Checklist of desmids (*Conjugatophyceae*, *Charophyta*) in Serbia. IV: genera *Euastrum*, *Micrasterias*, *Staurodesmus* and *Xanthidium*

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Abstract. The first data on the distribution of desmids in Serbia date back to 1883; ever since and up to 2021, 646 different taxa have been identified. The genus *Euastrum* is represented by 34 taxa, genus *Micrasterias* by 16 taxa, genus *Staurodesmus* by 26 taxa, and genus *Xanthidium* by 11 taxa. All these taxa occur in a large variety of habitats in Serbia, but the greatest diversity has been recorded in the high-mountain peat bogs. This paper presents a review of the main taxonomic and ecological characteristics of the *Euastrum*, *Micrasterias*, *Staurodesmus,* and *Xanthidium* taxa recorded from Serbia.

Key words: algae, desmids, *Euastrum*, *Micrasterias*, *Staurodesmus*, *Xanthidium*

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Introduction

The earliest data on the distribution of algae in Serbia were published in 1883 (Schaarschmidt 1883). Ever since, a considerable number of algologists had conducted surveys, primarily of the aquatic ecosystems in Serbia. In the first decade of the 20th century, the research of desmid algae by Košanin (1908a, 1908b, 1910), Katić (1910) and Đorđević (1910) stands out. In the middle of the 20th century, in the period from 1953 to 1973, Milovanović published several papers on the desmid flora in Vlasinska Tresava, and on the peat bogs in the Kopaonik, Golija, Ostrozub, and Željin mountains. Generally, Milovanović recored 350 desmid taxa from various freshwater habitats (Milovanović 1959, 1960a, 1960b, 1960c, 1962, Cvijan & Fužinato 2010). Several other phycologists have also contributed indirectly to the knowledge of desmid algae in Serbia: Stanković (1932), Marinović (1954, 1960), Filipović (1966, 1969), Janković (1966, 1975, 1977) and Obušković (1979, 1992). At the end of the 20th century, Cvijan & Laušević investigated the desmid algae in the Vlasina Lake, formed by immersion of the Vlasina peat bog (1991a, 1991b). Urošević made

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a great contribution to the spread of boreal, alpine and arctic-alpine desmid taxa by researching the nival and glacial lakes on Šara and Prokletije mountins (Urošević 1997a, 1997b, 1997c, 1997d, 1997e, 1998a, Urošević & Savić 1997). Research of desmid algae in different aquatic habitats in the Vojvodina Province was carried out by Stamenković at the beginning of the 21st century, when 12 new taxa for the flora of desmid algae in Serbia were recorded from predominantly alkaline and eutrophic habitats (Stamenković 2005). In the period from 2007 to 2011, a comprehensive research of desmid algae was conducted in 30 accumulations (Fužinato 2012) and peat bogs in Horgoš, Pešter Plateau, Mt. Tara and Mt. Golija (Fužinato & al. 2013), when 69 new desmids taxa have been recorded (Fužinato 2012). Subsequently, desmid algae have been found in the course of other algological examinations (Predojević 2017, Trbojević 2018).

A review of literature data has revealed the presence of 646 taxa of desmid algae in Serbia, classified into five families and 25 genera. So far, checklists have been published for the elongate baculiform desmids (Stamenović & al. 2008) and the genera *Cosmarium* (Fužinato & al. 2011a) and *Staurastrum* (Fužinato & al. 2011b). The present study presents a compilation of the data on the distribution and ecology of the genera *Euastrum* (34 taxa), *Micrasterias* (16), *Staurodesmus* (26), and *Xanthidium* (11) recorded so far from Serbia.

Material and methods

The paper presents an overview of all recorded taxa of *Euastrum*, *Micrasteria*, *Staurodesmus,* and *Xanthidium* that have been recorded in Serbia up to date. The author has reviewed all available literature (papers, manuscripts and proceedings) related to the distribution and ecology of desmid algae from these four genera. Furthermore, data from the survey of peatbogs Pešter and Golija in the summer of 2021 are included. An annotated list of *Euastrum*, *Micrastrias*, *Staurodesmus,* and *Xanthidium* taxa reported from Serbia is given in the Appendix.

Samples of desmid algae were taken during the summer of 2021 from several localities in the area of Pešter Plateau (Cetanovića brook, Đerekare, Vapa, Melajska, and Vrelo rivers, and peat bogs near Trojan and Karajukića Bunari) and Mt. Golija (Daićko and the Okruglica lakes, Crčevska river, and Bele Vode peat bog). Phytoplankton samples were collected with a plankton mesh (Ø 33 μm), then placed in plastic bottles and preserved in formaldehyde to a final concentration of 4%. Some of the samples were left at daylight for several days to try and stimulate the zygospores, which are an important taxonomic character in some desmid algae. Phytobenthos samples were collected with a pipette from the surface of mud and sand. Epiphytic samples were collected by scraping the submerged parts of plants and moss squeezing. Phytobenthos and epiphyta samples were preserved in formaldehyde. Air and water temperature (T), pH, oxygen concentration (O2), saturation (S), and conductivity (C) were measured on site by a WTW Multi 3420 portable device.

The collected algae material was observed under a Zeiss AxioImager.M1 light microscope, using an AxioCam MRc5 and AxioVision 4.9 digital camera software. The individual taxa of *Euastrum*, *Micrasterias*, *Staurodesmus,* and *Xanthidium* have been processed according to Coesel & Meesters 2007, 2013, Kouwets 1987, 1997, 1998, 2001 and Lenzenweger 1996, 1997. Data from ALgaeBase (Guiry & Guiry) were used to complete the synonymy. Classification of the desmid taxa followed Coesel & Meesters (2007). A database for the identified taxa of desmid algae on the territory of Serbia has been created, with separate entrees for each taxon. As a platform for the database, the following open-source software tools were used: an Apache server, programming PHP language, and MySQL relational database.

The new data on the localities, where the genera of *Euastrum*, *Micrasterias*, *Staurodesmus,* and *Xanthidium* were found during the survey of summer 2021, are marked with "Ud" (unpublished data), followed by the initials in brackets of the locality, where the respective taxon has been found. Namely: Cetanovića book (CB), Đerekare river (ĐR), Vapa river (VR), Malajska river (MR), Vrelo river (VrR), Trojan peatbog (TR), Karajukića Bunari peat bog (KB), Daićko lake (DL), Okruglica lake (OL), and Crčevska river (CR).

Frequency of each taxon is recorded on the following scale: Exceptionally Rare (ER) - taxa found in one locality only; Rare (R) - taxa found in less than 10%

of the surveyed localities; Frequent (F) - taxa found in 10-50% of the surveyed localities. No common desmid taxa have been found in more than 50% of the surveyed localities in Serbia.

Results

So far, 611 taxa of desmid algae have been recorded in Serbia, of which *Eusatrum* (34 taxa), *Micrasterias* (17), *Staurodesmus* (27), and *Xanthidium* (11). A great number of the taxa recorded in Serbia are Extremely Rare and Rare. Many of these species are also rare in other European countries such as Austria (Lenzenweger 1996, 1997), Croatia (Gligora & Plenković-Moraj 2003), Czech Republic (Šťasny 2009), France (Kouwets, 1987, 1997, 1998, 2001), Great Britain (Brook & Johnson 2003), Lithuania (Kostkeviciene & al. 2003), the Netherlands (Coesel & Meesters 2007, 2013; Tooren & Westen 2011); Poland (Tomaszewicz 1998, Tomaszewicz & Kowalski 1993), Russia (Sterlyagova 2008; Briškaite & al. 2016, Anissinova 2021, Anissimova & Terlova 2014, 2015), Slovenia (Krivograd-Klemenčić & Vrhovšek 2003), and Turkey (Şahin 2005, 2021).

In the present paper, in addition to literature sources, are also presented the results of the analysis of algological samples collected from seven localities on the Pešter Plateau and three localities on Mt. Golija. Furthermore, during the research in 2021, the following taxa were found: *Eustrum* (7) , *Micrasterias* (5) , *Staurodesmus* (7), and *Xanthidium* (5).

The Pešter Plateau is located in Southwest Serbia and lies at an altitude of 1150-1492 m a.s.l. With an area of about 50 km², Pešter is the largest plateau in Serbia, and the highest one on the Balkan Peninsula, as well as the last preserved large peat bog in Serbia. Mt. Golija is situated in Southwest Serbia and is a part of the Dinaric Mountain Range. It covers an area of 75 138 hectares. Generally, high-mountain wetlands are a very specific environment, with unique ecological properties and remarkably high diversity of desmid flora. They are disappearing gradually, owing to anthropogenic and climatic factors. Extensive development of tourism, construction of ski centers and natural hydrological changes affect negatively the high-mountain water habitats. Physical and chemical water parameters of the investigated localities are summarized in Table 1.

Table 1. Physical and chemical water parameters of the investigated localities

Locality	Geographical coordinates	A [m]	T [°C]	pH	O2 [mg/l]	S [%]	C [µS/cm]
Cetanovića brook	43.158718 N 20.09284 E	1183	12.8	8.03	8.92	94.7	383
Đerekare river	43.020933 N 20.170253 E	1224	14.8	7.79	9.45	102.6	298
Vapa river	43.237048 N 20.102028 E	1065	13.7	7.76	9.37	102.7	284
Vrelo river	43.274192 N 20.240857 E	942	11.2	8.14	10.26	103.9	379
Melajska river	43.100654 N 20.24577 E	1054	12.6	7.99	9.28	100.3	276
Trojan peat bog	43.1083304 N 20.1607919 E	1301	15.5	6.53	7.30	88.1	408
Karajukića Bunari peat bog	43.0740461 N 20.0790430 E	1150	20.2	7.39	5.51	66.8	474
Daićko lake	43.4242900 N 20.2628732 E	1450	23.3	7.40	8.94	125.5	60.1
Okruglica lake	43.4542374 N 20.2809515 E	1434	22.0	7.51	5.90	68.0	110
Crčevska river	43.298846 N 20.256723 E	1152	13.8	7.72	9.81	99.8	301

Discussion

Distribution, ecology and biogeography of the *Euastrum* taxa in Serbia

The genus *Euastrum* comprises 34 taxa, or 5.23% of the total number of desmids recorded so far in Serbia. About 38% of the *Euastrum* taxa have been found in one locality only (Exceptionally Rare), whereas 50% have been found in less than 10% of the surveyed localities (Rare). The taxa of genus *Euastrum* have been found in the plankton and benthos, primarily in the alpine peat bogs, glacial and nival lakes. There are very few species, which in addition to high-mountain habitats, have been also found in other types of habitats. Almost 90% of all so far identified species of the genus *Euastrum* found in the alpine peatlands belong to the group of Rare (*E. ansatum* var. *ansatum, E. ansutum* var. *concavum, E. binale* var. *binale, E. binale* var. *gutwinski, E cuneatum, E. denticulatum, E. didelta, E. dubium, E. erosum, E. gemmatum, E. humerosum* var. *affine, E. insulare, E. pinnatum, E. spinulosum, E. sublobatum, E. verrucosum* var *.alatum*) or Extremely Rare species (*E. ansatum* var. *pyxidatum, E. ansatum* var. *rhomboidale, E. binale* var. *hians, E. crassangulatum, E. dubium* var. *latum, E. lacustre, E. montanum, E. pokoryanum* var. *trignum, E. sinuosum, E. turnerii, E. verrucosum* var. *alpinum).* A number of identified species of the genus *Euastrum* characteristically inhabit acidic habitats: *E. ampullaceum, E. binale var. binale, E. didelta, E. hummerosum, E. pinnatum* (Coesel & Meesters 2007). The taxa *E. ampullaceum, E. hummerosum* and E. *pulchellum* have been found exclusively in alpine and nival lakes. Only four species of the genus *Eusatrum* can be regarded as frequent (F) on the territory of Serbia: *E. bidantatum, E. elegans, E. oblongum,* and *E. verrucosum*. All these species are characteristic of mesotrophic habitats (Coesel & Meesters 2007). A great number of species of the genus *Euastrum* identified in Serbia are cosmopolitan. The presence of some subalpine, alpine and arcto-alpine species (*E. ampullaceum, E. montanum and E. verrucosum var. alpinum*) is characteristic of the high-mountain habitats.

Distribution, ecology and biogeography of the *Micrasterias* taxa in Serbia

The genus *Micrasterias* comprises 17 taxa, or 2.63% of the total number of desmids recorded so far in Serbia. About 37% of the *Micrasterias* taxa have been found in one locality only (*M. apiculata, M. denticulata* var. *angulosa, M. radiosa* var. *ornata, M. truncata* var. *bahusiense, M. truncata* var. *crenata, M. truncata* var. *semiradiata*), whereas 57% have been discovered in less than 10% of the surveyed localities (*M. crux-melitensis, M. denticulata, M. fimbriata, M. papilifera* var. *glabra, M. radiosa, M. rotata, M. thomasiana, M. thomasiana* var. *notata, M. truncata*). Only one species, *M. papilifera*, can be considered Frequent. The taxa of the genus *Micrasterias* are found in the plankton and benthos, primarily in highland peatbogs, glacial and nival lakes. Only two species (*M. crux-melitensis* and *M. papilifera*) have been found in different habitats. The greatest number of species of the genus *Micrasterias* identified in Serbia are cosmopolitan, characteristic of the oligotrophic and mesotrophic habitats (Coesel & Meesters 2007).

Distribution, ecology and biogeography of the *Staurodesmus* taxa in Serbia

The genus *Staurodesmus* comprises 27 taxa, or 4.17% of the total number of desmids recorded so far in Serbia. About 63% of the *Staurodesmus* taxa have been found in one locality only (*S. aversus, S.connatus, S. corniculatus, S. dejectus* var. *apiculatus, S. dejectus* var. *robustus, S. dickiei* var. *circularis, S. dickiei* var. *rhomboideus, S. glaber* var. *deberyanus, S. incus, S. lanceolatus* var. *compressum, S. mucronatus, S. omearae, S. pterosporus, S. sibiricus, S. subhexagonus, S. triangularis, S. validus*), whereas 33% have been discovered in less than 10% of the surveyed localities (*S. brevispina, S. convergeus, S. cuspidatus, S. dejectus, S. extensus, S. glaber, S. groenbladii, S. indentus, S. patens*). Only one species, *S. dickiei* can be regarded as Frequent. Taxa of the genus *Staurodesmus* are usually found in the plankton and benthos, primarily in highland peat bogs. Several species have been found in reservoirs, ponds and irrigation canals. The greatest number of species of the genus *Staurodesmus* identified in Serbia are cosmopolitan, characteristic of the acidic oligo-mesotrophic water bodies (Coesel & Meesters 2013). *S. corniculatus* is a specific boreal and (sub)alpine element, while *S. validus* is a pantropical species.

Distribution, ecology and biogeography of the *Xanthidium* taxa in Serbia

The genus *Xanthidium* comprises 11 taxa, or 1.70% of the total number of desmids recorded so far in Serbia. Six *Xanthidium* taxa have been found in one locality only (*X. antilopaeum var. dimazum, X. antilopaeum var. laeve, X. antilopaeum var. oligocanthum, X. antilpaeum var. planum, X. basidentatum, X. bifidum*), whereas five taxa have been discovered in less than 10% of the surveyed localities (*X. antilopaeum, X. crustatum, X. fasciculatum, X. octocorne* and *X. smithii*). The taxa of the genus *Xanthidium* were found in the plankton and benthos in alpine peatlands, and a smaller number of taxa occurred in glacial and nival lakes. The species *X. antelopeeum* var. *laeve, X. octocorne* and *X. smithii* are characteristically acidophilic species in oligotrophic habitats (Coesel & Meesters 2007). Other species have been found in mesotrophic habitats.

High-mountain peat bogs in Serbia represent important centers of desmids biodiversity. It is particularly important to preserve such habitats. Unfortunately, the research of desmid algae in recent years has shown a decrease in the number of typical alpine forms, and an increase in the number of ubiquitous and indifferent forms.

Appendix

Literature (Lit.): the numbers in literature refer to the numbers in brackets after the references in the References list. Unpublished data are designated as Ud., followed by the initials (in brackets) of the localities in which the taxon has been found.

Bas. – basionym; Syn. – synonym

Habitats: 1 - rivers, 2 - irrigation canals, 3 - lakes, 4 - ponds, 5 -marsh, 6 - fishpond, 7 - reservoirs, 8 – high-mountain peat bogs, 9 -high-mountain glacial lakes, 10 – high-mountain nival lakes.

Frequency: Exceprionally Rare (ER), Rare (R), Frequent (F).

Euastrum ampullaceum Ralfs 1848 (syn.: *Euastrum ampullaceum* var. *macrolobium* Denis 1926) – Lit.: 36, 37, 40, 41. – Hab.: 9,10. – R

Euastrum ansatum Ralfs 1848 var. *ansatum* (syn: *Euastrum rotundum* Playfair 1907; *E. ansatum* var. *dideltiforme* Ducellier 1918; *E. ansatum* var. *commune* Ducellier 1918; *Cosmarium pseudopyramidatum* var. *ansatum* Krieger *et* Gerloff 1965) – Lit.: 1, 2, 3, 4, 5, 6, 7, 8, 13, 15, 16, 23, 37, 40, 41, Ud (CB). – Hab.: 8,9,10. – R (Fig. 1)

Euastrum ansatum var. *concavum* Krieger 1922 – Lit.: 5, 17, 22, 25, 26. – Hab.: 8. – R

Euastrum ansatum var. *pyxidatum* Delponte 1876 – Lit.: 2, 6. – Hab.: 8. – ER

Euastrum ansatum var. *rhomboidale* Ducellier 1918 – Lit.: 2, 5, 23. – Hab.: 8. – ER

Euastrum bidentatum Nägeli 1849 (syn.: *Euastrum elegans* var. *bidentatum* (Nägeli) Jacobsen 1875; *E. bidentatum* var. *glabrum* Grönblad 1942) – Lit.: 2, 5, 6, 7, 8, 17, 21, 22, 23, 24, 25, 26, 36, 37, 41, Ud. (ĐR, VrR, TR, CR) – Hab.: 1, 8, 9, 10. – F (Fig. 2.)

Euastrum binale Ralfs 1848 var. *binale* – Lit.: 5, 6, 7, 8, 14, 17, 21, 22, 23, 24, 25, 26, 37, Ud. (OL, CB, KB, MR). – Hab.: 1, 8. – R

Euastrum binale var. *gutwinskii* (Schmidle) Homfeld 1929 (bas.: *Euastrum binale* f. *gutwinskii* Schmidle 1894) – Lit.: 2, 5, 6, 23, 33, 34. – Hab.: 2, 8. – R

Euastrum binale var. *hians* (W. West) Krieger 1922 (bas.: *Euastrum binale* f. *hians* W.West 1892) – Lit.: 5, 26. – Hab.: 8. – ER

Euastrum crassangulatum Børges 1890 – Lit.: 2, 6. – Hab.: 8. – ER

Euastrum cuneatum Jenner *in* Ralfs 1848 – Lit.: 2, 3, 5, 6, 14, 23, 24, 26. – Hab.: 8. – ER

Euastrum denticulatum (Kirchner) Gay 1884 (bas.: *Euastrum binale* var. *denticulatum* Kirchner 1878; syn.: *Euastrum amoenum* Gay 1884; *E. denticulatum* var. *granulatum* W. West 1892; *E. denticulatum* var. *angusticeps* Grönblad 1921) – Lit.: 1, 2, 3, 4, 5, 6, 7, 8, 14, 17, 23, 33, 36, 39, 40, 41. – Hab.: 2 ,8 , 9, 10. – R

Euastrum didelta Ralfs 1848 (syn.: *Euastrum didelta* f. *ansatiforme* Schmidle 1898; *E. didelta* var. *ansatiforme* (Schmidle) Ducellier 1915; *E. didelta* var. *cuneatiforme* Ducellier 1915) – Lit.: 2, 3, 12, 14. – Hab.: 8. – R

Euastrum dubium Nägeli 1849 (syn.: *Euastrum dubium* var. *triquetrum* Skuja 1964) – Lit.: 2, 5, 6, 7, 8, 17, 22, 23, 26, Ud. (DL, BV) – Hab.: 8. – R

Euastrum dubium var. *latum* Krieger 1922 – Lit.: 5, 17, 22. – Hab.: 8. – ER

Euastrum elegans Ralfs 1848 – Lit.: 2, 3, 5, 6, 7, 8, 13, 15, 16, 17, 21, 22, 23, 24, 26, 36, 38, 39, 41, Ud. (VrR, TR, BV, VR, OL). – Hab.: 1, 8, 9, 10. – F

Euastrum erosum Lundell 1871 – Lit.: 2, 5, 17, 22, 23. – Hab.: 8. – R

Euastrum gemmatum Ralfs 1848 – Lit.: 7, 8, 21, 37, Ud (KB). – Hab.: 8, 9, 10. – R (Fig. 3.)

Euastrum humerosum Ralfs 1848 (syn.: *Euastrum humerosum* var. *parallelum* Krieger 1937) – Lit.: 37. – Hab.: 9. – ER

Euastrum humerosum var. *affine* (Ralfs) Raciborski 1885 (bas.: *Eustarum affine* Ralfs 1848) – Lit.: 2, 5, 23, 24, 25, 26, 36, 37, 41. – Hab.: 8,9,10. – R

Euastrum insulare (Wittrock) Roy 1877 (syn.: *Euastrum binale* var. *insulare* Wittrock 1972) – Lit.: 2, 3, 5, 6, 7, 8, 13, 15, 23, 24, 37, 40, 41. – Hab.: 8, 9, 10. – R

Euastrum lacustre (Messikommer) Coesel 1984 (bas.: *Euastrum insulare* var. *lacustre* (Messikommer) Krieger 1937) – Lit.: 7, 8. – Hab.: 8. – ER

Euastrum montatum W. G. S: West 1905 – Lit.: 7, 8. – Hab.: 8. – ER

Euastrum oblongum Ralfs 1848 (syn.: *Euastrum oblongum* var. *depauperatum* W. *et* G. S. West 1905) – Lit.: 1, 2, 3, 5, 6, 12, 23, 13, 15, 16, 21, 22, 26, 36, 37, 38, 39, 41, Ud. (VR, KB, OL, CR). – Hab.: 3, 8, 9, 10. – F (Fig. 4.)

Euastrum pinnatum Ralfs 1848 – Lit.: 2, 6, 36, 39, 40, 41, 42. – Hab.: 8, 9, 10. – R

Euastrum pokornyanum Grunow var. *trigonum* (Nordstedt) Krieger *et* Gerloff 1965 (bas.: *Euastrum angustatum* var. *trigonum* Nordstedt 1875; syn: *Euastrum angustatum* (Wittrock) Lagerheim 1902) – Lit.: 3, 14. – Hab.: 8. – R

Euastrum pulchellum Brébisson 1856 – Lit.: 36, 41. – Hab.: 9. – ER

Euastrum sinuosum Lenordman *ex* Archer *in* Prichard 1861 (syn.: *Euastrum sinuosum* var. *reductum* W. *et* G. S. West 1897) – Lit.: 5, 25. – Hab.: 8. – ER

Euastrum spinulosum Delponte 1876 – Lit.: 37, 33, 34. – Hab.: 2, 8. – R

Euastrum sublobatum Brébisson *ex* Ralfs 1848 (syn.: *Euastrum sublobatum* var. *pileolatum* Brébisson 1856; *Cosmarium sublobatum* (Ralfs) Archer 1861) – Lit.: 2, 5, 23, 25, Ud. (MR, VrR, TR, DL). – Hab.: 1, 8. – R

Euastrum turnerii W. West 1892 – Lit.: 2, 5, 23. – Hab.: 8. – ER

Euastrum verrucosum Ralfs 1948 var. *verrucosum* – Lit.: 1, 2, 3, 7, 8, 13, 14, 23, 24, 36, 37, 38, 39, 41, Ud. (CB, TR, DL). – Hab.: 7, 8, 9, 10. – F (Fig. 5.)

Euastrum verrucosum var. *alatum* Wolle 1884 - Lit.: 2, 6, 40, 41. – Hab.: 8, 9. – R

Euastrum verrucosum var. *alpinum* (Huber-Pestalozzi) Krieger 1939 (bas.: *Euastrum verrucosum* var. *alatum* f. *alpinum* Huber-Pestalozzi 1931; syn.: *Euastrum verrucosum* var. *vallesiacum* Viret 1909; *E. verrucosum* var. *dalbisii* Laporte 1931) – Lit.: 7, 8. – Hab.: 8. – ER

Micrasterias apiculata (Ehrenberg) Meneghini *ex* Ralfs 1848 – Lit.: 2, 5, 6, 12, 15, 16, 23, Hab.: 8. – ER

Micrasterias crux – melitensis Ralfs 1848 (syn.: *Micrasterias crux-melitensis var. superflua* Turner 1885; *M. crux-melitesis* var. *janeira* (Raciborski) Grönblad 1920) – Lit.: 1, 2, 5, 6, 7, 8, 13, 15, 16, 23, 27, 33, Ud. (TR, KB). – Hab.: 2, 6, 8. – R (Fig. 6.)

Micrasterias denticulata Brébisson *ex* Ralfs 1848 var. *denticulata* (syn.: *Micrasterias angulosa* Hantzsch 1862; *M. denticulata* var. *lusitanica* Sampaio 1922) – Lit.: 5, 6, 13, 15, 16, 24, 26, 37, 41. – Hab.: 8,9. – R

Micrasterias denticulata var. *angulosa* (Hantzsch) W. *et* G. S. West 1902 (bas.: *Micrasterias angulosa* Hantzsch 1862) – Lit.: Hab.: 8. – ER

Micrasterias fimbriata Ralfs 1848 (syn.: *Micrasterias apiculata* var. *fimbriata* (Ralfs) W. *et* G. S.West 1905) – Lit.: 2, 13, 15, 16, 37, Ud. (DL). – Hab.: 8, 9. – R

Micrasterias papilifera Brébisson *ex* Ralfs 1848 var. *papilifera* (syn.: *Micrasterias papillifera* var. *verrucosa* Schmidle 1896) – Lit.: 1, 2, 5, 6, 7, 8, 13, 14, 15, 16, 23, 24, 25, 26, 30, 36, 37, 38, 39, 40, 41, 42, Ud (CB). – Hab.: 1, 8, 5, 6, 9, 10. – F (Fig. 7.)

Micrasterias papilifera Brébisson *ex* Ralfs 1848 var. *papilifera* (syn.: *Micrasterias papillifera* var. *verrucosa* Schmidle 1896) – Lit.: 1, 2, 5, 6, 7, 8, 13, 14, 15, 16, 23, 24, 25, 26, 30, 36, 37, 38, 39, 40, 41, 42, Ud. (CB, TR, KB, DL). – Hab.: 1, 8, 9, 10. – F

Micrasterias radiosa Ralfs 1848 (syn.: *Micrasterias sol* Ehrenberg *ex* Kützing 1849) – Lit.: 2, 6, Ud. (CB, KB). – Hab.: 8. – ER (Fig. 8.)

Micrasterias rotata Ralfs 1848 (syn.: *Micrasterias rotata* f. *granulata* W.West 1892; *M. rotata* f. *evoluta* Turner 1893; *M. rotata* var. *pulchra* Lemmermann 1896; *M. rotata* var. *evoluta* (Turner) Krieger 1939) – Lit.: 1, 2, 3, 4, 5, 6, 13, 15, 16, 23, 26. – Hab.: 8. – R

Micrasterias thomasiana Archer 1862 var. *thomasiana* (syn.: *Micrasterias denticulata* var. *subnotata* W. West 1892) – Lit.: 1, 2, 5, 6, 17, 22, 37. – Hab.: 8, 9, 10. – R

Micrasterias thomasiana var. *notata* (Nordstedt) Grönblad 1920 (bas.: *Micrasterias denticulata* var. *notata* Nordstedt 1888) – Lit.: 5, 6, 12, 13, 15, 16, 23, 26. – Hab.: 8. – R

Micrasterias truncata Ralfs 1848 var. *truncata* (syn.: *Micrasterias neodamensis* Braun 1856; *M. truncata* f. *granulata* Raciborski 1889; *M. truncata* var. *neodamensis* (Braun) Krieger 1939) – Lit.: 2, 5, 6, 12, 13, 15, 16, 17, 22, 23, 24, 25, 26, 40, 41, Ud. (DL). – Hab.: 8, 9. – R

Micrasterias truncata var. *bahusiensis* Wittrock 1869 – Lit.: 2, 7. – Hab.: 8. – ER

Micrasterias truncata var. *crenata* (Brébisson) Grönbland 1920 (bas.: *Micrasterias crenata* Brébisson *ex* Ralfs 1848) – Lit: 2, 7. – Hab.: 8 – ER

Micrasterias truncata var. *semiradiata* Wolle 1884 – Lit.: 1, 2. – Hab.: 8. – ER

Staurodesmus aversus (Lundell) Lillieroth 1950 (bas.: *Staurastrum aversum* Lundell 1871) – Lit.: 3.13. – Hab.: 8. – ER

Staurodesmus brevispina (Brébisson) Croasdale 1957 (bas.: *Staurastrum brevispina* Brébisson 1848) – Lit.: 2, 3, 5, 6, 7, 8, 13, 23, 27. – Hab.: 6, 8. – R

Staurodesmus connatus (Lundell) Thomosson 1960 (bas.: *Staurastrum dejectum* var. *connatum* Lundell 1871; syn.: *Staurastum hexacanthum* Gay 1884; *S. connatum* (Lundell) Roy *et* Bisset 1886) – Lit.: 2, 3, 5, 13, 23. – Hab.: 8. – ER

Staurodesmus convergens (Ehrenberg *ex* Ralf) Lilleroth 1950 (bas.: *Arthrodesmus convergens* Ehrenberg *ex* Ralfs 1848; syn.: *Arthrodesmus convergens* f. *deplanata* Deflandre 1926; *A. convergens* var. *deplanatus* (Deflandre) Laporte 1931) – Lit.: 1, 2, 3, 5, 6, 7, 8, 9, 13, 15, 16, 23, 33, 34, Ud. (CB, TR, DL). – Hab.: 2, 7, 8. – R (Fig. 9.)

Staurodesmus corniculatus (Lundell) Teiling 1967 (bas.: *Staurastrum corniculatum* Lundell 1871) – Lit.: 2, 3, 6, 13, 15, 16. – Hab.: 8. – ER

Staurodesmus cuspidatus (Brébisson) Teiling 1967 (bas.: *Staurastrum cuspidatum* Brébisson 1848; syn.: *Staurastrum mamillatum* Nordstedt 1870; *Arthrodesmus constrictus* Smith 1922; *Staurodesmus cuspidatus* subsp. *constrictus* (Smith) Teiling 1948; *S. cuspidatus* subsp. *tricuspidatus* (Brébisson) Teiling 1948; *S. joshuae* subsp. *trispinosus* Teiling 1948; *S. mamillatus* (Nordstedt) Teiling 1967) – Lit.: 3, 7, 7, 14, 32, 33, 37. – Hab.: 2, 3, 7, 8. – R

Staurodesmus dejectus (Brébisson) Teiling 1967 var. *dejectus* (bas.: *Staurastrum dejectum* Brébisson 1848; syn.: *Staurastrum dejectum* f. *maius* W. *et* G. S. West 1923) – Lit.: 1, 2, 3, 4, 7, 8,13, 14, 23, 25, 36, 41, Ud. (VR, CR). – Hab.: 1, 7, 8, 9, 10. – R (Fig. 10.)

Staurodesmus dejectus var. *apiculatus* (Brébisson) Croasdale 1957 (bas.: *Staurastrum apiculatum* Brébisson 1856; syn.: *Staurastrum dejectum* var. *apiculatum* Lundell 1871; *Staurodesmus apiculatus* (Brébisson) Lillieroth 1950) – Lit.: 2, 4, 6. – Hab.: 8. – ER

Staurodesmus dejectus var. *robustus* (Messikommer) Coesel 1993 (bas.: *Staurastrum cuspidatum* var. *robustum* Messikommer 1928) – Lit.: 7, 8. – Hab.: 8. – ER

Staurodesmus dickiei (Ralfs) Lillieroth 1950 (bas.: *Staurastum dickiei* Ralfs 1848; syn.: *Staurastrum dickiei* f. *punctata* W. West 1902) – Lit.: 1, 2, 3, 4, 5, 9,

10, 11, 13, 15, 16, 17, 19, 20, 21, 22, 23, 27, 39, 40, 41, Ud. (ĐR, VrR, KB, BV). – Hab.: 1, 2, 4, 5, 6, 8, 9. – F (Fig. 11.)

Staurodesmus dickiei var. *circularis* (Turner) Croasdale 1957 (bas.: *Staurastrum dickiei* var. *circulare* Turner 1892; syn.: *Staurodesmus dickiei* var. *semicirculare* W. *et* G. S. West 1893) – Lit.: 2, 5, 23. – Hab.: 8. – ER

Staurodesmus dickiei var. *rhomboideus* (W. *et* G. S. West) Lillieroth 1950 (syn.: *Staurastrum dickiei* var. *rhomboideum* W. *et* G. S. West 1903) – Lit.: 2, 5, 23. – Hab.: 8. – ER

Staurodesmus extensus (Borge) Teiling 1948 (bas.: *Staurastum dilatatum* var. *extensum* Borge 1906; syn.: *Arthrodesmus incus* var. *extensus* Borge 1890) – Lit.: 1, 2, 5, 7, 8, 27, Ud. (KB). – Hab.: 8. – R (Fig. 12.)

Staurodesmus glaber var *glaber* (Ralfs) Teiling 1848 (bas.: *Staurastrum glabrum* Ralfs 1848; syn.: *Arthrodesmus incus* f. *brebissonii* Raciborski 1889; *A. ralfsii* var. *brebissonii* (Raciborski) Smith 1924) – Lit.: 2, 4, 5, 7, 8, 23, 24, 25, 33. – Hab.: 2, 8. – R

Staurodesmus glaber var. *deberyanus* (Jacobsen) Teiling 1967 (*Staurastrum cuspidatum* var. *debaryana* Jacobsen 1874) – Lit.: 7, 8. –bHab.: 8. – ER

Staurodesmus groenbladii (Skuja) Teiling 1954 (bas.: *Staurastrum groenbladii* Skuja 1931) – Lit.: 33, 37, 41, Ud. (CB, TR, KB). – Hab.: 2, 9. – R

Staurodesmus incus (Hassal *ex* Ralfs) Teiling 1967 (bas.: *Arthrodesmus incus* Hassal *ex* Ralfs 1848) – Lit.: 2, 5, 6, 23. – Hab.: 8. – ER

Staurodesmus indentatus (W. *et* G. S. West) Teiling 1948 (bas.: *Arthrodesmus incus* var. *indentatus* W. *et* G. S. West 1912; syn.: *Arthrodesmus convergens* var. *indentatus* W. *et* G. S. West 1904) – Lit.: 5, 23, 25, Ud. (CB). – Hab.: 8. – R

Staurodesmus lanceolatus (Archer) Croasdale 1967 (bas.: *Staurastrum lanceolatum* W. Archer 1862) – Lit: Ud (CB). – Hab.: 8. – ER (Fig. 13.)

Staurodesmus mucronatus (Ralfs *ex* Ralfs) Croasdale 1957 (bas.: *Staurastrum mucronatum* Ralfs *ex* Ralfs 1848) – Lit.: 7, 8. – Hab.: 8. – ER

Staurodesmus omearae (Archer) Teiling 1948 (bas.: *Staurastrum omearae* Archer 1858) – Lit.: 2, 5, 6. – Hab.: 8. – ER

Staurodesmus patens (Nordstedt) Croasdale 1957 (bas.: *Staurastrum dejectum* var. *patens* Nordstedt 1887) – Lit.: 7, 8, 33, Ud. (KB, DL). – Hab.: 2, 8. – R (Fig. 14.)

Staurodesmus pterosporus (Lundell) Bourrelly 1966 (bas.: *Staurastrum pterosporum* Lundell 1871) – Lit.: 2, 6. – Hab.: 8. – ER

Staurodesmus sibiricus (Borge) Croasdale 1957 (bas.: *Staurastrum sibiricum* Borge 1891; syn.: *Staurastrum clepsydra* var. *sibiricum* (Borge) W. *et* G. S. West 1912) – Lit.: Hab.: 2. – ER

Staurodesmus subhexagonus (W. *et* G. S. West) Coesel 1993 (bas.: *Arthrodesmus incus* f. *subhexagonus* W. *et* G. S. West 1912) – Lit.: 7, 8. – Hab.: 8. – ER

Staurodesmus triangularis (Legerheim) Teiling 1948 (bas.: *Arthrodesmus triangularis* Legerheim 1886; syn.: *Arthrodesmus triangularis* f. *triquerta* W. *et* G. S. West 1912; *A. triangularis* var. *brevispina* Allorge 1930) – Lit.: 1, 2, 4. – Hab.: 8. – ER

Staurodesmus validus (W. *et* G. S. West) Thomasson 1962 (bas.: *Staurastrum incus* var. *validus* W. *et* G. S. West 1898; syn.: *Arthrodesmus incus* var. *validus* W. *et* G. S. West 1898; *A. convergens* var. *validus* W. *et* G. S. West 1898) – Lit.: 2, 5, 23. – Hab.: 8. – ER

Xanthidium antilopaeum Kützing 1849 var. *antilopaeum* (Syn.: *Xanthidium antilopaeum* var. *triquetrum* Lundell 1871; *X. antilopaeum* var. *hirsutum* Gay 1884; *X. spinulosum* Bannett 1886; *X. antilopaeum* var. *ornatum* Andersson 1890) – Lit.: 1, 2, 4, 5, 6, 23, 27, 39, 41, Ud. (CB, DL, BV). – Hab.: 8, 9, 10. – R (Fig. 15.)

Xanthidium antilopaeum var. *dimazum* Nordstedt 1873 – Lit.: 1, 2, 4. – Hab.: 8. – ER *Xanthidium antilopaeum* var. *laeve* Schmidle 1893 – Lit.: 2, 5, 23. – Hab.: 8. – ER

Xanthidium antilopaeum var. *oligocanthum* Schmidle 1894 – Lit.:39, 41. – Hab.: 9. – ER

Xanthidium antilopaeum var. *planum* Roll 1927 – Lit.: 7, 8. – Hab.: 8. – ER

Xanthidium basidentatum (Børgesen) Coesel 1993 (bas.: *Xanthidium brebissonii* var. *basidentatum*

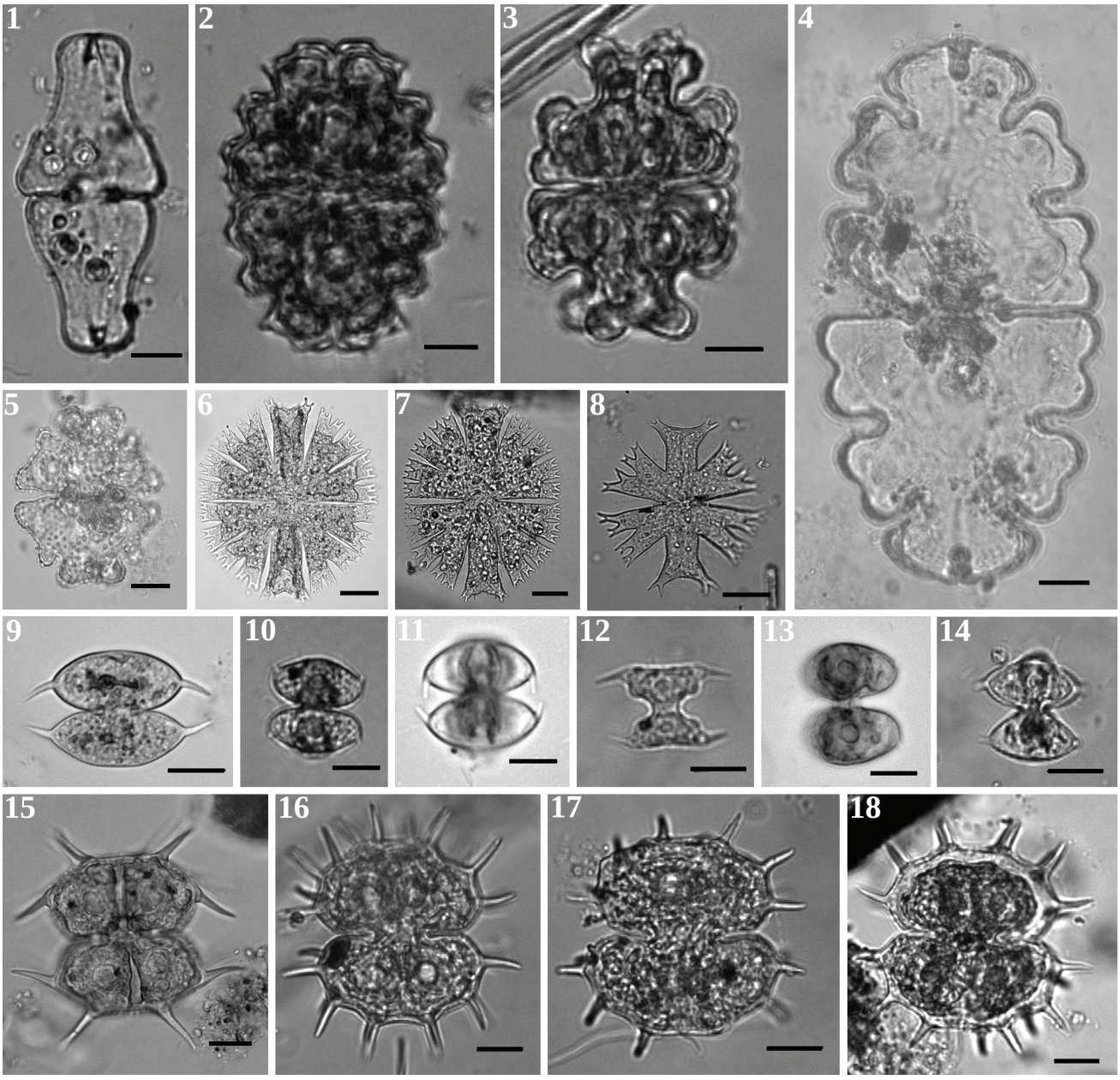

Plate I
Figs 1-18.
1. *Euastrum ansatum*; 2. *E. bidentatum*; 3. *E. gemmatum*; 4. *E. oblongum*; 5. *Euastrum verrucosum*; 6. *Micrasterias crux-melitensis*; 7. *M. papilifera*; 8. *M. radiosa*; 9. *Staurodesmus convergens*; 10. *S. dejectus*; 11. *S. dickiei*; 12. *S. extensus*; 13. *S. lanceolatus*; 14. *S. patens*; 15. *Xanthidium antilopaeum*; 16. *X. basidentatum*; 17. *X. cristatum*, 18. *X. fasciculatum*

Scale bar 10 μm

Børgesen) – Lit: Ud. (CB). – Hab.: 8. – ER (Fig. 16.)

Xanthidium bifidum (Brébisson) Deflandre 1929 (bas.: *Arhrodesmum bifidus* Brébisson 1856) – Lit.: 2, 5, 6, 23. – Hab.: 8. – ER

Xanthidium cristatum Brébisson *ex* Ralfs 1848 (syn.: *Halocanthum cristatum* (Brébisson *ex* Ralfs) Wille 1890) – Lit.: 1, 2, 3, 5, 6, 13, 14, 15, 16, 23, 27, Ud. (TR). – Hab.: 8. – R (Fig. 17.)

Xanthidium fasciculatum Ehrenberg *ex* Ralfs 1848 (syn.: *Xanthidium fasciculatum* var. *polygonum* Ehrenberg *ex* Ralfs 1848; *X. fasciculatum* var. *ornatum* Nordstedt 1885) – Lit.: 2, 4, 5, 6, 7, 8, 13, 15, 16, Ud. (KB). – Hab.: 7, 8. – R (Fig. 18.)

Xanthidium octocorne Ehrenberg *ex* Ralfs 1848 (syn.: *Arthrodesmus octocornis* Ehrenberg *ex* Ralfs 1848) – Lit.: 5, 6, 27, Ud. (CB, BV). – Hab.: 7, 8. – R

Xanthidium smithii Archer 1860 – Lit. : 7, 8. – Hab.: 8. – R

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