a species of community interest for conservation (but also probably because of its rarity and inconspicuousness) no primary data from targeted studies were published in the mainstream literature in Romania. Most of the data available comes as collateral information, scattered occasionally in floristic lists or haphazardly in phytosociologic works about associations where this species happens to occur.

The Romanian distribution of *Sedum caespitosum* (Cav.) D.C., is relatively wide but localized, remaining virtually that published in the old monography of RĂVĂRUȚ in Flora of RSR edited by Săvulescu (RĂVĂRUȚ 1956), as I review below, in which I mention the sources only for the few recent additions, the rest just citing Răvăruț 1956:

Alba county: Zlatna on Piatra Caprei, Abrud on Mt. Vulcan; Bihor county: Mădăraș; AR: Șimand, Chișineu-Criș, Mășca, Adea, Pilu, Socodor, Pecica, Grăniceri, Arad, Vulcan, Rubicioara; Timiș county: Foeni, Dinaș (STERE 1977), Distr. Timiș-Torontal without locality (BORZA 1944); Bacau county: Fântânele (MITITELU et al., 1993), Tepoaia (MITITELU et al., 1993), Vladnic (MITITELU et al., 1993); Tulcea county: Babadag (ȘTEFUREAC 1970), Denis Tepe Hill (ANDREI 1963), Beștepe (SÂRBU & ȘTEFAN 2005).

Later studies mention *Sedum caespitosum* D.C. again in Tulcea county at Beidaud (PETRESCU et al 2014).

More recent fieldwork research with Barca Valentin, following hints by respected older botanists (ANDREI 1963; Negrean G., Cristorean I., and personal communications with all of them) pointed out the fact that the ecology and phytocoenology of *Sedum caespitosum* D.C. in Dobrogea differs considerably from those of the populations from the western part of the country, where the plant was considered typical halophyte, inhabiting in the spring the margins of the salt pans resulted from snowmelt and spring rains.

The phenology and general survival strategy was similar, but the autecology and phytocoenology was quite different in the two regions of the country.

Thus, while in Western areas of Romania (BORZA, 1944) and, to perhaps some extent also in Moldova (MITITELU et al., 1993; SÂRBU & ȘTEFAN 2005), Slovakia (FEHÉR, 2007), Hungary (BÁTORI et al., 2014; BORHIDI, 2003; JAKAB & TÓTH, 2003; JAKAB, 2005; MOLNÁR et al 2012; KIRÁLY, 2007; TÓTH, 2003), Serbia (KNEŽEVIĆ et al., 2008), *Sedum caespitosum* D.C. is a halophyte clearly associated with salt pans, in Dobrogea it grows in limestone, and in plant associations clearly non-halophyllous, likewise some of the populations in Southern Europe and Bulgaria (where PAVLOVA et al (2003) reported it from serpentine substrate in Mt Rodopi).

This aspect prompted me to report here preliminary data about the phenology, autecology and phytocoenology of one population of *Sedum caespitosum* D.C. from Central Dobrogea as a first step towards understanding the real ecological characteristics and physiological requirements and adaptations of this species concerning the saline content of the soil in the habitats it occupies in its vast natural distribution range.

The population studied is located close to the heart of the distribution range of the species in Dobrogea, being one of the last populations downstream on the river Casimcea, before this river flows into the coastal/litoral lake Tasaul.

MATERIAL AND METHODS

Study site of the population studied is located in the center of the distribution range of the species in Dobrogea, with the following coordinates (in WGS84 system): N 44 29' 11" E 28 29' 30".

Data were gathered during fieldwork observations in situ during the vegetation season of the local population of *S. caespitosum*, using a hand magnifying glass. Measurements in situ were made using a caliper, and some specimens were further measured in the lab using a stereo-microscope or a compound microscope with an eyepiece micrometer, calibrated with an objective/stage micrometer, both produced by IOR Bucharest.

Illustrative photographs of some individuals were taken in-situ and ex-situ using a 16MP digital camera (Sony NEX5n) equipped with a Macro 100mm f 2.8 lens with 1:1 macro capabilities or a lighter Sony DSCH3 with its native macro zoom lens at various focal lengths and magnifications. Photographs were post-processed using GIMP software to improve brightness and contrast and to improve color rendition, and image size by cropping and print resolution were adjusted.

Phenophase limits were taken as follows; -the beginning was marked when at least 10 individuals from a patch of more than 100 began the respective phenophase, the end of a phenophase was marked when most (more than 50%) of the individual plants in a plot with a populations of at least 100 made that transition.

For each phenophase the length and approximate dates are presented, and also the relative share of the lifecycle of each phenophase is presented in charts. Illustrative color pictures of plants representative for each phenophase are presented.

RESULTS

Sedum caespitosum is a therophyte, and the seeds which represent the resting propagules, overwinter in the shallow soil on the rocky outcrops or in the dried follicles of the fruits. The active, vegetative and generative phase of the life cycle begins in March and lasts only about two months, as by June the seeds are ripe and the plants are completely dry.

The structure of the life cycle and phaenophases in *Sedum caespitosum* (Cav) DC. in a natural population in the proximity of Gura Dobrogei site, Central Dobrogea, Romania is documented for the first time herein and presented in a synthetic form in Table 1.

Table 1. Structure of the life cycle and phaenophases in *Sedum caespitosum* (Cav) DC. in a natural population in the proximity of Gura Dobrogei site, Central Dobrogea, Romania.

Phenophase		Length (days)	Aproximative Dates		Activity Phase	Dormant seeds / seed bank (multiannual)	
Winter/spring Seed phase		135	1.I-17.IV		Winter-Spring rest		
Vegetative + Generative prezygotic	Common preflower phase	Shoot Development	22		18.III-9.IV		
		Flower buds	3		9.IV-11.IV		
Generative	1 st Bloom	1 st Flower phase	7		12.IV-18.IV		
		1 st Fruit Maturation	14		19.IV-2.VI		
	2 nd Bloom	2 nd Flower phase	7		15.V-21.V		
		2 nd Fruit Maturation	9		22.V-30.V		
Resting Seed Phase		Autumn/winter Seed phase	180	3.VI (3I).V -31.XII			Autumn-winter rest

The germination and emergence of the new plantlets. At the first annual visit to the site during the year of study the 25th of March, some tiny 2-leaved and 4-leaved plantlets were found, so the actual emergence of the first plantlets in situ was inferred to be March 18, fact supported by the long emergence period of plantlets in ex-situ culture in Bucharest, due to an unusual warm winter and a late cold spell in March.

The pre-flowering phase of shoot development lasted for about 22 days, between 18.III and 9.IV, so the first floral buds were visible on April 9th. The buds matured in 3 days and the first flowers were open April 13th.

First blooming, The anthesis started April 12. The flower phase lasted about a week, between 12.IV-18.IV, the afternoon of April 17 a bit under 30% of the flowers turned to fruits, with the follicles still orthokarpic, fact that was used to infer 18.IV as the end of flower phase, fact supported also by the evolution of ex-situ cultures.

Fruit maturation phase lasted about 14 days between 19.IV-2.V, phase during which the fruits were first green and succulent, then turned yellow-light brown with some reddish speckles, until finally turning light brown and appearing completely exsiccated around May 2. After May 2, most of the plants had completely dry fruit, with divergent follicles, and the plants proper started to wither and their leaves become dry and shriveled. Then, after about 3 more weeks the fruits started to show some adaxial folds along the suture, resembling the well-known lips found in the fruits of other *Sedum* species like for example in *S. urvillei*, but the folds were very narrow and inconspicuous.

Second blooming. After about 2 weeks from the anthesis of the first flowers, i.e. around may 14 some plants (many of them being almost devoid of fleshy, succulent leaves at that moment) produced a second generation of floral buds which quickly proceeded to anthesis so that many individuals in the population showed a second blooming phase which tentatively started on May 14, but as most of the plants were in full bloom by May 15, I concluded that the second blooming lasted for about a week between 15-21.V as by may 21st almost all of the flowers were withered and the follicles were starting to tilt.

Fruit maturation phase of the fruits resulted from the second blooming phase lasted about 9 days between 22.V-30.V, so by may 30 the vast majority of follicles were brown and dry.

The fruits resulted from the second blooming phase evolved in a similar manner as the ones of the first blooming phase the fruits first green and succulent, then turned light brown with more reddish speckles, until finally turning light brown and appearing completely exsiccated before May 30. On May 30, most of the plants had completely dry fruits, with divergent follicles, and the stems and the leaves plants were apparently completely dry and shriveled.

I consider based on both the in-situ observations and the evolution of plants in ex-situ culture the beginning of June as the start of the summer/autumn seed phase, which is the resting phase of *S. caespitosum*.

The summer/autumn seed phase in which the seeds are first contained within the dry /ripe follicles, lasted for approximately 180 days between 3.V (31).V -31.XII. It is arbitrarily limited by the end-of year day of Dec 31, but physiologically and phenologically this phase is not broken in 2 sections or periods by the calendar year, as the life cycle is indeed cyclic.

The winter-spring seed phase continues the summer/autumn seed phase and lasts about 135 days between 1.I-17.IV, until the start of the next vegetative phase of the following year.

The Overall Resting Seed Phase which is divided in 2 parts only due to calendar year reasons, comprises the summer-autumn /winter seed phase and the winter-spring seed phase. At the beginning of next year's vegetative phase some dry fruits with open follicles are to be found in situ along the tiny plantlets newly germinated from seeds from previous years.

The Active phase / Resting Seed Phase periods of the life cycle were split approximately 42 / 213 days with an apparently short active phase being actually longer than usually displayed by the plants in ex-situ culture, due to the erratic weather pattern of the year studied.

I must additionally mention here that the seeds enter a resting phase which is continued for a proportion of the seeds with a dormancy period resulting in germination delayed by one or several years, and -by consequence- resulting in the actual provision of a seed-bank for the population, fact not apparent from this study but demonstrated experimentally via multi-annual artificial cultures (Barca V, personal communication).

The absolute length of the phenophases in the life cycle of *S. caespitosum* in a natural population in the proximity of Gura Dobrogei site, Central Dobrogea, Romania is presented in the chart in, together with the calendar dates of the actual limits of the phenophases discussed (Fig. 1).

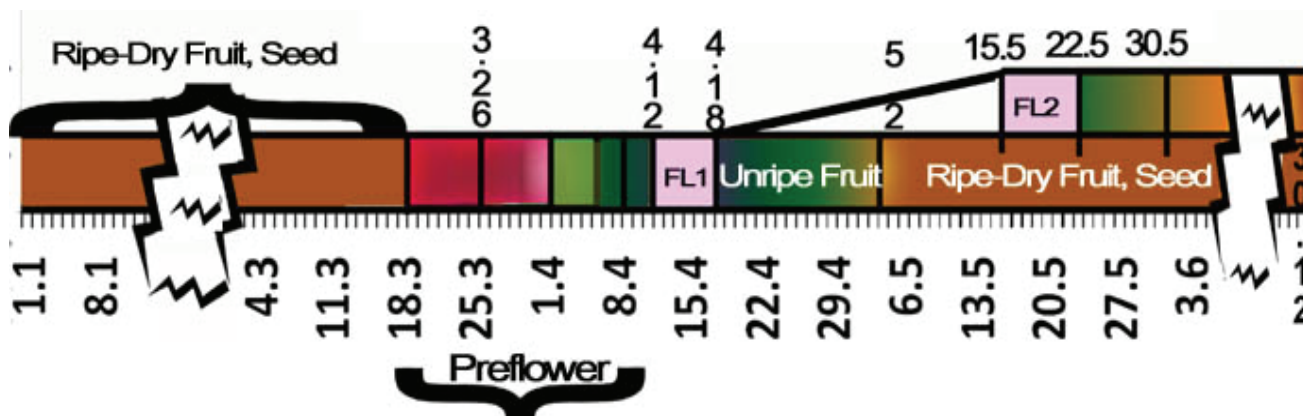


Figure 1. The absolute length of the phenophases in the life cycle of *S. caespitosum* in a natural population in the proximity of Gura Dobrogei site, Central Dobrogea, Romania. The horizontal axis is discontinuous, to improve the resolution of the time scale, parts of the resting phase of the life cycle were eliminated, with the gaps being figured as blank spaces between zigzagged lines. The approximate dates of the phenophase limits are marked in the system DD.M, above the chart.

To facilitate a better understanding of the relative contribution of each of the phases in the overall life cycle, the relative length of the Phenophases in the life cycle of *S. caespitosum* is presented in the chart if Fig. 2, with color pictures illustrating the aspect of representative plants for each phase described.

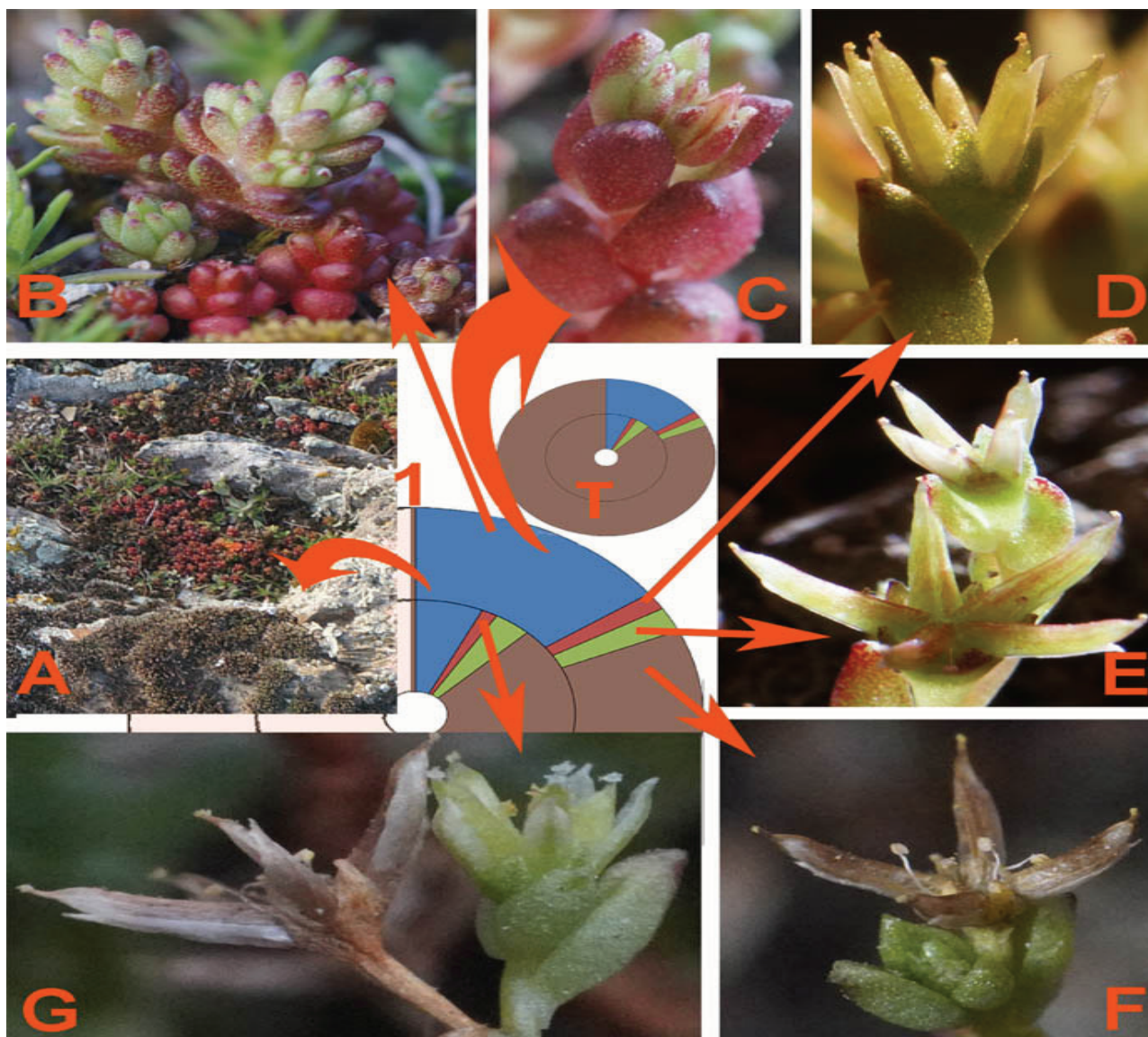


Figure 2. The relative length of the phenophases in the life cycle of *S. caespitosum* in a natural population in the proximity of Gura Dobrogei site, Central Dobrogea, Romania. In the center the life cycle is depicted in full (T) and a quarter slice of the cycle representing the active phases, with arrows linking the illustrative picture of plants in situ with the corresponding phases of the cycle.

A: Aspect of very young new plantlets in the 2nd week of shoot development in situ within the phytocoenosis;

B: close-up of young new plantlets in the 2nd week of shoot development in situ within the phytocoenosis, together with young shoots of *Sedum urvillei*; C: A young plant with advanced flower buds, ready to bloom;

D: Mature flower towards the end of the anthesis of the first blooming, the fertilized follicles start spreading,

E: maturing fruits of the first generation, with different ages, the older one with fully spread follicles is a rarer pentamerous form,

F: mature, dried fruit of the first blooming phase, and the primordium of the flower of the 2nd bloom;

G: mature, dried fruit of the first blooming phase, and a flower of the 2nd generation in full bloom; All photos made by Bârcă Valentin.

Autecological characteristics. The population studied herein grows in relatively dense colonies on shallow topsoil on skeletal, fragmented and/or intensely fractured superficial bedrock, in slight contrast with another habitat in a different place nearby, where it grows directly on exposed, unfragmented rocky calcareous outcrops or in pockets or crevices, formed by dissolution during exoclastic activity on probably Triassic or Jurassic limestones. Aspect of the habitat is depicted in Fig. 3, in which *Sedum caespitosum* is shown in situ on the first type of habitat.



Figure 3. The aspect of the phytocoenosis inhabited by *S. caespitosum* in a natural population in the proximity of Gura Dobrogei site, Central Dobrogea, Romania, 1: clearly visible dry fruits of the first blooming phase; 2: flowers of the second blooming phase just beginning the anthesis, on the same individuals; yS.u: young shoots of *Sedum urvillei* in situ within the phytocoenosis, together with; oS.u: an older (probably a 1-year old plant from the last year) with incipient flower buds; dS.u: a dry, dead, 2-year-old *Sedum urvillei* plant from previous years (original).

The population studied herein grows in relatively dense colonies on shallow topsoil on skeletal, intensely fractured superficial bedrock, in slight contrast with another habitat in a different place nearby, where it grows directly on exposed, unfragmented rocky calcareous outcrops or in pockets or crevices, formed by dissolution during exoclastic activity on probably Jurassic limestones.

The native, natural *Sedum caespitosum* population in the proximity of Gura Dobrogei site inhabits the gentle slopes of the left banks of Casimcea River. The topsoil is very shallow with dark richer soil, immobilized in place in crevices and cracks in the highly fractured substrate. The bedrock substrate is calcareous, composed of probably Jurassic limestone consisting often of narrow calcareous sheaths with fractures sealed with calcite inclusions.

This structure with the sheaths oriented in places perpendicular to the soil surface allows better fixation of alluvial soil and especially of the loess where apparent, and also allows better root penetration in the vertical cracks and fissures between the lamellar sheaths.

Phytocoenological characteristics. In the studied site, *S. caespitosum* occurs in the intensely grazed and trampled pasture situated on the left banks and slopes on the left side of river Casimcea, where it stood very strong pressure from herds of sheep/goats from a sheep farm located in close proximity (less than 100m). The facies of the site corresponds to Assoc. *Artemisia austriacae-Poëtum bulbosae* Pop 1970, which is built by *Poa bulbos*, and much less by *Artemisia austriaca* -which is surpassed by *Thymus sp.* (probably *T. pannonicus*). In patches less disturbed, *S. caespitosum* thrived at Gura Dobrogei in Assoc. *Sedo hillebrandtii-Polytrichetum piliferi* Horeanu et Mihai 1974 included in Western Pontic thyme steppes with *Thymus zygioides* (code 34.9211). The Assoc. is built mainly by *Polytrichum piliferum* and *Sedum urvillei*, with reported accompanying species *Dichanthium ischaemum*, *Potentilla argentea*, *Thymus zygioides* and *Thymus pannonicus*, *Xeranthemum annuum*, *Sanguisorba minor*, *Scleranthus perennis*. According to PETRESCU (2012), PETRESCU et al., (2014) this Assoc. also hosts the of European interest, like *Campanula romanica*, *Dianthus nardiformis*, *Moehringia grisebachii* and also other rare locally threatened species like *Festuca callieri* and *Gagea szovitzii*, the last species being also significant for the in situ blooming and vegetation period of *S. caespitos*.

DISCUSSIONS

The phenology of *Sedum caespitosum* is the typical one for an ephemeral therophyte, and the seeds which represent the resting propagules, overwinter in the shallow soil on the rocky outcrops or in the dried follicles of the fruits. The active phase of the life cycle begins in March and lasts only about two months, as by June the seeds are ripe and the plants are completely dry.

One interesting fact mentioned here for the first time is that *Sedum chaespitosum* Cav (Crassulaceae) population from Central Dobrogea studied shows a distinct, second blooming phase, sometimes succeeding a brief apparent vegetative arrest or even death of parts of the shoots and leaves of the shoots which bloomed in the first blooming period. This second bloom occurs when enough water is available, and could be interpreted as a strategy to take advantage of extended favorable periods during the same vegetative season. This finding warrants further experimental research coupled with phylogenetic examination of similar behavior in other *Sedum* taxa exhibiting more than one blooming phase in the same season.

Normally, annual herbs are monocarpic and this second blooming phase would suggest existence of dormant buds, primordia derived from meristems dormant or with delayed development, which begin re-growth as the first flowers wither and dry. As suggested by (VOLAIRE & NORTON, 2006), for the case of perennial grasses of Mediterranean origin, this second blooming phase could be interpreted like a condensed period of summer dormancy (endodormancy) triggered by the longer days and warmer temperatures caused by an overall delay in lifecycle due to shift of the anthesis, coupled with a subsequent break of endodormancy. This hypothesis though lacks a trigger for the putative release from dormancy, which in the case of Mediterranean perennial grasses is represented by temperature decrease (or day length decrease!?) in autumn.

In annuals, flowering appears to be “direct” (GRAINGER 1939, meaning anthesis follows flower initiation without any intervening rest period), a process which exploits and exhausts all floral meristems of any given individual during the completion of the life cycle within one year.

In many of the *Sedum caespitosum* population studied, the second blooming phase occurred after the leaves and even the stems of those individuals were apparently completely dry, suggesting a brief resting period between blooming phases and indicating the existence of a subset of meristems which entered a delayed anthesis after a brief dormancy. If this hypothesis holds true, this would be a highly unusual case in an annual plant, and could be assimilated with some sort of condensed polycarpy (as Bărcă V. suggested in personal communication).

Another, more orthodox explanation for this observed phenomenon -as TOOKE & BATTEY (2010) suggest, could be that sub-optimal chilling during a long and unusually warm winter which could have made budbreak protracted (but only a for subset of meristems in the same individuals), followed by a brief late coldspell which could explain good synchronization among individuals and among the 2 meristem subsets, consistent with the report of (SUNLEY et al. 2006 apud TOOKE & BATTEY 2010) that increasing chilling of blackcurrants and raspberries leads to more synchronous flowering. Further detailed experimental work is warranted to verify this hypothesis.

The ecology and phytocoenology of *Sedum caespitosum* D.C. on the Dobrogean site studied was found to differ indeed to a considerable extent from those of the populations from the western part of the country where the plant was considered typical halophyte, inhabiting in the spring the margins of the saltpans resulted from snowmelt and spring rains.

this study showed that, while the phenology and general survival strategy was similar, the autecology and phytocoenology was quite different in the two regions of the country.

Thus, in Western areas of Romania (BORZA, 1944) an likewise in the East-Central European countries, *Sedum caespitosum* D.C. was found to be a halophyte clearly associate with saltpans, as reported in many works, some quite recent.

In Hungary these ecological traits of *Sedum caespitosum* D.C. were reported in the recent years by (BÁTORI et al 2014; BORHIDI A., 2003; JAKAB, 2005; JAKAB & TÓTH 2003, MOLNÁR et al 2012; KIRÁLY, 2007; TÓTH, 2003) and all of them consider this species as a halophyte, and similar perception was expressed about the ecology and phytocoenology of *Sedum caespitosum* D.C. by researchers of other salt-rich habitats in Slovakia (FEHÉR, 2007) and Serbia (KNEŽEVIĆ et al., 2008).

Unlike the populations in Western Romania and in Hungary some of the populations in Bulgaria were reported in Mt Rodopi from serpentine substrate PAVLOVA et al (2003)).

Although I have no direct knowledge of the ecology and phytocoenology of *Sedum caespitosum* D.C in the mountain populations, I expect the ones in Moldova (MITITELU et al., 1993; SĂRBU & ȘTEFAN, 2005), to be less halophylous.

The data reported herein show that, like the populations in Western and Southwestern Europe where *Sedum caespitosum* D.C. is not a halophylous plant, in Dobrogea it grows in plant associations clearly non-halophylous developed on shallow topsoil covering superficial limestone bedrock without any halophylous traits.

The data reported here about the autecology and phytocoenology of one population of *Sedum caespitosum* D.C. from Central Dobrogea, support the hypothesis suggested by Barca Valentin (personal communication) that *Sedum caespitosum* D.C. is not necessarily a typical halophylous but it tolerates higher concentrations of cations –not specifically Na⁻; and of anions (not only Cl⁻ or SO₄⁻) but more likely Ca, Mg, CO₃, this more general salt tolerance allowing *Sedum caespitosum* to occupy and take advantage of ecological niches inhospitable for other plants, escaping in

this manner from the competition which it seems mostly unable to withstand. These data lead us to consider *Sedum caespitosum* at most an opportunistic halophyte.

Another explanation of the autecological and phytocoenological discrepancies exhibited by *Sedum caespitosum* populations from different areas is that the halophyllous *Sedum caespitosum* populations from South-Eastern Central Europe indeed belong to a distinct taxon, specialised in exploiting salt-rich flatlands and saltpans, as claimed by Simonkai when describing *Sedum deserti-hungarici* Simonkai (1890) based on specimens from one of those halophyllous populations.

All these aspects should be taken in consideration when devising conservation measures aimed not only at preserving this important Crassulacean species, but also, when implementing measures for preservation of animal species which might critically depend for their survival on the wellbeing of this tiny plant which they might use as food-plant like perhaps other cases which were documented previously; of *Aizobius sedi* Germ. (Apionidae, Curculionoidae) (BÂRCĂ & NICULAE, 2011), and *Scolitantides orion* (Pallas 1771) (Lepidoptera, Lycaenidae), (BÂRCĂ & NICULAE, 2018a) to use other Crassulaceans) and also see other cases of trophic interactions documented for *Alcea rosea* L. (Malvaceae) used by the weevil *Rhopalapion longirostre* Olivier, 1807 as host plant (BÂRCĂ et al., 2011), or of *Aristolochia clematitis* L used by *Zerynthia polyxena* (Dennis et Schiffermuller, 1775), (Lepidoptera, Papilionidae) as food-plant (BÂRCĂ, 2018a; BÂRCĂ & NICULAE, 2018b).

CONCLUSIONS

The phenology of *Sedum caespitosum* is the typical one for an ephemeral therophyte, and the seeds which represent the resting propagules, overwinter in the shallow soil on the rocky outcrops or in the dried follicles of the fruits. The active phase of the life cycle begins in March and lasts only about two months, as by June the seeds are ripe and the plants are completely dry.

Particularly unusually though, *S. chaespitosum* population from Central Dobrogea studied shows a distinct, second blooming phase, sometimes succeeding a brief apparent vegetative arrest or even death of parts of the shoots and leaves of the shoots which bloomed in the first blooming period, indicating the existence of a subset of meristems which entered a delayed anthesis after a brief dormancy. If this hypothesis holds true, this would be a highly unusual case in an annual plant, and could be assimilated with some sort of condensed polycarpy (as Barca V suggested in personal communication).

The ecological and phytocoenological data reported here support the hypothesis that *Sedum caespitosum* D.C. in Dobrogea grows in clearly non-halophyllous plant associations developed on shallow topsoil covering superficial limestone bedrock, so it is at most an opportunistic halophyte being just a salt-tolerant species exploiting ecological niches inhospitable for other plants, thus escaping the competition which it is unable to withstand.

Another explanation of the observed autecological and phytocoenological inconsistencies exhibited by *Sedum caespitosum*, is that the halophyllous *Sedum caespitosum* populations from South-Eastern Central Europe indeed belong to a distinct taxon, specialised in exploiting salt-rich flatlands and saltpans, as claimed by Simonkai when describing *Sedum deserti-hungarici* Simonkai (1890) based on specimens from one of those halophyllous populations.

All these aspects should be taken in consideration when devising conservation measures aimed at both preserving this important Crassulacean species, and, also, for preservation of animal species which depend somehow on this plant.

ACKNOWLEDGEMENTS

I want to thank Dr. Valentin BÂRCĂ for the help with the documentary photographic material and for providing some data from his fieldwork, and for the helpful discussions improving the manuscript.

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Received: March 31, 2018

Accepted: September 14, 2018