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A checklist of desmids (Conjugatophyceae, Chlorophyta) of Serbia. II. Genus *Cosmarium*

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Abstract – The desmid flora of Serbia has been surveyed during various periods. The first data on the distribution of desmids in Serbia date back to 1883 and from then on until 2009 altogether 630 different taxa were identified. Among 23 genera of desmids in all, the most diverse and most commonly found is *Cosmarium* (242 taxa or 38.4% of the total number of taxa). Taxa belonging to the genus *Cosmarium* grow in distinctly diverse habitats, from lowland rivers to high-mountain peat bogs. The present paper gives a survey of the major taxonomic and ecological characteristics of the *Cosmarium* taxa which have been identified in Serbia. The present studies regarding the distribution of *Cosmarium* taxa over the territory of Serbia, show that extremely rare, very rare and rare taxa comprise 96.3% of all recorded *Cosmarium* taxa. The species *Cosmarium botrytis*, *C. laeve*, *C. meneghinii* and *C. subprotumidum* appear widely distributed in the territory of Serbia. High-mountain peat bogs are characterized by the greatest diversity of the *Cosmarium* taxa.

Checklist / desmids / *Cosmarium* / diversity / floristics / ecology / Serbia

Résumé – Checklist des desmidiées (Conjugatophyceae, Chlorophyta) de Serbie. II. *Cosmarium*. La flore desmidiale de Serbie a été étudiée durant différentes périodes. Les premières données sur la distribution des desmidiées ont été publiées en 1883. Depuis cette date, et jusqu'en 2009, 630 taxons de desmidiées ont été identifiés. Sur un total de 23 genres de desmidiées le genre dominant est *Cosmarium* (242 taxons, soit 38,4 % du total). En Serbie, les espèces du genre *Cosmarium* sont observées dans des habitats très diversifiés, depuis les rivières de plaine jusqu'aux tourbières de haute montagne. Cet article donne une vue d'ensemble des caractéristiques taxonomiques et écologiques majeures des taxons du genre *Cosmarium* identifiés en Serbie. Les espèces extrêmement rares, très rares, et rares, représentent 96,3 % des taxons de *Cosmarium*. Les espèces à large distribution sur le territoire de Serbie sont *Cosmarium botrytis*, *C. laeve*, *C. meneghinii* and *C. subprotumidum*. La plus forte diversité de *Cosmarium* se trouve dans les tourbières de haute montagne.

Liste floristique / desmidiées / *Cosmarium* / diversité / floristique / écologie / Serbie

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INTRODUCTION

The first data on the distribution of taxa belonging to the genus *Cosmarium* in Serbia were published by Schaarschmidt (1883). He recorded the species *Cosmarium margaritiferum, C. turpinii, C. crenatum* and *C. meneghinii.*

In the first decade of the 20th Century, Košanin, Katić and Đorđević started more serious studies concerning the diversity and distribution of desmids in Serbia (Košanin, 1908a, 1908b; 1910; Katić, 1910; Đorđević, 1910). Milovanović (Milovanović, 1959, 1960a, 1960b, 1960c, 1962) greatly contributed to the knowledge of the desmid flora in Serbia by studying desmid algae of the Vlasina peat bog and Daićko lake and the peat bogs on Mts. Kopaonik, Željin and Ostrozub.

Floristically, peat bogs constitute a separate group of wetland habitats that are ecologically clearly distinct from other fresh-water habitats. They are distinguished by particular physico-chemical characteristics as well as by a distinctive flora and fauna. Phylogenetically, peat bogs are very important as significant relict habitats. In Serbia they are not as numerous as in northern and western Europe. In adition, they gradually disappear due to the expansion of agricultural areas, deforestation and creation of reservoirs. These factors mutually affect the composition of the total algal flora, including the desmid flora. The most expressive example of human influence on peat bogs in Serbia was the formation of a reservoir (called Vlasina Lake) after the Vlasina peat bog had been inundated. Košanin (Košanin, 1910b) recorded 79 taxa from 15 genera in the Vlasina peat bog in 1910, whereas during the same year, Đorđević (Đorđević, 1910) recorded 193 taxa from 16 genera. The study performed in 1948 (Milovanović, 1960a) revealed 217 desmid taxa in all, of which only 39 taxa had been previously recorded by Košanin and Đorđević (Košanin, 1910b; Đorđević, 1910) and the genus *Cosmarium* was dominant. In the period of Vlasina Lake formation (1949-1954) almost the entire community of desmids disappeared (Milovanović, 1973). Only a small portion of the community survived in the littoral zone which was not submerged. The main reason of the degradation of the desmid community was explained by sudden changes in physico-chemical water properties. The last extensive study of the desmid flora in the Vlasina Lake showed that the diversity of desmids had increased remarkably (Cvijan & Laušević, 1991b).

Up to the present, the total number of known desmid taxa in Serbia amounts to 630, revealing the families Desmidiaceae and Closteriaceae as qualitatively dominant. The cosmopolitan genus *Cosmarium*, comprising 242 taxa, represents the most diverse genus among desmids. The greatest diversity of the representatives of this genus was recorded in dystrophic ecosystems – high-mountain peat bogs, pits, mires, etc. However, representatives of this genus can also be found in the other types of water bodies and slow running rivers, thus constituting an important part of the phytoplankton and phytobenthic community. In the present paper a survey on the diversity of *Cosmarium* taxa hitherto recorded from the territory of Serbia is given.

MATERIALS AND METHODS

This paper is the continuation of Stamenković *et al.* (2008), which dealt with the distribution of elongate baculiform desmids within Serbia. For the present enumeration, all available literature sources of desmid taxa (published papers, manuscripts and proceedings) concerning the genus *Cosmarium* occurring

in Serbia were examined, including theses dealing with the diversity, distribution and ecology of the genus *Cosmarium*. In addition to the all previously quoted literature data (Stamenković *et al.*, 2008), in the present paper new literature data on two thermomineral springs (Blaženčić & Cvijan, 1980; Cvijan, 1986), as well as new unpublished data, with respect to the distribution of taxa of the genus *Cosmarium* in the peat lake of Peshter plateau (algae were collected in July and September 2008 and May 2009) and three salt marshes (Slatina, Pečena slatina and Rusanda) of the Province of Vojvodina (algae were collected several times during 2003 and 2006) are included.

Phytoplankton samples were collected by towing a plankton net (mesh size 25 μm) through the open water. Samples of phytobenthos were collected with a pipette from the surface of the bottom deposits. Sampling of epiphytes was performed by squeezing the submerged parts of plants. Water temperature was measured by a digital thermometer with metal electrode, accuracy being 0.1°C.

The physico-chemical analysis of the water was performed in the Institute for Public Health of Serbia "Dr. Milan Jovanovic-Batut" applying standard analytical methods, according to JUS-ISO (APHA, AWWA, WPCF).

Taxonomic analyses were carried out using a Reichert Diastar microscope with a Canon Power Shot S40 digital camera. Taxa of the genus *Cosmarium* were identified with the aid of relevant literature (see References). Based on all the localities surveyed in Serbia, frequencies of desmid taxa are designated here according to the following scale: very rare (VR) – taxa recorded in < 10% of investigated sites; rare (R) – taxa recorded in 10 – 30 % of investigated sites; common (C) – taxa recorded in 30 – 70% of investigated sites; frequent (F) – taxa recorded in 70 – 90% of investigated sites; very frequent (VF) – taxa recorded in > 90% of investigated sites. Exceptionally rare (ER) taxa are those recorded in only one locality in the territory of Serbia.

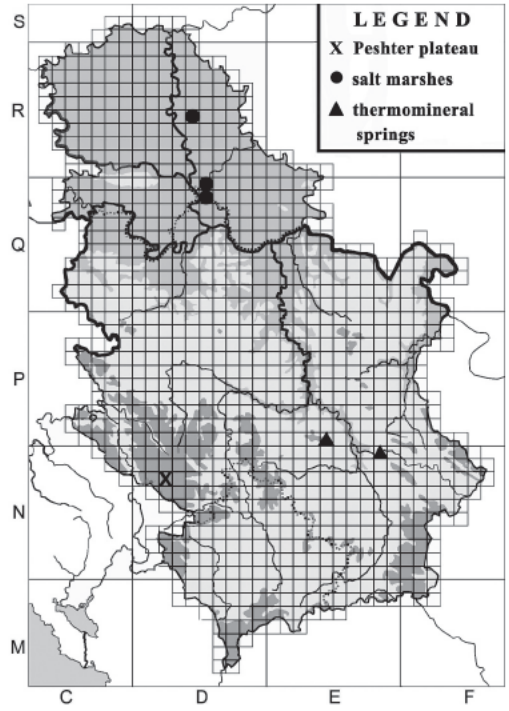
RESULTS AND DISCUSSION

Habitats of *Cosmarium* taxa in Serbia

Taxa of the genus *Cosmarium* are widely distributed in Serbia. Text-fig. 1 in Stamenković *et al.* (2008) shows the location of the habitats of the different taxa of the elongate baculiform desmid taxa, and of the genus *Cosmarium* as well. In addition, the locations of the four newly investigated habitats of desmids (peat-bog lake at Peshter plateau and three salt marshes), as well as of two thermomineral springs (in Niška and Ribarska Spa – literature data), which contain representatives of the genus *Cosmarium* are presented in Text-Figure 1. in the present paper.

Different taxa of the genus *Cosmarium* have been previously reported from both periphyton and phytoplankton communities in Serbia. Unfortunately, most phycologists in Serbia have provided only a list of *Cosmarium* taxa without additional remarks and with only few illustrations. Therefore it was not possible to verify older reports and reports of taxa recorded from a single locality.

Some physico-chemical characteristics of the previously investigated habitats were presented in Stamenković *et al.* (2008). Some physico-chemical characteristics of newly investigated habitats (peat lake at the Peshter plateau and three salt marshes) and two thermomineral springs (literature data) are presented in this paper.



Text-figure 1. UTM map of Serbia (10 × 10 km) showing the new location of the habitats of the genus *Cosmarium*.

In general the physico-chemical characteristics of the peat bogs in Serbia favour the development of a very rich desmid flora (Stamenković *et al.*, 2008). It should be noted that large peat bogs in Serbia and in the Balkan Peninsula are of a rare occurrence, owing to the southern position of those regions with respect to peat bog distribution centres in Europe. Ecosystems of mountainous peat bogs are extremely fragile not only in Serbia, but also in the Balkan Peninsula as a whole. Vegetation of mountainous peat bogs is threatened in the first place by peat exploitation, development of mountain tourism, melioration and irrigation as well as by nitrification processes, i.e. eutrophication due to pollution with organic waste.

The Peshter plateau constitutes one of the last preserved large peat bogs from upland and mountainous areas in Serbia. Negative influence of the submerging of Vlasinska peat bog or urbanization of Mts. Tara and Golija stress the importance of the peat bog of the Peshter plateau. The peat bog lake of the Peshter plateau is situated at an altitude of 1155-1161 m above sea level and is the third largest in Serbia. The lake vegetation is mainly composed of members of the genus *Carex*. The *Sphagnum* moss peat, which occurs here, is composed of *Sphagnum subsecundum* Nees and *S. contortum* Schultz. *Hypnum* moss peat is also abundantly present. Water pH varies from 6.5 to 7.3. The results of physical-chemical water analysis show low ion concentrations, which is in accordance with the fact that it is a high-mountain peat bog. The peat bog lake is characterized by a very small quantity of organic compounds and high concentrations of dissolved oxygen. Somewhat higher concentrations of ammonia probably originate from local arable lands.

In Serbia salt marshes are present in greatest number in the northern and north-eastern regions, *i.e.* in Vojvodina. Most often, the development of salt soils is caused by the former existence of seas and salt lakes, which is in line with data that once this territory was covered with the Pannonian Sea. The main and continual couse of salinization and alkalization are shallow underground waters level throughout the year. Physico-chemical analyses of salt marshes in Vojvodina generally show high ion concentrations, which result in total water salinity and high pH values ranging from 7.6 to 9.3 (Slatina: 8.4-9.3; Pečena slatina: 7.9-9.3; Rusanda: 7.6-8.1). Owing to the dominance of Na^+ and Cl^- ions, those waters are classified as sodium chloride. K^+ concentration is significantly lower than that of Na^+, and Mg^{2+} concentration is considerably higher than that of Ca^{2+}, which is rather rare in nature. In low-mineralized waters the ratio $Ca^{2+} : Mg^{2+}$ varies from

4:1 up to 1:1 (Dimitrijević, 1988). It seems likely that Mg^{2+} and Ca^{2+} concentrations result from high precipitation, aluminosilicate formation, ions exchange or their incorporation into clay. Concentration of these ions in water is also dependent on evaporation (Oduor & Schagerl, 2007). Some increased nitrate and total phosphorus concentration probably originate from local arable lands. High concentrations of Chlorophyll *a* indicate a high primary production and intensive photosynthetic activity.

The thermomineral water of Niška Spa is characterized by high concentrations of Ca^{2+} and HCO_3^- ions and it belongs to the group of homeothermic waters of moderate radioactivity (Cvijan, 1986, 1994; Petrovska, 1969). Springs of thermomineral water of Ribarska Spa occur on andesitic rocks which belong to younger volcanism. The thermomineral water belongs to the group of sulfuric homeothermic watars of low radioactivity (Blaženčić & Cvijan, 1980).

Distribution and ecology of *Cosmarium* taxa in Serbia

Qualitatively, the genus *Cosmarium* is the dominant genus of the desmid flora of Serbia (after detailed revision – 242 taxa). It comprises 38.4% of the total number of desmid taxa that have been recorded in the territory of Serbia so far. According to all the existing investigations dealing with the diversity of the *Cosmarium* taxa in Serbia, the majority of 242 taxa may be designated in Serbia as exceptionally rare (121 taxa, or 50%) or very rare (101 taxa or 41.7% of the total number of *Cosmarium* taxa). Remarkably, more than 96% of the *Cosmarium* taxa reported from Serbia are rare or very rare taxa, or taxa found only on one locality. Some of these taxa are also rare in other European countries, e.g. in Austria (Lenzeweger, 1999), Czech Republic (Štastnŷ, 2008, 2009), France (Kouwets, 1987), Netherlands (Coesel & Meesters, 2007), Lithuania (Kostekviciene *et al.*, 2003; Briskaite *et al.*, 2008), Russia (Sterlyagova, 2008), Turkey (Şahin, 2005) and Great Britain (Brook & Johnson, 2003).

Common species (*Cosmarium formosulum, C. granatum*, *C. impressulum, C. ochthodes* and *C. subcrenatum*) account for only 2.1% of the total number of *Cosmarium* taxa. Only 4 *Cosmarium* species (or 1.7%) were frequently recorded in the territory of Serbia. These are *Cosmarium botrytis, C. laeve, C. meneghinii* and *C. subprotumidum*. These species were widely distributed in Serbia and they were found in high-mountain peat bogs, oligotrophic mountainous lakes (glacial and nival lakes), thermomineral springs, salt marshes, fishponds, irrigation ditches and similar habitats. This is not surprizing, since these species are inhabitants of meso- to eutrophic waters and have a cosmopolitan distribution.

In terms of percentages, the distribution of *Cosmarium* taxa over oligo- meso- and eutrophic waterbodies, respectively, was as follows. The greatest number of taxa of the genus *Cosmarium* was found in high-mountain peat bogs and oligotrophic glacial and nival lakes. A total number of 80 or 33% of the *Cosmarium* taxa were exclusively found in high-mountain peat bogs. Many of them are designated as exceptionally rare (*Cosmarium anisochondrum, C. brebissonii, C. canaliculatum, C. cruciatum, C. elegantissimum, C. everettense, C. fontigenum, C. isthmochondrum, C. kitchelii, C. ornatum, C. perforatum, C. polymorphum, C. praemorsum, C. prominulum, C. striolatum*).

According to Urošević (1994a) glacial and nival lakes in the territory of Kosovo and Metohija Province provide suitable habitats to 19 taxa (almost 8%) of the genus *Cosmarium* that have not been found in other localities in Serbia

(*Cosmarium amoenum, C. conspersum var. latum, C. crenatum var. bicrenatum, C. crenatum f. boldtianum, C. cyclicum var. arcticum, C. debaryi, C. etchachanense, C. garrolense, C. granulatum, C. hammeri, C. logiense, C. magnificum, C. pseudamoenum, C. pseudonitidulum, C. quadratum var. willei, C. subalatum, C. subexcavatum, C. subimpressulum, C. umbilicatum*).

About 40% of the taxa of the genus *Cosmarium* have been found in mesotrophic stagnant and running waters, which is only slightly less than the oligotrophic group mentioned above. Some of them have only been found only in irrigation canals in the territory of Vojvodina (*Cosmarium angulosum* var. *concinnum, C. boitierense, C. depressum* var. *achondrum, C. granatum* var. *granatum* f. *messikommeri, C. impressulum* var. *alpicolum, C. intermedium, C. margaritatum* f. *minus, C. novae-semliae* var. *granulatum, C. praecisum, C. pseudobiremum, C. regnellii* var. *minimum, C. regnellii* var. *pseudoregnellii, C. reniforme* var. *compressum, C. staurastroides, C. subprotumidum* var. *gregorii, C. trachypleurum* var. *minus, C. variolatum* var. *cataractarum*). Water of Vojvodina watercourses and canals is characterized by a high content of mineral salts and very frequently by a significant load of various biodegradable compounds. As a result, concentrations of nitrogen and phosphorus compounds are increased, consequently causes the decreasing of dissolved oxygen concentrations. pH values of waters in the rivers and canals in Vojvodina range between 6.5 and 9.0 (Stamenković, 2005). *Cosmarium boitierense*, which was recorded in the Žabalj locality, seemed highly tolerant to high Fe concentration and extremely high concentration of evaporable phenols (Stamenković & Cvijan, 2008c).

About 20% of the *Cosmarium* taxa are characteristic inhabitants of eutrophic fishponds, ponds, puddles and marshes. These habitats are very rich in nitrogen and phosphorus compounds as well as in sodium, calcium and magnesium salts, water pH values ranging from 6.9-9.0 (Milovanović & Živković, 1953).

Finally, some additional remarks can be made on the desmid flora of a few particular habitats.

In Peshter peatlake were found 50 taxa of the genus *Cosmarium*. The taxa *Cosmarium cymatopleurum* var. *archeri, C. difficile* var. *subimpressulum, C. granatum* var. *elongatum, C. ocellatum, C. paragranatoides, C. paragranatoides* var. *dickii, C. pseudoconnatum, C. pygmaeum* var. *heimerlii, C. quadrum* and *C. subgranatum* var. *borgei*) had not been recorded so far in the desmid flora of Serbia. In salt marshes Slatina and Pečena Slatina *Cosmarium angulosum* var. *concinnum, C. bioculatum* var. *depressum, C. formosulum, C. granatum* and *C. laeve* were found. Additionaly, *C. laeve* var. *octangulare* was found only in Slatina (Subakov - Simić *et al.*, 2006). In salt marsh Rusanda, *Cosmarium impressulum*, *C. depressum* and *C. subcucumis* were found.

In the thermomineral water of Niška Spa, at the concrete bottom of the canal with slowly runing and very shallow (about 3 cm) water, at water temperature ranging from 23 to 33.5°C and pH 7.2, *Cosmarium laeve* was recorded (Cvijan, 1986). In the thermomineral water of Ribarska spa, at the concrete in a small, shallow (0.5 m) water basin, at water temperature of 31°C and pH 7, the species *Cosmarium laeve* and *C. obtusatum* were found (Blaženčić & Cvijan, 1980).

Biogeography of the genus *Cosmarium* in Serbia

The majority of the *Cosmarium* taxa recorded from the territory of Serbia are considered cosmopolitan, which is in accordance with a global distribution of this genus.

A relatively large number of *Cosmarium* taxa are submontane, montane and subalpine such as *C. depressum* var. *achondrum, C. didymochondrum, C. elegantissimum, C. exiguum, C. garrolense, C. hammeri, C. nitidulum, C. orbiculatum, C. retusiforme, C. sportella*.

A relatively large number of *Cosmarium* taxa are arctic-alpine, boreal-arctic, arctic and holarctic. According to Milovanović (1959), Lenzenweger (2003), Kostkeviciene *et al.* (2003), Sahin (2005) and Sterlyagova (2008): *C. annulatum, C. conspersum, C. crenatum var. bicrenatum, C. crenatum f. boldtianum, C. cucumis, C. cyclicum var. arcticum, C. homalodermum, C. laeve var. septentrionale, C. nasutum, C. novae-semliae, C. pseudooctangulare, C. subexcavatum, C. tetragonum.* The presence of subalpine, alpine and arctic-alpine elements in Serbia, particular in the peat bogs, indicates the glacial origin of these peat bogs.

In adition, and possibly as a result of the geographic position and climate regime in Southeast Europe, a small number of *Cosmarium* taxa are warm-temperate such as *Cosmarium polymorphum, C. striolatum* var. *intermedium, C. subalatum, C. constrictum* var. *minus*.

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APPENDIX

List of *Cosmarium* taxa in Serbia

Literature: the numbers in the literature column refer to numbers in brackets after the references in the Reference list. New, unpublished data, are designated as Ud.

Bas.: basionym; **Syn.**: synonym.

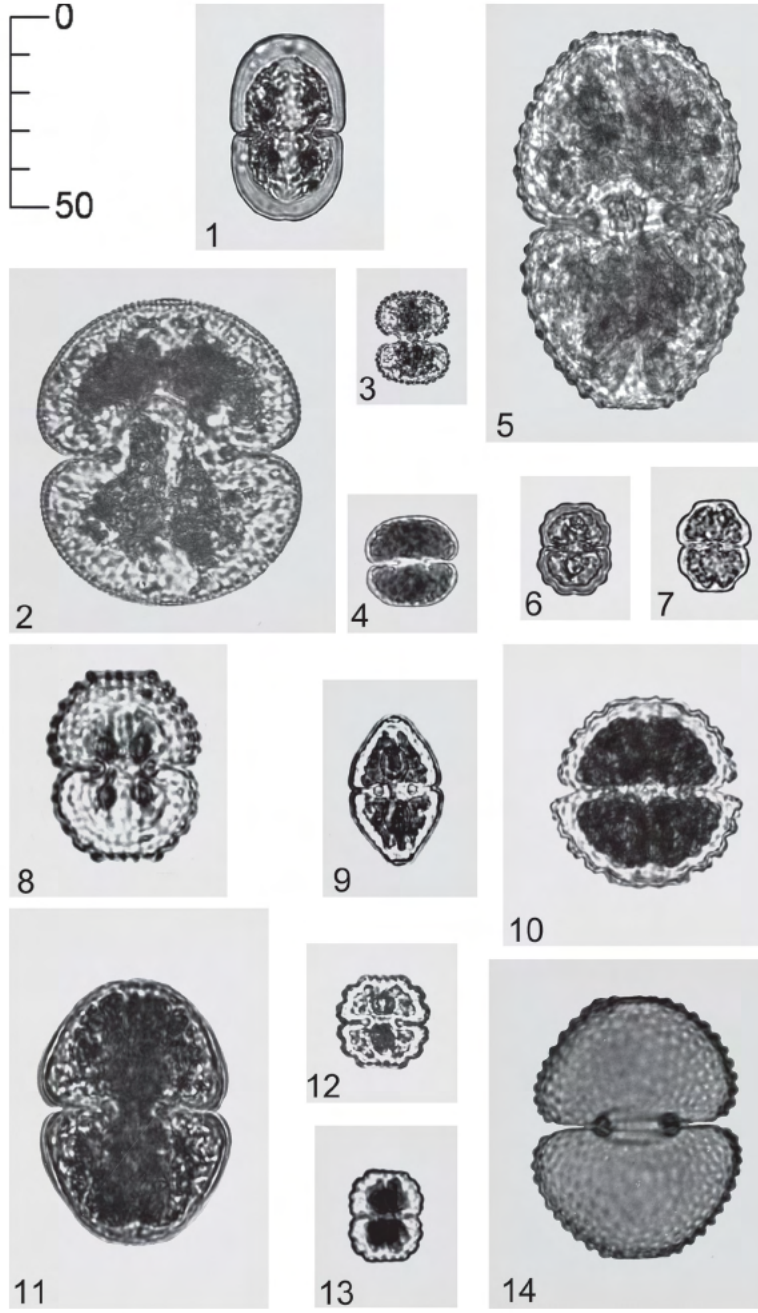
Habitats: 1. river; 2. canal; 3. lake; 4. pond; 5. marsh; 6. brook; 7. fish pond; 8. barren pond (after coal exploatation); 9. irrigation canal; 10. spring; 11. stream; 12. salt marsh; 13. high-mountain peat bog; 14. high-mountain glacial lake; 15. high-mountain nival lake; 16. high-mountain solifluctional lake; 17. reservoir; 18. thermal spring; 19. mineral spring; 20. thermo-mineral spring; 21. sublacustrine spring.

Frequency: exceptionally rare (ER); very rare (VR); rare (R); common (C); frequent (F); very frequent (VF)

C. abbreviatum Racib. 1885 – Lit.: 76, 83, Ud. – Hab.: 1, 13, 17. – VR

C. abruptum Lund. 1871 – Lit.: 11, 28, 30. – Hab.: 13. – VR

C. amoenum (Bréb.) Ralfs 1848 var. *amoenum* – Lit.: 86. – Hab.: 14. – ER



Figs 1-14. **1.** *Cosmarium quadratum* var. *quadratum*, **2.** *C. pachydermum* var. *aethiopicum*, **3.** *C. portianum* var. *portianum*, **4.** *C. phaseolus* var. *phaseolus*, **5.** *C. teraophthalmum*, **6.** *C. impressulum* var. *impressulum*, **7.** *C. trilobulatum*, **8.** *C. formosulum* var. *formosulum*, **9.** *C. granatum* var. *granatum*, **10.** *C. cyclicum* var. *cyclicum*, **11.** *C. perforatum*, **12.** *C. subprotumidum* var. *subprotumidum*, **13.** *C. sexnotatum* var. *tristriatum*, **14.** *C. botrytis* var. *tumidum*

C. amoenum var. *mediolaeve* Nordst. 1887 – Lit.: 45. – Hab.: 13. – ER

C. anceps Lund. 1871 – Lit.: 32, 34, 35, 86, 91, 92, 94, Ud. – Hab.: 1, 10, 13, 14. – VR

C. angulosum Bréb. 1856 var. *angulosum* (Syn.: *Cosmarium meneghinii* var. *angulosum* (Bréb.) Rabenh. 1868) – Lit.: 9, 10, 12, 13, 76, 89, 91, Ud. – Hab.: 1, 9, 13, 14. – VR

C. angulosum var. *concinnum* (Rabenh.) W. *et* G. S. West 1901 (Bas.: *Euastrum concinnum* Rabenh. 1862; Syn.: *Cosmarium concinnum* Reinsch 1867, *C. meneghinii* var. *concinnum* Rabenh. 1871, *C. concinuum* var. *laeve* Wille 1880) – Lit.: 76, Ud. – Hab.: 9, 12. – VR

C. anisochondrum Nordst. 1878 – Lit.: 13. – Hab.: 13. - ER

C. annulatum (Näg.) de Bary 1858 (Bas.: *Dysphinctium annulatum* Näg. 1849) – Lit. 11, 13, 27, 28, 30, 31. – Hab.: 13. – VR

C. asphaerosporum var. *corribense* (W. *et* G. S. West) Krieg. *et* Gerloff 1969 (Bas.: *Cosmarium corribense* W. *et* G. S. West 1906) – Lit.: 59. – Hab. 1. – ER

C. bioculatum Bréb. *ex* Ralfs 1848 var. *bioculatum* (Syn.: *Euastrum bioculatum* (Bréb. *et* God.) Kütz. 1845, *Cosmarium rotundatum* (Gay) De Toni 1889) – Lit.: 11, 13, 29, 45, 53, 76. – Hab.: 1, 9, 13. – VR

C. bioculatum var. *depressum* (Schaarschm.) Schmidle 1894 – Lit.: 13, 45, 48, 76, 77, 78, Ud. – Hab.: 1, 9, 12, 13. – VR

C. bioculatum var. *hians* W. *et* G. S. West 1897 – Lit.: 13, 45. – Hab.: 13. – ER

C. bipunctatum Børgesen 1890 (Syn.: *Cosmarium vogesiacum* var. *alpinum* f. *bipunctatum* (Børgesen) Laporte 1931, *C. polonicum* var. *quadrigranatum* f. *bipuncatum* Laporte 1931) – Lit.: 76. – Hab.: 1. – ER

C. biretum Bréb. *ex* Ralfs 1848 (Syn.: *Cosmarium biretum* var. *triquetrum* Bréb. 1856, *C. quadrangulatum* Hantzsch 1860, *C. biretum* var. *minus* Hans. 1888) – Lit.: 13, 76, 94. – Hab.: 9, 10, 13. – VR

C. blyttii Wille 1880 – Lit.: 13, 88, 89, 91, 94. – Hab.: 10, 13, 14, 15. – VR

C. boeckii Wille 1880 – Lit.: 45, 86, 88, 91. – Hab.: 13, 14, 15. – VR

C. boitierense Kouwets 1998 – Lit.: 80. – Hab.: 9. – ER

C. botrytis Menegh. *ex* Ralfs 1848 var. *botrytis* (Syn.: *Euastrum botrytis* (Ralfs) Näg. 1849) – Lit.: 3, 4, 5, 6, 9, 10, 12, 13, 14, 15, 24, 32, 33, 34, 35, 37, 38, 40, 41, 45, 46, 49, 52, 53, 54, 55, 57, 60, 61, 62, 65, 66, 67, 68, 69, 76, 87, 89, 91, Ud. – Hab.: 1, 3, 4, 5, 7, 8, 9, 10, 11, 13, 14, 16, 17, 20. – VF

C. botrytis var. *gemmiferum* (Bréb.) Nordst. 1888 (Bas.: *Cosmarium gemmiferum* Bréb. 1856) – Lit.: 45, 94, Ud. – Hab.: 10, 13. – VR

C. botrytis var. *mediolaeve* W. West 1892 – Lit.: 45, 48, 76, Ud. – Hab.: 9, 13. – VR

C. botrytis var. *subtumidum* Wittr. 1872 – Lit.: 32, 33, 34, 35, 76. – Hab.: 1. – VR

C. botrytis var. *tumidum* Wolle 1884 **(Fig. 14.)** – Lit.: 45, 76, Ud. – Hab.: 9, 13. – VR

C. brebissonii Menegh. *ex* Ralfs 1884 – Lit.: 11, 13, 27, 28, 31, 45. – Hab.: 13. – ER

C. broomei Thwaites *ex* Ralfs 1848 – Lit.: 13, 27. – Hab.: 13. – ER

C. caelatum Ralfs 1848 var. *caelatum* (Syn.: *Euastrum decorum* Gay 1884) – Lit.: 11, 28, 31, 44, 45, 48, 86, 89, 91. – Hab.: 13, 14. – VR

C. caelatum var. *spectabile* (De Not.) Nordst. 1876 (Bas.: *Cosmarium spectabile* De Not. 1867) – Lit.: 13. – Hab.: 13. – ER

C. calcareum Wittr. 1872 – Lit.: 13, 76, 77, 78, 86, 88, 91. – Hab.: 1, 9, 13, 14, 15. – VR

C. canaliculatum W. *et* G. S. West 1896 – Lit.: 13. – Hab.: 13. – ER

C. coarctatum W. West 1892 – Lit.: 46, 47, 48. – Hab.: 13. – ER

C. connatum Bréb. *ex* Ralfs 1848 (Syn.: *Dysphinctium connatum* (Ralfs) Reinsch 1866) – Lit.: 9, 10, 11, 12, 13, 28, 30, 31, 45, Ud. – Hab.: 13. – ER

C. conspersum Ralfs 1848 var. *conspersum* – Lit.: 13, 45, 88, 89, 91. – Hab.: 13, 14, 15. – VR

C. conspersum var. *latum* (Bréb.) W. *et* G. S. West 1912 (Bas.: *Cosmarium latum* Bréb. 1856; Syn.: *C. anomalum* Delp. 1877) – Lit.: 88, 89, 91, Ud. – Hab. 13, 14, 15. – VR

C. constrictum Delp. 1878 var. *constrictum* – Lit.: 76. – Hab.: 1. – ER

C. constrictum var. *minus* Fritsch. *et* Rich 1924 – Lit.: 26. – Hab.: 1. – ER

C. contractum Kirchn. 1878 var. *contractum* – Lit.: 11, 13, 28, 30, 31, 42, 45, 52, 76, 77, 78. – Hab.: 1, 4, 7, 13. – R

C. contractum var. *ellipsoideum* (Elfv.) W. *et* G. S. West 1902 – Lit.: 13. – Hab.: 13. – ER

C. contractum var. *minutum* (Delp.) Coesel 1989 (Bas.: *Cosmarium minutum* Delp. 1877) – Lit.: 76. – Hab.: 1. – ER

C. crenatum Ralfs 1848 var. *crenatum* – Lit: 28, 30, 31, 35, 37, 38, 39, 44, 74, 86. – Hab.: 2,4, 5, 13, 14. – R

C. crenatum var. *bicrenatum* Nordst. 1872 – Lit.: 86. – Hab.: 14. – ER

C. crenatum f. *boldtianum* (Gutw.) W. *et* G. S. West 1912 (Bas.: *Cosmarium boldtianum* Gutw. 1894) – Lit.: 86, 90. – Hab.: 14. – VR

C. crenulatum Näg. 1849 (Syn.: *Cosmarium undulatum* var. *crenulatum* (Näg.) Wittr. 1869, C. *impressulum* var. *crenulatum* (Näg.) Krieg. *et* Gerloff 1969) – Lit.: 6, 13, 95, Ud. – Hab.: 8, 10, 13. – VR

C. cruciatum Bréb. 1856 – Lit.: 13. – Hab.: 13. – ER

C. cucumis Corda *ex* Ralfs 1848 var. *cucumis* (Syn.: *Pleurotaeniopsis cucumis* (Ralfs) Lagerh. 1889) – Lit.: 13, 86, Ud. – Hab.: 13, 14. – VR

C. cucumis var. *helveticum* Nordst. 1880 – Lit.: 11, 28, 30, 31, 45. – Hab.: 13. – ER

C. cyclicum Lund. 1871 var. *cyclicum* **(Fig. 10.)** – Lit.: 11, 28, *et* G. S. West 1905 – Lit.: 86. – Hab.: 14. – ER

C. cyclicum var. *arcticum* (Nordst.) W. *et* G. S. West 1905 (Bas.: *Cosmarium cyclicum* subsp. *arcticum* Nordst. 1872) – Lit.: 86. – Hab.: 14. – ER

C. cyclicum var. *nordstedtianum* (Reinsch) W. *et* G. S. West 1905 (Bas.: *Cosmarium nordstedtianum* Reinsch 1875) – Lit.: 35, 44, 45. – Hab.: 13. – VR

C. cymatopleurum Nordst. 1872 var. *cymatopleurum* – Lit.: 52. – Hab.: 7. – ER

C. cymatopleurum var. *archeri* (Roy *et* Biss.) W. *et* G. S. West 1900 – Lit.: Ud. – Hab.: 13. – ER

C. debaryi Arch. *in* A. Pritch. 1861 – Lit.: 88, 89, 91. – Hab.: 14, 15. – VR

C. decedens (Reinsch) Racib. 1889 (Bas.: *Cosmarium plicatum* var. *decedens* Reinsch 1867; Syn.: *Euastrum decedens* (Reinsch) Roy 1883, *E. anomalum* Gay 1884) – Lit.: 48, 90. – Hab.: 13, 21. – VR

C. depressum (Näg.) Lund. 1871 var. *depressum* (Syn.: *Cosmarium scenedesmus* Depl. 1877) – Lit.: 12, 13, 20, 21, 22, 23, 52, Ud. – Hab.: 3, 7, 13, 17. – VR

C. depressum var. *achondrum* (Boldt) W. *et* G. S. West 1905 (Bas.: *Cosmarium phaseolus* var. *achondrum* Boldt 1885) – Lit.: 76. – Hab.: 9. – ER

C. depressum var. *granulatum* Turn. 1893 – Lit. 76, 77, 78. – Hab.: 1. – ER

C. depressum f. *minutum* Heimerl 1891 – Lit.: 76. – Hab.: 1. – ER

C. depressum var. *planctonicum* Reverd. 1919 (Syn.: *Cosmarium abrreviatum* var. *planctonicum* W. *et* G. S. West 1905, *C. subtumidum* var. *minus* Ström 1920) – Lit.: 76, Ud. – Hab.: 1, 9, 13. – VR

C. dickii Coesel 1989 (Syn.: *Cosmarium blyttii* var. *bipunctulatum* (Dick) Růžicka 1972) – Lit.: 52, Ud. – Hab.: 7, 13. – VR

C. didymochondrum Nordst. 1876 – Lit.: 90, 91. – Hab.: 14. – ER

C. difficile Lütkem. 1892 var. *difficile* – Lit.: 18, 35, 44, 45, 46, 48, 76. – Hab.: 1, 13. – VR

C. difficile var. *subimpressulum* Messik. 1927 – Lit.: Ud. – Hab.: 13. – ER

C. elegantissimum Lund. 1871 – Lit.: 45. – Hab.: 13. – ER

C. etchachanense Roy *et* Biss. 1894 – Lit.: 86. – Hab.: 14. – ER

C. everettense Wolle 1883 – Lit.: 13. – Hab.: 13. – ER

C. exiguum W. & G. S. West 1864 – Lit.: 92. – Hab.: 10. – ER

C. fontigenum Nordst. 1878 (Syn.: *Cosmarium fontigenum* f. *pseudofontigenum* (Gutw.) Borzec 1920 – Lit.: 13. – Hab.: 13. – ER

C. formosulum Hoff *in* Nordst. 1888 var. *formosulum* **(Fig. 8.)** – Lit.: 9, 10, 12, 16, 32, 33, 34, 35, 44, 46, 48, 73, 76, 77, 78, 82, 96, Ud. – Hab.: 1, 3, 9, 11, 12, 13, 14, 17. – C

C. formosulum var. *nathorstii* (Boldt) W. *et* G. S. West 1908 – Lit.: 76, 77, 78. – Hab.: 1. – ER

C. furcatospermum W. *et* G. S. West 1894 – Lit.: 76. – Hab.: 1. – ER

C. galeritum Nordst. 1870 – Lit.: 32, 34, 35, 58. – Hab.: 1, 4. – VR

C. garrolense Roy *et* Biss. 1894 – Lit.: 86, Ud. – Hab.: 13, 14. – ER

C. geminatum Lund. 1871 – Lit.: 76. – Hab.: 1. – ER

C. gostyniense (Racib.) Grönbl. 1921 (Bas.: *Cosmarium abruptum* var. *gostyniense* Racib. 1885) – Lit.: 27, 28. – Hab.: 13. – ER

C. granatum Bréb. *ex* Ralfs 1848 var. *granatum* **(Fig. 9.)** (Syn.: *Cosmarium granatum* f. *pentagonum* Racib 1892) – Lit.: 5, 9, 10, 12, 13, 17, 19, 36, 41, 45, 52, 53, 56, 76, 77, 78, 88, 89, Ud. – Hab.: 1, 3, 4, 7, 9, 12, 13, 14, 15, 20. – C

C. granatum var. *elongatum* Nordst. 1872 – Lit.: Ud. – Hab.: 13. – ER

C. granatum var. *granatum* f. *messikommeri* Croasd. 1973 – Lit.: 76. – Hab.: 9. – ER

C. granulatum W. West 1889 – Lit.: 88, 89, 91. – Hab.: 14, 15. – VR

C. hammeri Reinsch 1866 var. *hammeri* – Lit.: 84, 91. – Hab.: 14. – ER

C. hammeri var. *protuberans* W. *et* G. S. West 1896 (Syn.: *Cosmarium retusum* var. *laeve* Roy *et* Biss. 1889) – Lit.: 35, 44, 45, 48. – Hab.: 13. – VR

C. heimerlii W. *et* G. S. West 1895 (Syn.: *Cosmarium minutissimum* Heimerl 1891) – Lit.: 6. – Hab.: 8. – ER

C. hexalobum Nordst. 1872 – Lit.: 32, 34, 35, 90, 91. – Hab.: 1, 14. – VR

C. holmiense var. *integrum* Lund. 1871 – Lit.: 32, 34, 35, 45, 48, Ud. – Hab.: 1, 13. – VR

C. homalodermum Nordst. 1875 (Syn.: *Cosmarium hammeri* var. *homalodermum* (Nordst.) W. *et* G. S. West 1905) – Lit.: 11, 30, 32, 34, 35, 44, 46. – Hab.: 1, 13. – VR

C. hornavanense Gutw. 1909 (Syn.: *Cosmarium hornavanense* var. *hornavanense* f. *helvetica* Ducel 1918, *Cosmarium tetraophthalmum var. pyramidatum* Ström. 1923) – Lit.: 45, 71, 89, 91, 94. – Hab.: 1, 10, 13, 14. – VR

C. humile (Gay) Nordst. *ex* De Toni 1889 var. *humile* (Bas.: *E. humile* Gay 1884; Syn.: *Euastrum celatum* Gay 1884) – Lit.: 6, 9, 10, 12, 52, 76, 78, Ud. – Hab.: 7, 8, 9, 13. – VR

C. humile var. *glabrum* Gutw. 1892 – Lit.: 35, 44. – Hab.: 13. – ER

C. humile var. *lacustre* Taylor 1934 – Lit.: 76, 79. – Hab.: 9. – ER

C. humile var. *striatum* (Boldt) Schmidle 1895 (Bas.: *Cosmarium striatum* Boldt 1885) – Lit.: 11, 28, 45. – Hab.: 13. – ER

C. humile var. *substriatum* (Nordst.) Schmidle 1895 (Bas.: *Cosmarium substriatum* Nordst. 1889) – Lit.: 45, 76, 77, 78, 79. – Hab.: 1, 9, 13. – VR

C. impressulum Elfv. 1881 var. *impresulum* **(Fig. 6.)** (Syn.: *Cosmarium meneghinii* f. *latiusculum* Jacobs. 1876, *C. impressulum* f. *minus* Manguin 1935) – Lit.: 6, 9, 10, 12, 18, 43, 45, 47, 48, 52, 84, 85, 86, 88, 89, 92. – Hab.: 4, 7, 8, 10, 12, 13, 14, 15. – C

C. impressulum var. *alpicola* Schmidle 1895 – Lit.: 76. – Hab.: 9. – ER

C. impressulum var. *integratum* Heimerl 1891 – Lit.: 11, 29. – Hab.: 13. – ER

C. impressulum var. *suborthogonum* (Racib.) W. *et* G. S. West 1908 – Lit.: 12, 32, 34, 35. – Hab.: 1, 13. – VR

C. inconspicuum W. *et* G. S. West 1896 – Lit.: 35, 44, 46, 47, 48. – Hab.: 13. – VR

C. intermedium Delp. 1878 – Lit.: 76. – Hab.: 9. – ER

C. isthmochondrum Nordst. 1873 – Lit.: 13. – Hab.: 13. – ER

C. kitchelii Wolle 1882 – Lit.: 13. – Hab.: 13. – ER

C. kjellmanii Wille 1879 – Lit.: 76, 77, 78. – Hab.: 1. – ER

C. laeve Rabenh. 1868 var. *laeve* (Syn.: *Euastrum leiodermum* Gay 1884, *Cosmarium laeve* var. *hispanicum* Lewin 1888, *C. portuense* Sampaio 1922) – Lit.: 1, 5, 6, 7, 8, 9, 10, 11,13, 15,18, 24, 25, 29, 35, 43, 44, 46, 47, 48, 50, 51, 52, 53, 54, 55, 64 ,76, 77, 78, 81,82, 87, 91, 95, Ud. – Hab. 1, 4, 6, 7, 8, 9, 11, 12, 13, 16, 18, 19, 20. – VF

C. laeve var. *octangulare* (Wille) W. *et* G. S. West 1908 (Bas.: *Cosmarium meneghinii* var. *meneghinii* f. *octangulare* Wille 1879) – Lit.: 32, 33, 34, 35, 76, Ud. – Hab.: 1, 9, 12, 13. – VR

C. laeve var. *septentrionale* Wille 1879 – Lit.: 13. – Hab.: 13. – ER

C. logiense Biss. 1884 – Lit.: 84, 91. – Hab.: 14. – ER

C. lundellii Delp. var. *corruptum* (Turn.) W. *et* G. S. West 1902 (Bas.: *Cosmarium corruptum* Turn. 1893) – Lit.: 13, 32, 34, 35. – Hab.: 1, 13. – VR

C. magnificum Nordst. 1887 – Lit.: 85, 91. – Hab.: 14. – ER

C. margaritatum (Lund.) Roy *et* Biss. 1886 var. *margaritatum* (Bas.: *Cosmarium latum* var. *margaritatum* Lund. 1871) – Lit.: 35, 44, 48. – Hab.: 13. – VR

C. margaritatum var. *margaritatum* f. *minus* (Boldt) W. *et* G. S. West 1897 (Bas.: *Cosmarium latum* var. *margaritatum* f. *minus* Boldt 1888) – Lit.: 76. – Hab.: 9. – ER

C. margaritiferum Menegh. *ex* Ralfs 1848 (Syn.: *Cosmarium confusum* subsp. *ambiguum* W. West 1892, *C. malinvernianum* var. *badense* Schmidle 1894) – Lit.: 6, 45, 74, 86, 88, 89, 91, 95. – Hab: 1, 4, 8, 13, 14, 15. – R

C. meneghinii Bréb. *ex* Ralfs 1848 var. *meneghinii* – Lit.: 2, 5, 6, 13, 17, 37, 38, 39, 41, 43, 46, 47, 51, 52, 73, 74, 76, 84, 89, 90, 91, 92. – Hab.: 1, 3, 4, 5, 7, 8, 9, 10, 13, 14, 15, 20, 2. – VF

C. meneghinii var. *granatoides* Schmidle 1893 – Lit.: 6. – Hab.: 8. – ER

C. meneghinii var. *rotundatum* Jacobs. 1876 – Lit.: 13. – Hab.: 13. – ER

C. moniliforme Turp. *ex* Ralfs 1848 var. *moniliforme* – Lit.: 2, 13, 37, 38, 39, 92, Ud. – Hab.: 4, 5, 10, 13. – VR

C. moniliforme var. *panduriforme* (Heimerl) Schmidle 1891 Lit.: 52, 76, 79. – Hab.: 7, 9. – VR

C. naegelianum Bréb. 1856 Lit.: 6, 27. – Hab.: 8, 13. – VR

C. nasutum Nordst. 1872 (Syn.: *Euastrum scitum* W. West 1892) – Lit.: 35, 44, 45, 48. – Hab.: 13. – VR

C. nitidulum De Not. 1867 (Syn.: *Cosmarium klebsii* Gutw. 1892, *C. subtumidum* var. *klebsii* (Gutw.) W. *et* G. S. West 1905 – Lit.: 6, 11, 13, 27, 28, 29, 32, 33, 34, 35, 52, 53, 86. – Hab.: 1, 7, 8, 13, 14. – R

C. norimbergense Reinsch 1867 – Lit.: 35, 44, 48. – Hab.: 13. – VR

C. notabile Bréb. 1856 var. *notabile* (Syn.: *Cosmarium notabile* f. *minus* Wille 1879) – Lit.: 45, 84, 91, 92. – Hab.: 10, 13, 14. – VR

C. notabile var. *heterocrenatum* (W. *et* G. S. West) Krieg. & Gerloff 1965 – Lit.: 32, 34, 35. – Hab.: 1. – ER

C. novae-semliae Wille 1879 var. *novae-semliae* – Lit.: 35, 44, 45, 47, 84, 88, 91. – Hab.: 13, 14, 15. – VR

C. novae-semliae var. *granulatum* Schmidle 1898 – Lit.: 76. – Hab.: 9. – ER

C. obsoletum (Hantzsch) Reinsch 1867 – Lit.: 11, 28, 30, 45. – Hab.: 13. – VR

C. obtusatum (Schmidle) Schmidle 1898 (Bas.: *Cosmarium undulatum* var. *obtusatum* Schmidle 1894) – Lit.: 1, 10, 13, 42, 76, 84, 88, 91, Ud. – Hab.: 4, 9, 13, 14, 15, 19. – R

C. ocellatum Eichl. *et* Gutw. 1894 – Lit.: Ud. – Hab.: 13. – ER

C. ochthodes Nordst. 1875 var. *ochthoides* – Lit.: 13, 18, 45, 48, 52, 76, 82, 87, 90, 91, 92. – Hab.: 1, 7, 10, 13, 14, 16, 21. – C

C. ochtodes var. *amoebum* W. West 1892 – Lit.: 35, 44, 45, 46, 48. – Hab. 13. – VR

C. orbiculatum Ralfs 1848 – Lit.: 11, 28, 31, 89, 91. – Hab.: 13, 14. – VR

C. ornatum Ralfs 1848 (Syn.: *Cosmarium ornatum* var. *perornatum* Grönblad 1948) – Lit.: 13. – Hab.: 13. – ER

C. orthostichum Lund. 1871 – Lit.: 86. – Hab.: 14. – ER

C. pachydermum Lund. 1871 var. *pachydermum* – Lit.: 11, 12, 13, 28, 30, 31, 35, 43, 45, 46, 48, 87, 88, 91. – Hab.: 4, 13, 14, 15, 16. – R

C. pachydermum var. *aethiopicum* W. *et* G. S. West 1905 **(Fig. 2.)** – Lit.: 13. – Hab.: 13. – ER

C. paragranatoides Skuja var. *paragranatoides* 1930 – Lit.: Ud. – Hab.: 13. – ER

C. paragranatoides var. *dickii* Krieg. *et* Gerloff 1965 – Lit.: Ud. – Hab.: 13. – ER

C. perforatum Lund. 1871 **(Fig. 11.)** – Lit.: 12. – Hab.: 13. – ER

C. phaseolus Bréb. *ex* Ralfs 1848 var. *phaseolus* **(Fig. 4.)** – Lit.: 2, 5, 9, 10, 12, 13, 76, 89, 91, Ud. – Hab.: 1, 3, 4, 13, 14. – R

C. phaseolus var. *elevatum* Nordst. 1873 – Lit.: 13, 76, 79, Ud. – Hab.: 9, 13. – VR

C. phaseolus var. *minus* (Boldt) Krieg. *et* Gerloff 1862 – Lit.: 76. – Hab.: 1, 9. – VR

C. polonicum Racib. 1884 – Lit.: 76. – Hab.: 1. – ER

C. polygonum (Näg.) Arch. 1861 (Bas.: *Euastrum polygonum* Näg. 1849) – Lit.: 6, 13, 76. – Hab.: 8, 9, 13. – VR

C. polymorphum Nordst. 1870 – Lit.: 13. – Hab.: 13. – ER

C. portianum Arch. 1860 var. *portianum* **(Fig. 3.)** (Syn.: *Cosmarium portianum* var. *orthostichum* Schmidle 1894) – Lit.: 9, 10, 12, 35, 44, 45, 52, 76, 88, 89, 91, Ud. – Hab.: 7, 9, 10,13, 14, 15. – R

C. portianum f. *majus* Smith 1932 – Lit.: 45. – Hab.: 13. – ER

C. praecisum Borge 1921 – Lit.: 76, Ud. – Hab.: 9, 13. – ER

C. praemorsum Bréb. 1856 – Lit.: 11, 13, 28, 30, 31, 45. – Hab.: 13. – ER

C. prominulum Racib. 1885 var. *prominulum* – Lit.: 45. – Hab.: 13. – ER

C. prominulum var. *subundulatum* W. *et* G. S. West 1894 – Lit.: 45. – Hab.: 13. – ER

C. protractum (Näg.) De Bary 1858 – Lit.: 52. – Hab.: 7. – ER

C. pseudamoenum Wille 1884 – Lit.: 86, 89, 91. – Hab.: 14. – VR

C. pseudobiremum Boldt. 1885 – Lit.: 76. – Hab.: 9. – ER

C. pseudobroomei Wolle 1884 – Lit.: 9, 10, 12, 76. – Hab.: 9, 13. – VR

C. pseudoconnatum Nordst. 1870 – Lit.: Ud. – Hab. 13. – ER

C. pseudonitidulum Nordst. 1873 var. *pseudonitidulum* – Lit.: 88, 91. – Hab.: 15. – ER

C. pseudonitidulum var. *validum* W. *et* G. S. West 1905 – Lit.: 13. – Hab.: 13. – ER

C. pseudooctangulare Grönbl. 1921 – Lit.: 95. – Hab. 1. – ER

C. pseudopyramidatum Lund. 1871 var. *pseudopyramidatum* (Syn.: *Cosmarium pyramidatum* var. *minus* Reinsch 1866) – Lit.: 13,76, 77. – Hab.: 1, 9, 13. – VR

C. pseudopyramidatum var. *stenonotum* Nordst. 1876 – Lit.: 13. – Hab.: 13. – ER

C. pseudorectangulare Messik. 1933 – Lit.: 76. – Hab.: 1. – ER

C. punctulatum Bréb. 1856 var. *punctulatum* – Lit.: 6, 11, 28, 29, 30, 42, 45, 61, 76, 77, 78, 86. – Hab.: 1, 4, 8, 9, 13, 14. – R

C. punctulatum var. *granulusculum* (Roy *et* Biss.) W. *et* G. S. West 1908 **(**Bas.: *Cosmarium granulusculum* Roy *et* Biss. 1894) – Lit.: 48. – Hab.: 13. – ER

C. punctulatum var. *subpunctulatum* (Nordst.) Børges. 1894 (Bas.: *Cosmarium subpunctulatum* Nordst. 1877; Syn.: *C. subpunctulatum* var. *boergesenii* W. West 1892) – Lit: 45, 76. – Hab.: 9, 13. – VR

C. pusillum (Bréb.) Arch. 1861 (Bas.: *Euastrum pusillum* Bréb. 1856) – Lit.: 35, 44. – Hab.: 13. – ER

C. pygmaeum Arch. 1864 var. *pygmaeum* (Syn.: *Cosmarium pygmaeum* var. *schliephackeanum* (Grunow) W. *et* G. S. West 1898 – Lit.: 11, 13, 29, 47, 52, 76, 77, 78, 86, 89, 91, Ud. – Hab.: 1, 7, 13, 14. – VR

C. pygmaeum var. *heimerlii* (W. *et* G. S. West) Krieg. *et* Gerloff. 1965 – Lit.: Ud. – Hab.: 13. – ER

C. pyramidatum Bréb. in Ralfs 1848 var. *pyramidatum* (Syn. *Cosmarium pyramidatum* var. *transitorium* (Heimerl) Irénée – Marie 1938) – Lit.: 11, 28, 30, 31, 35, 41, 44, 45. – Hab.: 10, 13. – VR

C. pyramidatum var. *angustatum* W. *et* G. S. West 1894 – Lit.: 13, 45. – Hab.: 13. – ER

C. quadratulum (Gay) De Toni 1889 (Bas.: *Euastrum quadratulum* Gay 1884) – Lit.: 35, 44, 45, 48, 52, 58, Ud. – Hab.: 1, 7, 13. – VR

C. quadratum Ralfs 1848 var. *quadratum* **(Fig. 1.)** – Lit.: 11, 28, 30, 31, 45, 46, 86, 90, 94. – Hab.: 10, 13, 14. – VR

C. quadratum var. *willei* (Schmidle) Krieg. *et* Gerloff. 1969 (Bas.: *Dysphinctium quadratum* var. *willei* Schmidle 1893) – Lit.: 86. – Hab.: 14. – ER

C. quadrifarium Lund. 1871 – Lit.: 90. – Hab.: 21. – ER

C. quadrum Lund. 1871 – Lit.: Ud. – Hab.: 13. – ER

C. raciborskianum De Toni 1889 – Lit.: 11, 28, 30, 31. – Hab.: 13. – ER

C. radiosum Wolle 1884 – Lit.: 45, 48. – Hab.: 13. – VR

C. ralfsii Ralfs var. *montanum* Racib. 1885 – Lit.:13. – Hab.: 13. – ER

C. repandum Nordst. 1887 – Lit.: 45. – Hab.: 13. – ER

C. rectangulare Grunow. 1868 var. *rectangulare* – Lit.: 41. – Hab.: 20. – ER

C. rectangulare var. *cambrense* (Turp.) W. *et* G. S. West 1896 (Syn.: *Cosmarium gothlandicum* var. *cambrense* Turn. 1893) – Lit.: 45. – Hab.: 13. – ER

C. regnellii Wille 1884 var. *regnellii* (Syn: *Cosmarium meneghinii* var. *regnellii* (Wille) Playfair 1913) – Lit.: 52, 76, 86, 88, 91, Ud. – Hab.: 7, 9, 13, 14, 15. – VR

C. regnellii var. *minimum* Eichl. *et* Gutw. 1894 – Lit.: 76, Ud. – Hab.: 9, 13. – ER

C. regnellii var. *pseudoregnellii* (Messik.) Krieg. *et* Gerloff 1944 (Bas.: *Cosmarium braunii* var. *pseudoregnellii* Messik. 1929; Syn.: *C. repandum* var. *retusum* Printz 1915) – Lit.: 76. – Hab.: 9. – ER

C. regnesii Reinsch 1866 var. *regnesii* (Syn.: *Cosmarium regnesii* var. *tritum* W. West 1892) – Lit.: 52. – Hab.: 7. – ER

C. regnesii var. *polonicum* (Eichler. *et* Gutw.) Compère 1976 (Bas.: *Cosmarium novae-semliae* var. *polonicum* Eichler. *et* Gutw. 1894; Syn.: *C. regnesii* var. *montanum* Schmidle 1895 – Lit.: 11, 29, 46, 47. – Hab.: 13. – VR

C. reinschii Arch. 1891 – Lit.: 31, 45. – Hab.: 13. – ER

C. reniforme (Ralfs) Arch. 1874 var. *reniforme* (Bas.: *Cosmarium margaritiferum* var. *reniforme* Ralfs 1848) – Lit.: 9, 10, 12, 17, 45, 51, 52, 76, Ud. – Hab.: 4, 5, 7, 9, 13. – VR

C. reniforme var. *compressum* Nordst. 1887 – Lit.: 76. – Hab.: 9. – ER

C. retusiforme (Wille) Gutw. 1890 (Bas.: *Cosmarium hammeri* f. *retusiforme* Wille 1880) – Lit.: 45, 76. – Hab.: 9, 13. – VR

C. scopulorum Borge 1913 – Lit.: 76. – Hab.: 1, 9. – VR

C. sexangulare Lund. var. *minus* Roy *et* Biss. 1886 – Lit.: 76. – Hab.: 1. – ER

C. sexnotatum Gutw. var. *tristriatum* (Lütkem.) Schmidle 1895 **(Fig. 13.)** (Bas.: *Cosmarium blyttii* var. *blyttii* f. *tristriatum* Lütkem. 1893; Syn.: *C. hammeri* var. *africanum* Fritsch 1921) – Lit.: 9, 10, 12, 13. – Hab.: 13. – ER

C. simplicius (W. *et* G. S. West) Grönbl. 1931 (Bas.: *C. elegantissimum* var. *simplicius* W. *et* G. S. West 1898; Syn. *Cosmarium elegantissimum* f. *minus* W. West 1892) – Lit.: 35, 44, 45, 46, 48, 84, 91, Ud. – Hab.: 13, 14. – VR

C. speciosum Lund. 1871 var. *speciosum* – Lit.: 18, 45, 46, 48, Ud. – Hab.: 13. – VR

C. speciosum var. rostafinskii (Gutw.) W. *et* G. S. West 1908 (Bas.: *Cosmarium rostafinskii* Gutw. 1890) – Lit.: 11, 28, 30, 31, 35, 44, 46, 75, Ud. – Hab.: 1, 13. – VR

C. speciosum var. *rostafinskii* f. *americanum* W. *et* G. S. West 1908 – Lit.: 32, 34, 35. – Hab.: 1. – ER

C. speciosum var. *simplex* Nordst. 1872 – Lit.: 35, 44, 45, 46, 48. – Hab.: 13. – VR

C. sportella Bréb. *ex* Kütz. 1849 – Lit.: 45, 46, 48, Ud. – Hab.: 13. – VR

C. staurastroides Eischl. *et* Gutw. 1894 – Lit.: 76. – Hab.: 9. – ER

C. striolatum (Näg.) Arch. 1861 var. *striolatum* (Syn.: *Cosmarium tesselatum* (Delp.) Nordst. 1876) – Lit.: 45. – Hab.: 13. – ER

C. striolatum var. *intermedium* Krieg. 1932 – Lit.: 45, 48. – Hab.: 13. – VR

C. subalatum W. *et* G. S. West 1895 – Lit.: 86. – Hab.: 14. – ER

C. subcostatum Nordst. 1876 var. *subcostatum* – Lit.: 48, 59, 76, 86, Ud. – Hab.: 1, 9, 13, 14. – VR

C. subcostatum var. *beckii* (Gutw.) W. *et* G. S. West 1905 – Lit.: 76. – Hab.: 1, 9. – VR

C. subcostatum var. *minus* W. *et* G. S. West 1896 – Lit.: 35, 44, 45, 46, 47, 48, 76, Ud. – Hab.: 9, 13. – VR

C. subcrenatum Hantzsch 1868 – Lit.: 13, 15, 19, 35, 42, 44, 47, 48, 52, 60, 86, 89, 90, 91, 94, UD. – Hab.: 1, 4, 7, 10, 11, 13, 14, 21. – C

C. subcucumis Schmidle 1893 (Syn.: *Cosmarium angulatum* var. *subcucumis* (Schmidle) Playfair 1914) – Lit.: 13, 32, 34, 35, 44, 46, 47, 48. – Hab.: 1, 12, 13. – VR

C. subexcavatum W. *et* G. S. West 1900 – Lit.: 89, 91. – Hab.: 14. – ER

C. subgranatum (Nordst.) Lütkem. 1902 var. *subgranatum* (Bas.: *Cosmarium granatum* var. *subgranatum* Nordst. 1878) – Lit.: 43, 51, 52, 76, 77. – Hab.: 1, 4, 7, 9. – VR

C. subgranatum var. *borgei* Krieg. 1944 – Lit: Ud. – Hab.: 13. – ER

C. subimpressulum Borge 1894 – Lit. 88, 91. – Hab.: 15. – ER

C. subprotumidum Nordst. 1876 var. *subprotumidum* **(Fig. 12.)** – Lit.: 9, 10, 12, 43, 48, 51, 52, 53, 76, 85, 86, 88, 89, 90, 91, 93, 95. – Hab.: 1, 4, 5, 7, 9, 13, 14, 15, 21. – F

C. subprotumidum var. *gregorii* (Roy *et* Biss.) W. & G. S. West 1900 (Bas.: *Cosmarium gregorii* Roy *et* Biss. 1890) – Lit.: 76. – Hab.: 9. – ER

C. subretusiforme W. *et* G. S. West 1894 – Lit.: 13. – Hab.: 13. – ER

C. subspeciosum Nordst. 1875 var. *subspeciosum* – Lit.: 76, 77, 78. – Hab.: 1. – ER

C. subspeciosum var. *validus* Nordst. 1888 – Lit.: 45. – Hab.: 13. – ER

C. subtumidum Nordst. 1878 (Syn.: *Cosmarium subtumidum* var. *minor* Sampaio 1922) – Lit.: 13, 45, 48, 52, 76, 77, 78, Ud. – Hab.: 1, 7, 9, 13. – R

C. succisum W. West 1892 – Lit.: 13, 19. – Hab.: 9, 13. – VR

C. taxichondriforme Eichl. *et* Gutw. 1894 – Lit.: 13. – Hab.: 13. – ER

C. taxichondrum Lund. 1871 – Lit. 45. – Hab.: 13. – ER

C. tenue Arch. 1868 – Lit.: 6, 13, 21, 22, 23, 76, 77, 78, Ud. – Hab.: 1, 3, 8, 9, 13, 17. – VR

C. tetragonum (Näg.) Arch. var. *tetragonum* (Bas.: *Euastrum tetragonum* Näg. 1849) 1861 – Lit.: 11, 31, 61. – Hab.: 1, 13. – VR

C. tetragonum var. *intermedium* Boldt. 1885 – Lit.: 35, 44, 48. – Hab.: 13. – VR

C. tetragonum var. *lundellii* Cooke 1887 (Syn.: *Cosmarium bigorrense* Gay 1891, *Euastrum bigorrense* (Gay) Commère 1901) – Lit.: 35, 44, 45, 46, 48. – Hab.: 13. – VR

C. tetraophthalmum Bréb. *ex* Ralfs 1848 **(Fig. 5.) –** Lit.: 9, 10, 11, 12, 18, 28, 30, 31, 35, 44, 45, 48, 84, 91, Ud. – Hab.: 13, 14. – VR

C. thwaitesii Ralfs 1848 – Lit.: 76, 77, 78. – Hab.: 1. – ER

C. tinctum Ralfs 1848 (Syn.: *Cosmarium tinctum* var. *aggregatum* Bréb. 1856) – Lit.: 6, 76, Ud. – Hab.: 8, 9, 13. – VR

C. trachydermum W. *et* G. S. 1895 West – Lit.: 52. – Hab.: 7. – ER

C. trachypleurum var. *minus* Racib. 1884 (Syn.: *Cosmarium minus* Racib. 1892) – Lit.: 76. – Hab.: 9. – ER

C. trilobulatum Reinsch 1866 **(Fig. 7.)** – Lit.: 9, 10, 12, 88, 91. – Hab.: 13, 15. – VR

C. truncatellum (Perty) Rabenh. 1868 – Lit.: 11, 28, 30, 31, 35, 44, 45, 46. – Hab.: 13. – VR

C. tumidum Lund. 1871 – Lit.: 13, 63, 70, 71, 72. – Hab.: 1, 3, 13, 17. – VR

C. turneri Roy 1890 – Lit.: 35, 44, 45, 48. – Hab. 13. – VR

C. turpinii Bréb. 1856 var. *turpinii* – Lit.: 74, 76, 77, 78, 83, 84, 91. – Hab.: 1, 4, 15, 17. – VR

C. turpinii var. *podolicum* Gutw. 1890 – Lit.: 36, 44, 51, 56. – Hab.: 3, 5, 13. – VR

C. umbilicatum Lütkem. 1893 – Lit.: 84, 86, 91. – Hab.: 14. – VR

C. undulatum Corda *ex* Ralfs 1848 var. *undulatum* – Lit.: 2,13, 25, 35, 37, 38, 39, 44, 89, 91. – Hab.: 4, 5, 6, 13, 14. – R

C. undulatum var. *minutum* Wittr. 1869 – Lit.: 13, 19, 48, Ud. – Hab.: 6, 13. – VR

C. undulatum var. *wollei* W. West 1892 – Lit.: 35, 44, 46. – Hab.: 13. – VR

C. variolatum Lund. 1871 var. *variolatum* – Lit.: 76. – Hab.: 1. – ER

C. variolatum var. *cataractarum* Racib. 1889 – Lit.: 76. – Hab.: 9. – ER

C. venustum (Bréb.) Arch. 1861 var. *venustum* – Lit.: 45, 46, 88, 89, 91. – Hab.: 13, 14, 15. – VR

C. venustum f. *minus* Wille 1879 – Lit.: 45, 48. – Hab.: 13. – VR

C. vexatum W. West 1892 var. *vexatum* (Syn.: *Cosmarium vexatum* var. *concavum* Schmidle 1894) – Lit.: 7, 35, 44, 76, 95, Ud. – Hab.: 1, 13, 19, 20. – VR

C. vexatum var. *rotundatum* Messik. 1942 – Lit.: 76. – Hab.: 1. – ER

C. wembaerense Schmidle 1898 (Syn.: *Cosmarium laeve* var. *tumidum* Grönblad 1939) – Lit.: 43, 76, 77, 78, 79. – Hab.: 1, 4, 9. – VR

C. wittrockii Lund. 1871 – Lit.: 11, 28, 30, 31. – Hab.: 13. – ER