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DESMIDIALES (ZYGNEMATOPHYCEAE, STREPTOPHYTA) OF THE QUARRY POND ZAVODSKE – A HOTSPOT OF DESMIDS DIVERSITY IN CHERNIHIV POLESIE, UKRAINE

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DESMIDIALES (ZYGNEMATOPHYCEAE, STREPTOPHYTA) КАР'ЄРНОЇ ВОДОЙМИ ЗАВОДСЬКЕ – «ГАРЯЧОЇ ТЕРИТОРІЇ» БІОРІЗНОМАНІТТЯ ДЕСМІДІЄВИХ ВОДОРОСТЕЙ В ЧЕНІГІВСЬКОМУ ПОЛІССІ, УКРАЇНА

ABSTRACT

Purpose. Study of the composition of desmids in Zavodske quarry pond (Chernihiv Polesie, Ukraine), preparation of the taxonomical list. Microphotographs illustrating the cells of desmid algae found Ukrainian and their dimensional characteristics are intended to facilitate their identification and can be used for comparative analysis by both Ukrainian and foreign desmidiologists.

Methodology. As part of the PhD dissertation, several field research trips were conducted and algological samples were collected in Zavodske quarry pond (8,625 m^2, depth 1.5-2 m), located near the village of Zavodske, Dobryana village community, Chernihiv district and region, Ukraine. From the middle to the end of the last century it was used for extraction of the clay for the needs of the local brick-making plant.

The samples were examined alive as well as fixed with 4 % formalin for further storage and examination. Water chemical variables (pH and electrical conductivity) were determined by H&M COM-100 and H&M PH-200 portable multimeters. Microscopic examination of the samples was carried out using light microscopes Olympus BX-51 (samples 2018–2021) and Zeiss Imager A2 (samples 2021–2022).

The main literature for the definition: Conjugates – *Conjugatophyceae*. Part 2. Desmids – *Desmidiales*. In: Identification manual of the freshwater algae of Ukrainian RSR. Palamar-Mordvintseva, 1986; Flora of algae in continental water bodies of Ukraine. Desmid algae. Part 2: *Desmidiaceae*. Palamar-Mordvintseva, 2005; Desmidiaceen-flora von Österreich, Teil 3. Lenzenweger, 1999; Desmids of the Lowlands Mesotaeniaceae and Desmidaceae of the European Lowlands. Coesel & Meesters, 2007.

Scientific novelty. This is the first study of the desmid species composition of Zavodske quarry pond. In total 110 taxa were identified, 16 of them recorded for the first time in Ukraine.

Conclusions. Zavodske quarry pond is a unique locality with numerous desmids. The number of identified taxa (110 taxa – 11.4 % of the desmidioflora of Ukraine) and part of the newly found in Ukraine (16 out of 110 taxa – 1.65 % of the desmidioflora of Ukraine) are extraordinary and deserves close attention and protection of their habitat.

Key words: desmid algae, Chernihiv Polesie, quarry pond, biodiversity hotspot

АНОТАЦІЯ

Мета роботи. Дослідження складу десмідієвих водоростей кар'єрної водойми Заводське (Чернігівське Полісся). Складання таксономічного списку. Мікрофотографії, що ілюструють знайдені українські клітини десмідієвих водоростей, та їх розмірні характеристики. мають на меті полегшити їх визначення та можуть бути використані для порівняльного аналізу як українськими так і зарубіжними десмідіологами.

Методологія. В рамках дисертаційного дослідження були проведені експедиційні виїзди та відібрані альгологічні зразки в кар'єрній водоймі Заводське (8625 м^2, глибина 1.5–2 м), що розташована неподалік села Заводське Добрянської селищної громади Чернігівського району Чернігівської області України. З середини до кінця минулого століття з нього добували глину для потреб місцевого цегельного заводу.

Зразки досліджувались живими та були фіксовані 4 % формаліном для подальшого дослідження. pH та електропровідність води визначали портативними приладами H&M COM-100 та H&M PH-200. Мікроскопічне дослідження проб здійснювалось за допомогою світлових мікроскопів Olympus BX-51 (зразки 2018–2021) та Zeiss Imager A2 (зразки 2021–2022). Основна література для визначення: Визначник прісноводних водоростей Української РСР. Паламар-Мордвінцева 1986; Флора водоростей континентальних водойм України: Десмідієві водорості. Вип. 1, ч. 2 *Desmidiaceae*. Паламар-Мордвінцева, 2005; Desmidiaceenflora von Österreich, Teil 3. Lenzenweger, 1999; Desmids of the Lowlands Mesotaeniaceae and *Desmidaceae* of the European Lowlands. Coesel & Meesters, 2007.

Наукова новизна. Вперше досліджено видовий склад десмідієвих водоростей кар'єрної водойми Заводське. Визначено 110 таксонів, з них 16 вперше наводиться для України.

Висновки. Водойма Заводське є унікальним локалітетом різноманіття десмідієвих водоростей, в межах якого кількість визначених таксонів (110 таксонів – 11,4 % флори десмідієвих України), та частка в них знайдених вперше для України (16 з 110 таксонів – 1,65 % флори десмідієвих України) є надзвичайною і ця водойма заслуговує на увагу та охорону.

Ключові слова: десмідієві водорості, Чернігівське Полісся, кар'єрні водойми, «гаряча територія» біорізноманіття

Introduction

Zavodske (Fig. 1) is one of the smallest water bodies in the group of man-made quarry ponds, known as «Blue Lakes». Originally these ponds were quarries for extracting sand with high silicon dioxide content used for the glass industry. Zavodske originally was used for extraction of the clay for the needs of the local brick-making plant in the period from the middle to the end of the last century.

Fig. 1. Photograph of the quarry pond Zavodske (June)

The area of the pond is 8625 m^2, the depth is 1.5–2 m. It is located at the distance of 200 meters to the east from Zavodske village, Dobryana village community, Chernihiv district and region, Ukraine (N 51°96'3''; E 31°18'6'') among the massif of pine and oak-pine forests (see Figure 2).

Fig. 2 The map of location of the quarry pond Zavodske (taken from Google Maps; https://www.google.com/maps)

Our study is the first investigation of the species composition of desmids of Zavodske quarry pond. The first publication referring to this pond was in 2020 (Shyndanovina, 2020), the next one was issued in 2023 (Shyndanovina & Lukash, 2023). Both these publications were describing new for Ukraine and rare and extremely rare for Europe desmid taxa. One of the described species, *Pleurotaenium simplicissimum* Grönblad 1920, was considered close to extinction (Šťastný, 2009).

Samples were taken during 2018–2022, and 22 samples were collected in total. The results of this study are presented in the form of the taxonomic list with 35 plates of microphotographs providing characteristic illustrations of the newly found and some other taxa. Dimensions of every illustrated taxon are also indicated.

Materials and methods

The samples were examined as alive and fixed with 4 % formalin for further examination. Water chemical variables (pH and electrical conductivity) were determined by H&M COM-100 and H&M PH-200 portable multimeters. Microscopic examination of the samples was carried out using light microscopes Olympus BX-51 (samples 2018–2021) and Zeiss Imager A2 (samples 2021–2022). Photographs are taken with Canon Rebel XS and Canon R6 cameras.

The locality and the chemical variables of the algae habitat are described in detail in (Shyndanovina & Lukash, 2023). Here is a short resume provided for the convenience of the readers.

The hydrochemical parameters of the algae habitat are: pH: 7.5–7.7; EC: 36–38 $\mu S.cm^{-1}$; ion concentrations (mg/L) NO_3^-: 0.017; NH_4^+: 0.018; PO_4^{3-}: 9.283; Cu^{2+}: 0.057; Zn^{2+}: 0.036, $Fe^{(2+,3+)}$: 0.016; Mn^{2+}: 0.263.

Main literature used for identification: Palamar-Mordvintseva (1986, 2005), Desmidiaceenflora von Österreich (Lenzenweger, 1999), Desmids of the Lowlands (Coesel & Meesters, 2007).

Results and Discussion

The taxonomic list of the discovered desmid algae of the quarry pond Zavodske is presented in Table 1. There were identified 110 taxa of desmids in total. Sixteen of 110 taxa (14,5 %) are new for desmidioflora of Ukraine. Newly found taxa of desmids represent 1,65 % of the total number of taxa of desmids found in Ukraine.

Table 1

Taxonomic list of Desmidiales (Zygnematophyceae, Streptophyta) in the quarry pond Zavodske

Name				Author	№ of figure
Desmidiales				**Bessey**	
A)	**Closteriaceae**			**Bessey**	
	I)	***Closterium***		**Nitzsch ex Ralfs**	
		1	*Closterium acerosum*	Ehrenberg ex Ralfs 1848	
		2	*Closterium dianae*	Ehrenberg ex Ralfs 1848	
		3	*Closterium rostratum*	Ehrenberg ex Ralfs 1848	
		4	*Closterium striolatum*	Ehrenberg ex Ralfs 1848	
B)	**Desmidiaceae**			**Ralfs**	
	I)	***Actinotaenium***		**(Nägeli) Teiling**	
		1	*Actinotaenium capax*	(Joshua) Teiling 1954	
		2	*Actinotaenium clevei*	(P.Lundell) Teiling 1954	
		3	*Actinotaenium cucurbita*	(Brébisson ex Ralfs) Teiling 1954	
		4	*Actinotaenium americanum* *	(West & G.S. West) Coesel & Meesters 2023	3
		5	*Actinotaenium perminutum* *	(G.S.West) Teiling 1954	3
		6	*Actinotaenium turgidum*	(Ralfs) Teiling 1954	
		7	*Actinotaenium wollei*	(W. & G.S.West) Teiling 1954	
	II)	***Cosmarium***		**Corda ex Ralfs**	
		1	*Cosmarium alpestre* *	J.Roy & Bisset 1893	4
		2	*Cosmarium amoenum*	Brébisson ex Ralfs 1848	
		3	*Cosmarium binum*	Nordstedt 1880	5
		4	*Cosmarium bireme*	Nordstedt 1870	6
		5	*Cosmarium blyttii*	Wille 1880	
		6	*Cosmarium beckii*	Gutwinski 1897	
		7	*Cosmarium botrytis* var. *botrytis*	Meneghini ex Ralfs 1848	7, 8
		8	*Cosmarium botrytis* var. *tumidum*	Wolle 1884	8
		9	*Cosmarium brebissonii*	Ralfs 1848	
		10	*Cosmarium connatum*	Ralfs 1848	
		11	*Cosmarium contractum*	Kirchner 1878	9
		12	*Cosmarium neodepressum*	G.J.P.Ramos & C.W.N.Moura 2020	10
		13	*Cosmarium difficile*	Lütkemüller 1892	11
		14	*Cosmarium formosulum*	Hoff 1888	
		15	*Cosmarium gibberulum* *	Lütkemüller 1910	12
		16	*Cosmarium hornavanense*	Gutwinski 1909	13
		17	*Cosmarium humile*	Nordstedt ex De Toni 1889	14
		18	*Cosmarium impressulum*	Elfving 1881	15
		19	*Cosmarium margaritatum*	(P.Lundell) J.Roy & Bisset 1886	16
		20	*Cosmarium margaritiferum*	Meneghini ex Ralfs 1848	17
		21	*Cosmarium meneghinii*	Brébisson ex Ralfs 1848	
		22	*Cosmarium moniliforme*	Ralfs 1848	18

Name				Author	№ of figure
		23	*Cosmarium obsoletum*	(Hantzsch) Reinsch 1867	
		24	*Cosmarium obtusatum*	(Schmidle) Schmidle 1898	19
		25	*Cosmarium phaseolus* var. *notatum* *	(Nordstedt) Coesel 1991	20
		26	*Cosmarium ordinatum* *	(Børgesen) West & G.S.West 1896	21
		27	*Cosmarium pachydermum*	P.Lundell 1871	22, 23
		28	*Cosmarium perforatum*	P.Lundell 1871	24
		29	*Cosmarium porteanum*	W.Archer 1860	
		30	*Cosmarium pseudamoenum*	Wille 1884	
		31	*Cosmarium pseudoconnatum*	Nordstedt 1869	
		32	*Cosmarium pseudoornatum* *	B.Eichler & Gutwinski 1894	25
		33	*Cosmarium pseudoprotuberans var. pseudoprotuberans*	Kirchner 1878	26
		34	*Cosmarium pseudoprotuberans* var. *saxonicum* *	(Raciborski) Krieger & Gerloff 1965	27
		35	*Cosmarium pseudoprotuberans* var. *sulcatum* *	(Nordstedt) Coesel 1991	28
		36	*Cosmarium punctulatum*	Brébisson 1856	
		37	*Cosmarium pygmaeum*	W.Archer 1864	
		38	*Cosmarium quadratum*	Ralfs ex Ralfs 1848	
		39	*Cosmarium quadrum*	P.Lundell 1871	
		40	*Cosmarium rectangulare* var. *hexagonum*	West & G.S.West 1908	
		41	*Cosmarium regnellii*	Wille 1884	
		42	*Cosmarium reniforme*	(Ralfs) W.Archer 1874	
		43	*Cosmarium reniforme* var. *compressum*	Nordstedt 1887	
		44	*Cosmarium retusiforme*	(Wille) Gutwinski 1892	
		45	*Cosmarium retusiforme* var. *incrassatum*	Gutwinski 1890	
		46	*Cosmarium simplicius* *	(W. & G.S.West) Grönblad 1931	29
		47	*Cosmarium striolatum*	(Nägeli) W.Archer 1861	
		48	*Cosmarium taxichondriforme*	B.Eichler & Gutwinski 1894	
		49	*Cosmarium tetraophthalmum*	Brébisson ex Ralfs 1848	
		50	*Cosmarium tutum* *	Shyndanovina 2020	30
		51	*Cosmarium thwaitesii*	Ralfs 1848	
		52	*Cosmarium undulatum*	Corda ex Ralfs 1848	
	III)	***Desmidium***		**C.Agardh ex Ralfs**	
		1	*Desmidium swartzii*	C.Agardh ex Ralfs 1848	
	IV)	***Euastrum***		**Ehrenberg ex Ralfs**	
		1	*Euastrum ansatum*	Ehrenberg ex Ralfs 1848	
		2	*Euastrum dubium*	Nägeli 1849	
		3	*Euastrum montanum*	West & G.S.West 1905	
		4	*Euastrum turneri*	West 1892	
		5	*Euastrum verrucosum*	Ehrenberg ex Ralfs 1848	
	V)	***Haplotaenium***		**Bando**	
		1	*Haplotaenium minutum*	(Ralfs) Bando 1988	

Name				Author	№ of figure
	VI)	***Hyalotheca***		**Ehrenberg ex Ralfs**	
		1	*Hyalotheca dissiliens*	Brébisson ex Ralfs 1848	
		2	*Hyalotheca mucosa*	Ralfs 1848	
	VII)	***Micrasterias***		**C.Agardh ex Ralfs**	
		1	*Micrasterias americana*	Ehrenberg ex Ralfs 1848	
		2	*Micrasterias apiculata*	Meneghini ex Ralfs 1848	
		3	*Micrasterias crux-melitensis*	Ralfs 1848	
		4	*Micrasterias furcata*	C.Agardh ex Ralfs 1848	
		5	*Micrasterias truncata*	Brébisson ex Ralfs 1848	
	VIII)	***Pleurotaenium***		**Nägeli**	
		1	*Pleurotaenium coronatum*	(Ralfs) Rabenhorst 1868	
		2	*Pleurotaenium crenulatum*	(Ralfs) Rabenhorst 1868	
		3	*Pleurotaenium ehrenbergii*	(Ralfs) De Bary 1858	
		4	*Pleurotaenium elongatum*	(West) Coesel & Meesters 2023	
		5	*Pleurotaenium eugeneum*	(W.B.Turner) West & G.S.West 1904	
		6	*Pleurotaenium simplicissimum* *	Grönblad 1920	
		7	*Pleurotaenium trabecula*	Nägeli 1849	31
		8	*Pleurotaenium trabecula* var. *crassum**	Wittrock 1872	32
		9	*Pleurotaenium truncatum*	(Brébisson ex Ralfs) Nägeli 1849	
	IX)	***Sphaerozosma***		**Corda ex Ralfs**	
		1	*Sphaerozosma vertebratum* var. *latius* *	West & G.S.West 1897	33
	X)	***Spondylosium***		**Brébisson ex Kützing**	
		1	*Spondylosium luetkemuelleri*	Grönblad 1938	
	XI)	***Staurastrum***		**Meyen ex Ralfs**	
		1	*Staurastrum avicula*	Brébisson 1848	
		2	*Staurastrum bacillare var. obesum*	P.Lundell 1871	
		3	*Staurastrum bieneanum*	Rabenhorst 1862	
		4	*Staurastrum brevispina*	Brébisson 1848	
		5	*Staurastrum cosmarioides* *	Nordstedt 1870	34
		6	*Staurastrum dickiei*	Ralfs 1848	
		7	*Staurastrum gracile*	Ralfs ex Ralfs 1848	
		8	*Staurastrum orbiculare*	Meneghini ex Ralfs 1848	
		9	*Staurastrum tetracerum*	Ralfs ex Ralfs 1848	
		10	*Staurastrum vestitum*	Ralfs 1848	
	XII)	***Staurodesmus***		**Teiling**	
		1	*Staurodesmus convergens*	(Ralfs) S.Lillieroth 1950	
		2	*Staurodesmus cuspidatus*	(Brébisson) Teiling 1967	
		3	*Staurodesmus dejectus*	(Brébisson) Teiling 1954	
		4	*Staurodesmus glaber*	(Ralfs) Teiling 1948	
	XIII)	***Teilingia***		**Bourrelly**	
		1	*Teilingia granulata*	(J.Roy & Bisset) Bourrelly 1964	
	XIV)	***Xanthidium***		**Ehrenberg ex Ralfs**	
		1	*Xanthidium antilopaeum*	Kützing 1849	
		2	*Xanthidium cristatum*	Brébisson ex Ralfs 1848	
C)	**Gonatozygaceae**			**G.S.West**	

Name				Author	№ of figure
	I)	***Gonatozygon***		**De Bary**	
		1	*Gonatozygon aculeatum* *	Hastings 1892	35
		2	*Gonatozygon brebissonii*	De Bary 1858	36
		3	*Gonatozygon kinahanii*	(W.Archer) Rabenhorst 1868	37
		4	*Gonatozygon monotaenium* var. *pilosellum*	Wittrock & Nordstedt 1886	38
D)	**Peniaceae**			**Haeckel**	
	I)	***Penium***			
		1	*Penium margaritaceum*	Brébisson ex Ralfs 1848	

Note: * – New for Ukrainian flora

17 out of 30 genera of desmids represented in Ukraine (Petlovany & Tsarenko, 2015) were found in Zavodske. The number of desmid taxa found in Zavodske reflects 11,4 % of the total number of the desmid taxa in Ukraine. *Gonatozygon* and *Pleurotaenium* genera present in Zavoske exceed 60 % of the total number of taxa of these genera in Ukraine (see Table 2).

Consequently, Zavodske pond is rich in desmid species and part of them which new for Ukraine, rare and extremely rare species, not only for Ukraine, but also for the whole Europe, is high (see Shyndanovina & Lukash, 2023). Therefore such «hotspot» of desmids diversity deserves attention and conservation.

Table 2

Genera of Desmidiales (Zygnematophyceae, Streptophyta) present in Ukraine compared to the flora of Desmidiales in Zavodske

№	Genus name	Number of taxa in Ukraine (Petlovany & Tsarenko, 2015), pcs	Number of taxa in Zavodske pond, pcs	Part of taxa in Zavodske pond of the total number of taxa in Ukraine (Petlovany & Tsarenko, 2015), %
1	*Actinotaenium*	20	7	35.0
2	*Bambusina*	1		
3	*Closterium*	101	4	4.0
4	*Cosmarium*	427	52	12.2
5	*Cosmoastrum**	48		
6	*Cosmocladium*	2		
7	*Cylindriastrum**	5		
8	*Desmidium*	10	1	10.0
9	*Docidium*	2		
10	*Euastrum*	56	5	8.9
11	*Genicularia*	1		
12	*Gonatozygon*	6	4	66.7
13	*Haplotaenium*	4	1	25.0
14	*Heimansia*	2		
15	*Hyalotheca*	5	2	40.0
16	*Micrasterias*	30	5	16.7
17	*Octacanthium*	5		
18	*Onychonema*	3		
19	*Oocardium*	1		
20	*Penium*	6	1	16.7

№	Genus name	Number of taxa in Ukraine (Petlovany & Tsarenko, 2015), pcs	Number of taxa in Zavodske pond, pcs	Part of taxa in Zavodske pond of the total number of taxa in Ukraine (Petlovany & Tsarenko, 2015), %
21	*Pleurotaenium*	13	9	69.2
22	*Raphidiastrum**	14		
23	*Sphaerozosma*	5	1	20.0
24	*Spondylosium*	13	1	7.7
25	*Staurastrum*	107	10	9.3
26	*Staurodesmus*	52	4	7.7
27	*Teilingia*	4	1	25.0
28	*Tetmemorus*	5		
29	*Triploceras*	1		
30	*Xanthidium*	20	2	10.0
	Total:	**969**	**110**	**11.4**

Note: * – Cosmoastrum P.-M., Raphidiastrum P.-M. and Cylindriastrum P.-M. are currently regarded as heterotypic synonyms of *Staurastrum* Meyen ex Ralfs (see Guiry, 2013) but traditionally we use them for analysis and characterizations of Ukrainian desmid flora.

The illustrations of 37 taxa are presented in 36 plates of microphotographs that are all made by the author of the article (see Figs. 3–38). They are presenting all new for Ukraine taxa and some other cells.

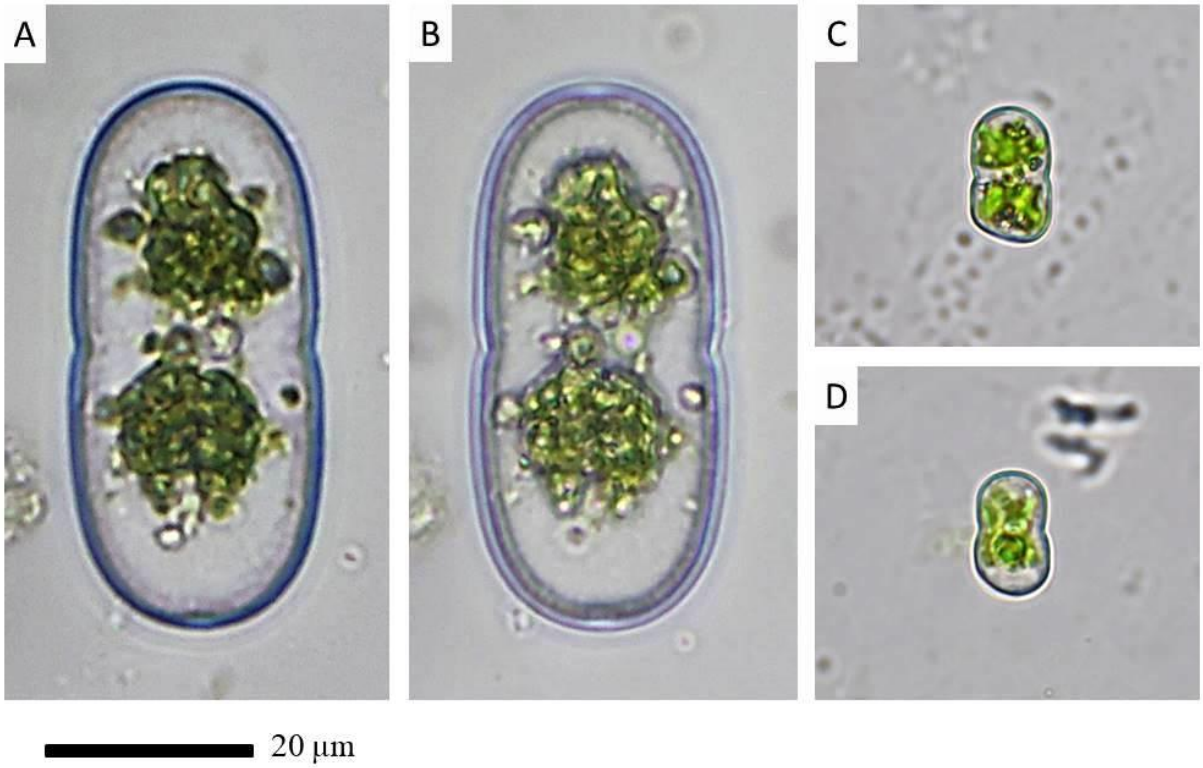

Fig. 3. Photographs A, B – *Actinotaenium americanum* (West & G.S. West) Coesel & Meesters 2023. Cell dimensions: length – 53.22 µm, breadth – 20.89 µm, isthmus – 23.39 µm. Photographs C, D – *Actinotaenium perminutum* (G.S.West) Teiling 1954. Cell dimensions C (D): length – 13.15 (12.05) µm, breadth – 8.02 (7.19) µm, isthmus – 7.19 (6.44) µm

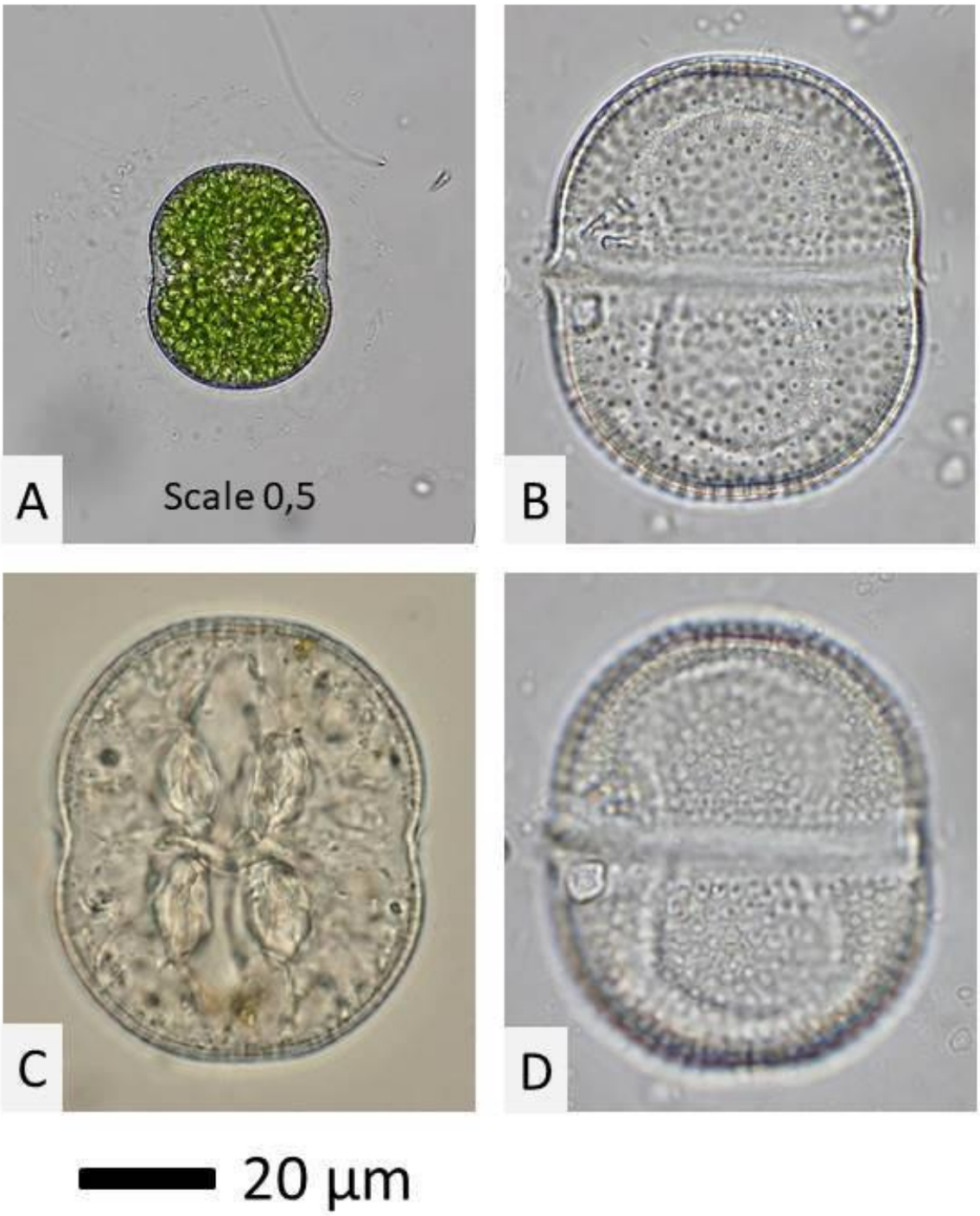

Fig. 4. Photographs of *Cosmarium alpestre* J.Roy & Bisset 1893.

Cell dimensions A: length – 65,93 µm,
breadth – 52,96 µm,
isthmus – 50,37 µm.

Cells B, D are deformed under the cover glass.
The cell with mucilage sheath is on photograph A.
The scale of photograph A is 0,5 of this figure scale

Fig. 5. Photographs of *Cosmarium binum* Nordstedt 1880.

Cell dimensions: length – 52,18 µm,
breadth – 41,98 µm,
isthmus – 15,25 µm

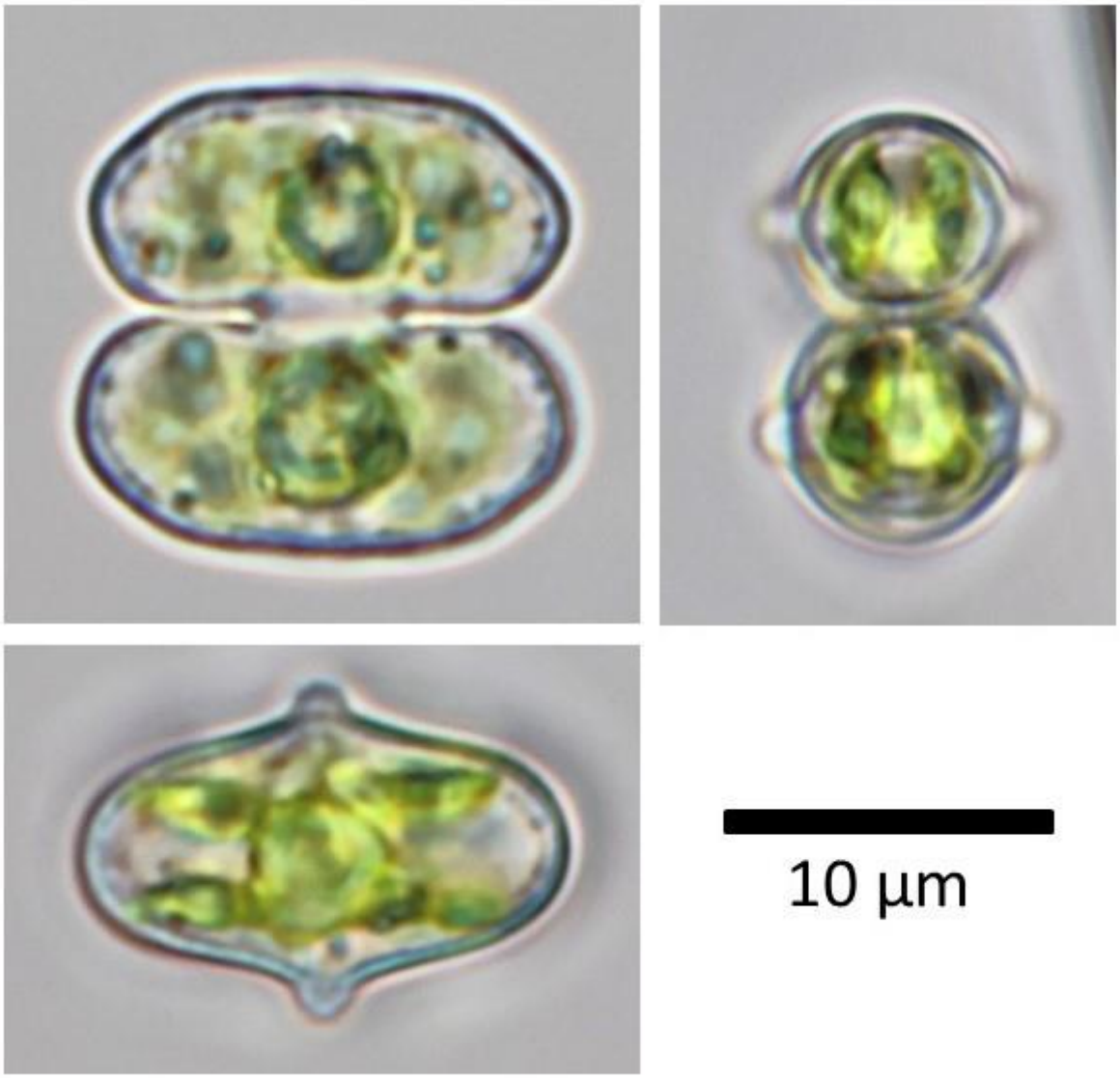

Fig. 6. Photographs of *Cosmarium bireme* Nordstedt 1870.

Cell dimensions: length – 14,43 µm,
breadth – 15,22 µm,
isthmus – 10,40 µm

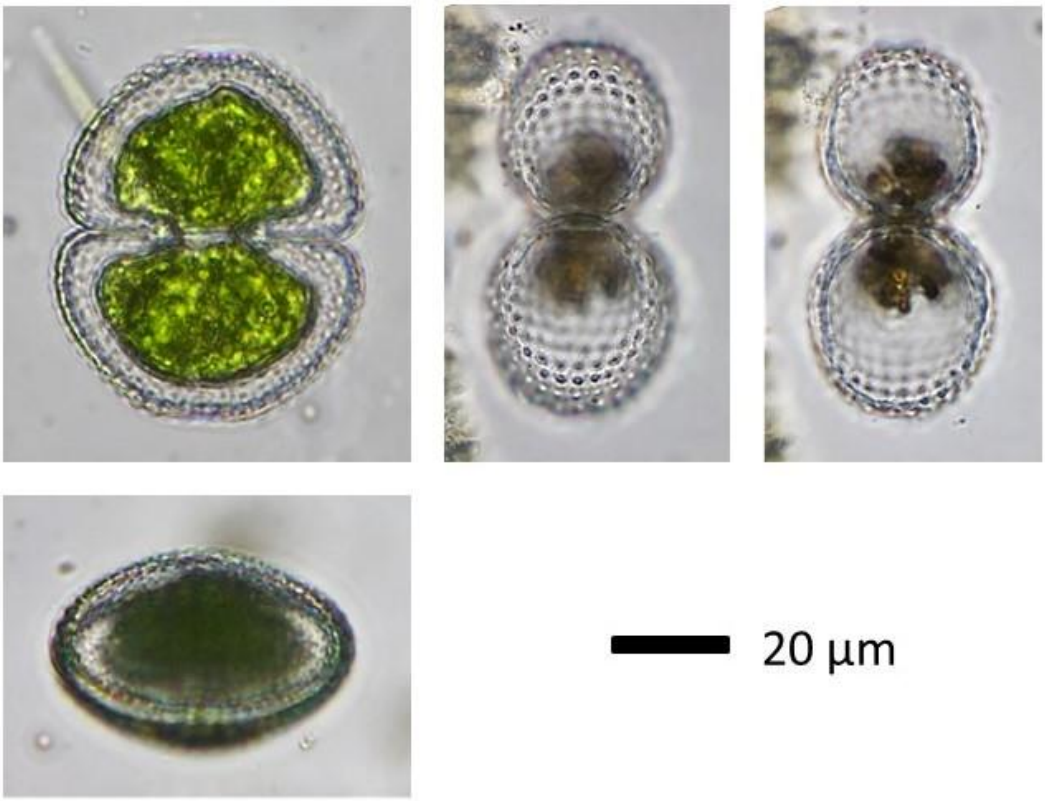

Fig. 7. Photographs of *Cosmarium botrytis* var. *botrytis* Meneghini ex Ralfs 1848. Cell dimensions: length – 63.84 µm, breadth – 53.90 µm, isthmus – 15.48 µm, thickness – 32.60 µm

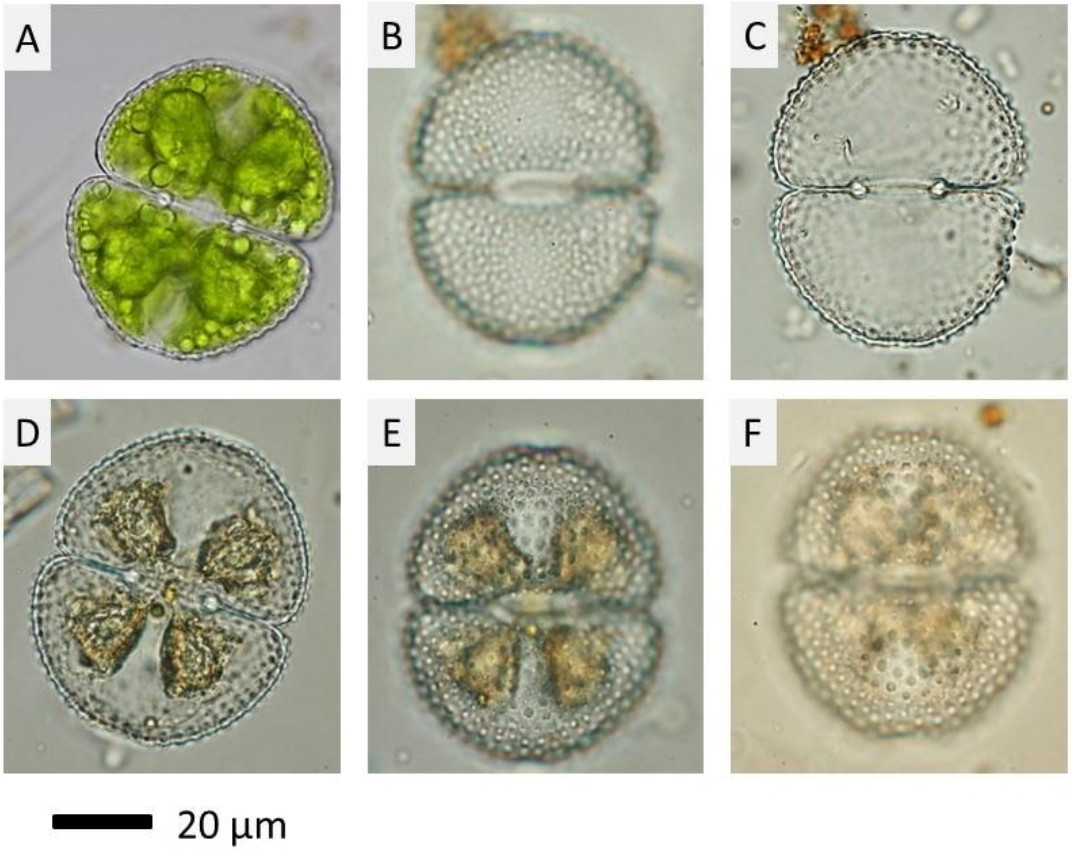

Fig. 8. Photographs of *Cosmarium botrytis* var. *botrytis* Meneghini ex Ralfs 1848 (A, B, C). Photographs of *Cosmarium botrytis* var. *tumidum* Wolle 1884 (D, E, F).

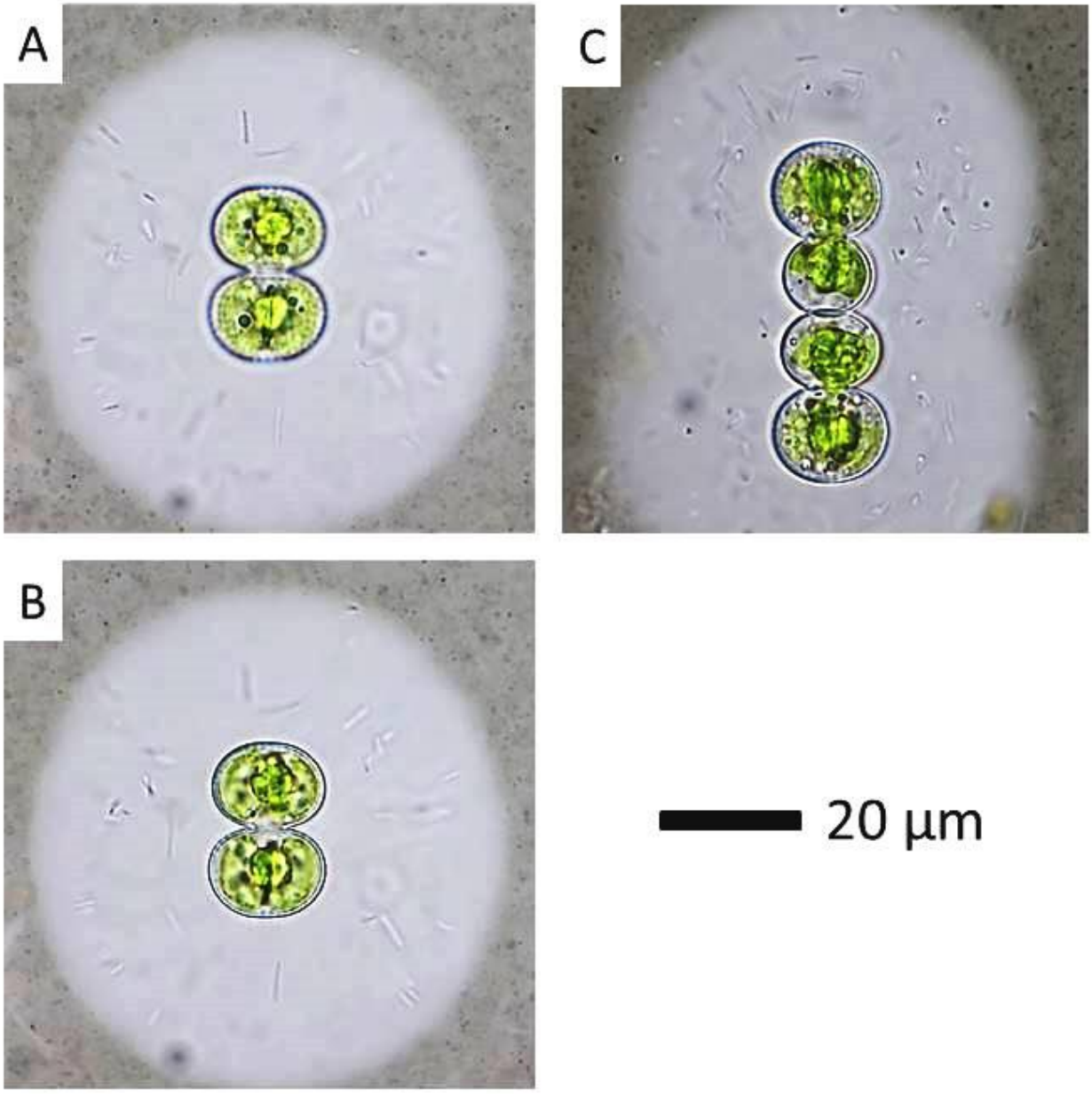

Fig. 9. Photographs of *Cosmarium contractum* Kirchner 1878.

Cell dimensions A (C): length – 25.05 (24.27) µm,
breadth – 16.86 (16.66) µm,
isthmus – 4.37 (4.50) µm

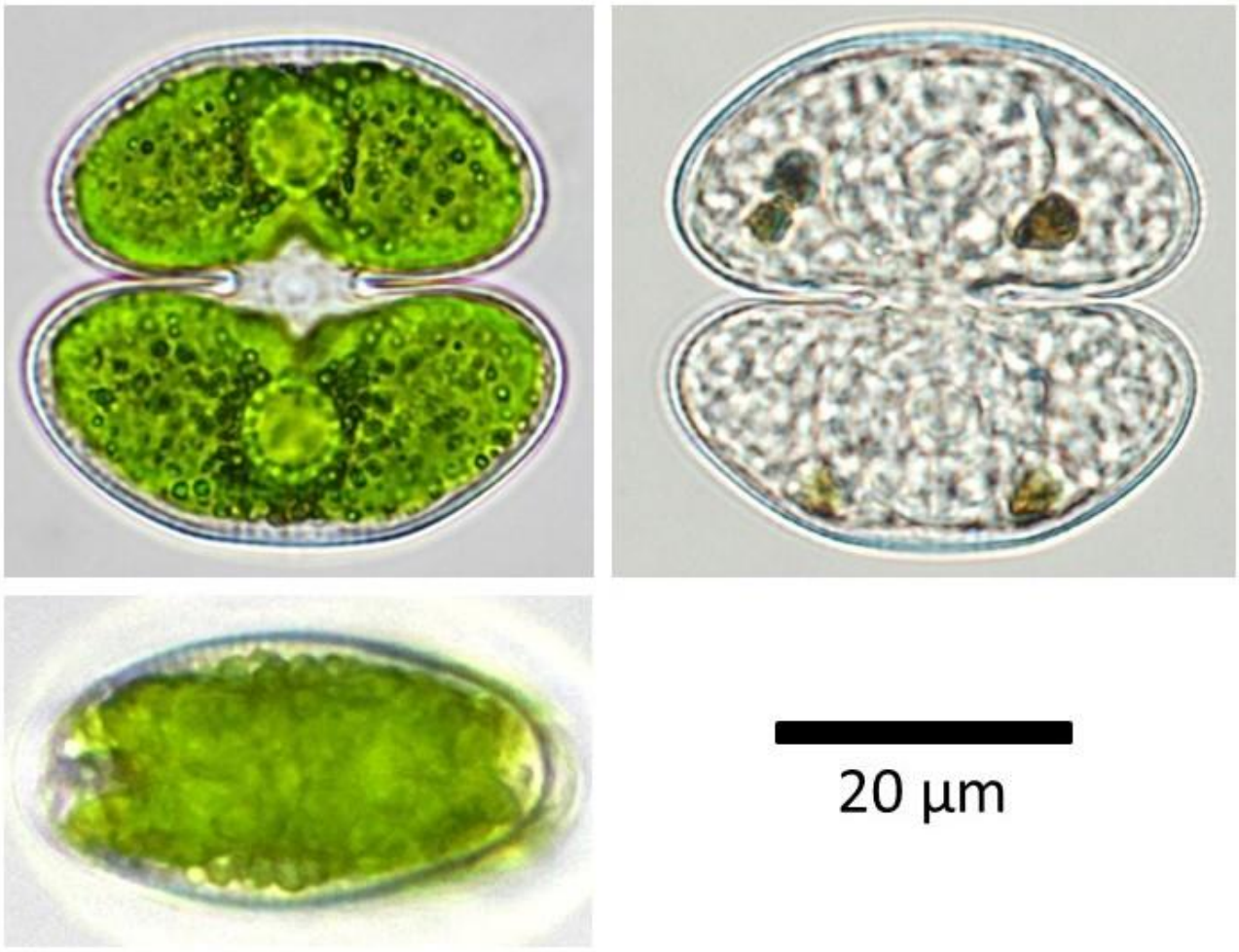

Fig. 10. Photographs of *Cosmarium neodepressum* G.J.P. Ramos & C.W.N. Moura 2020 (synonym: *Cosmarium depressum* (Nägeli) P. Lundell 1871).

Cell dimensions: length – 34.65 µm,
breadth – 36.93 µm,
isthmus – 9.70 µm,
thickness – 18.80 µm

Fig. 11. Photographs of *Cosmarium difficile* Lütkemüller 1892.

Cell dimensions A (D): length – 33.33 (32.89) µm,
breadth – 26.67 (21.85) µm,
isthmus – 5.33 (5.85) µm,
thickness (B) – 19.44 µm

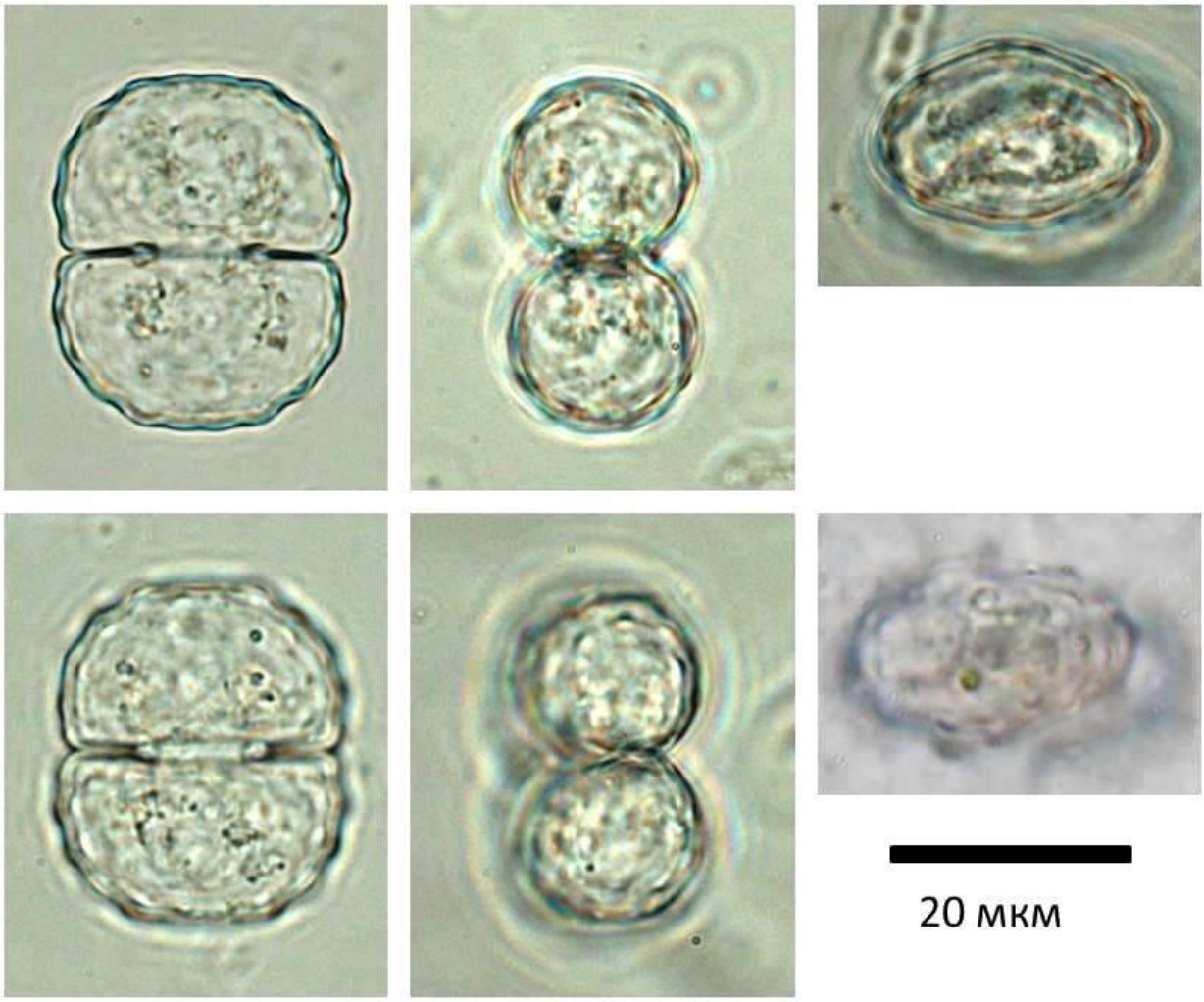

Figure 12. Photographs of *Cosmarium gibberulum* Lütkemüller 1910.

Cell dimensions: length – 29.95 μm,
breadth – 24.80 μm,
isthmus – 9.10 μm,
thickness – 16.53 μm

Fig. 13. Photographs of *Cosmarium hornavanense* Gutwinski 1909.

Cell dimensions: length – 77.60 µm,
breadth – 59.06 µm,
isthmus – 18.71 µm

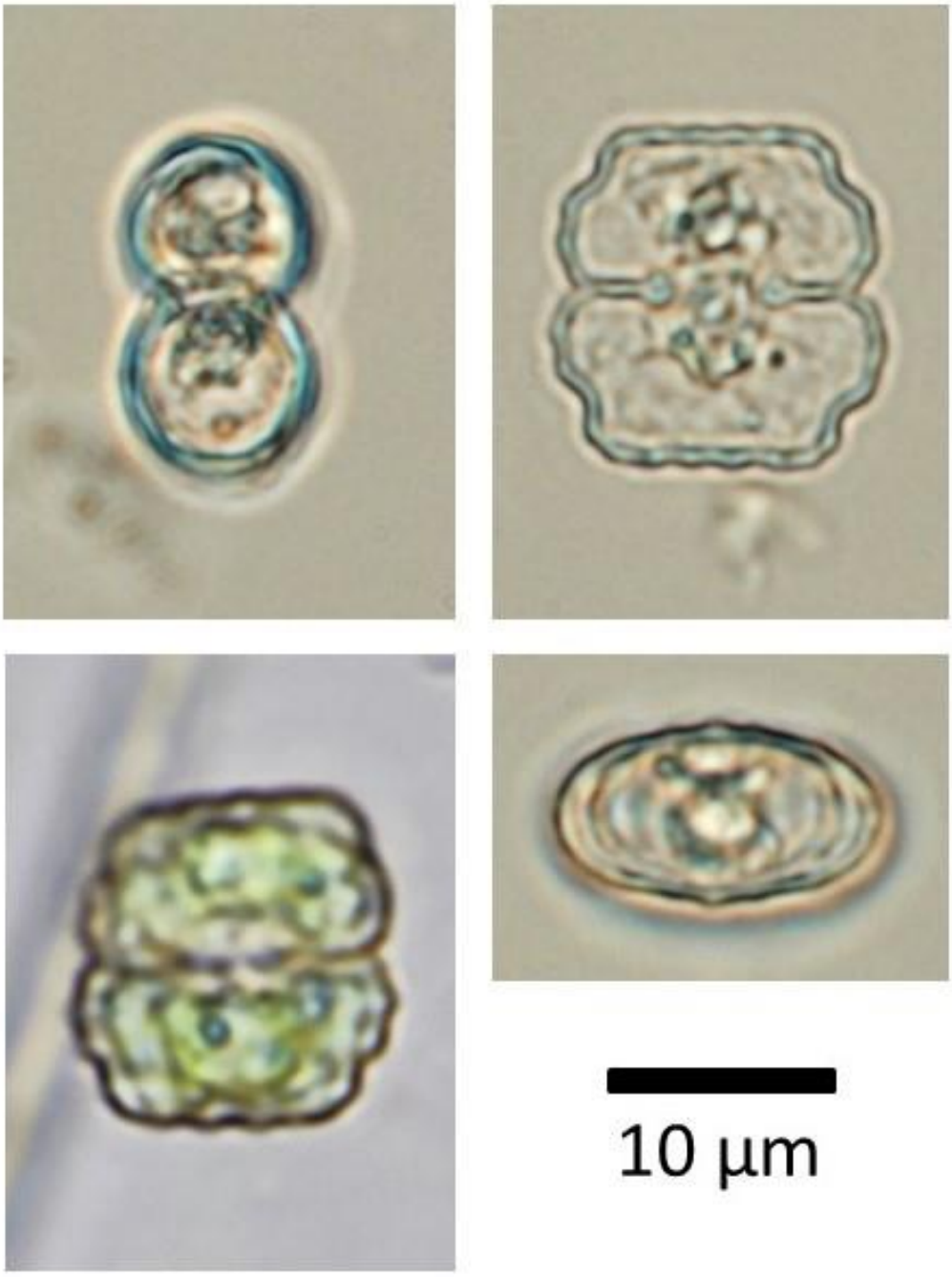

Fig. 14. Photographs of *Cosmarium humile* Nordstedt ex De Toni 1889.

Cell dimensions: length – 15.37 µm,
breadth – 14.07 µm,
isthmus – 3.80 µm

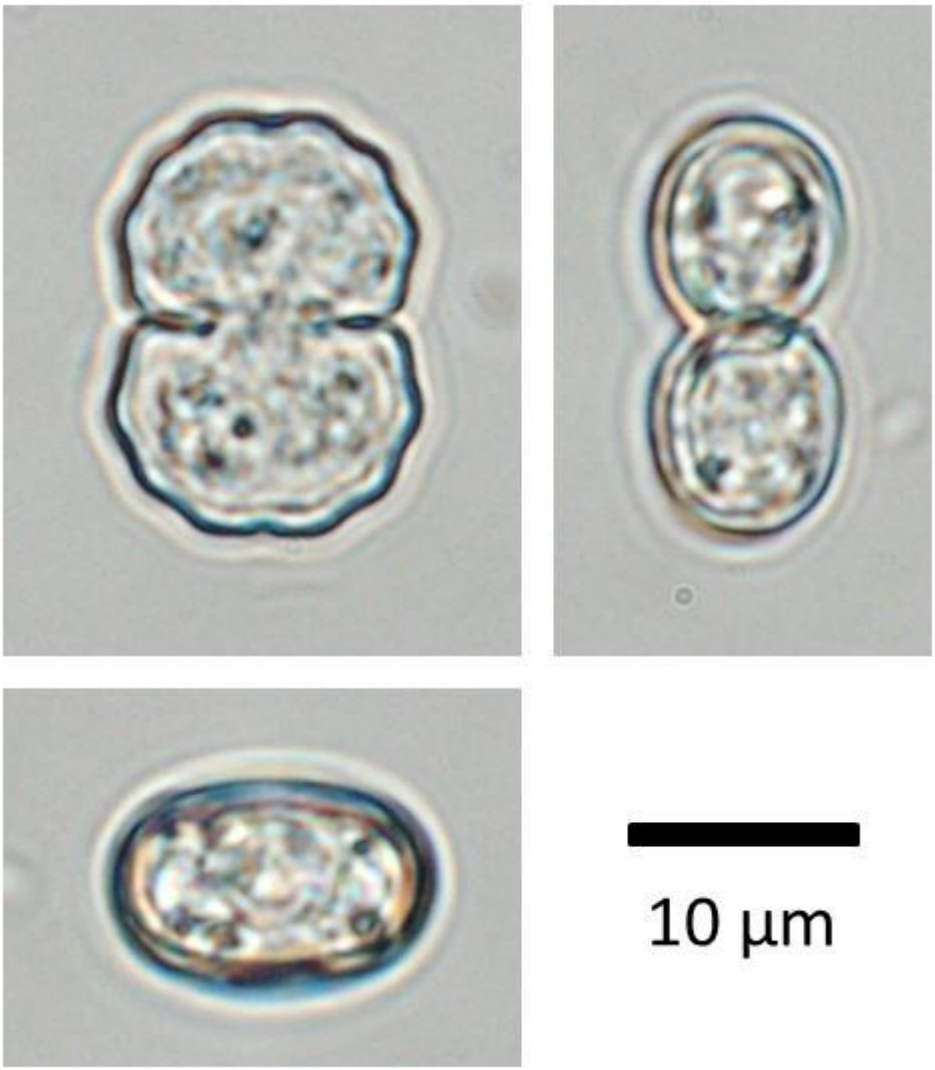

Fig. 15. Photographs of *Cosmarium impressulum* Elfving 1881.

Cell dimensions: length – 18.74 µm,
breadth – 13.82 µm,
isthmus – 4.93 µm

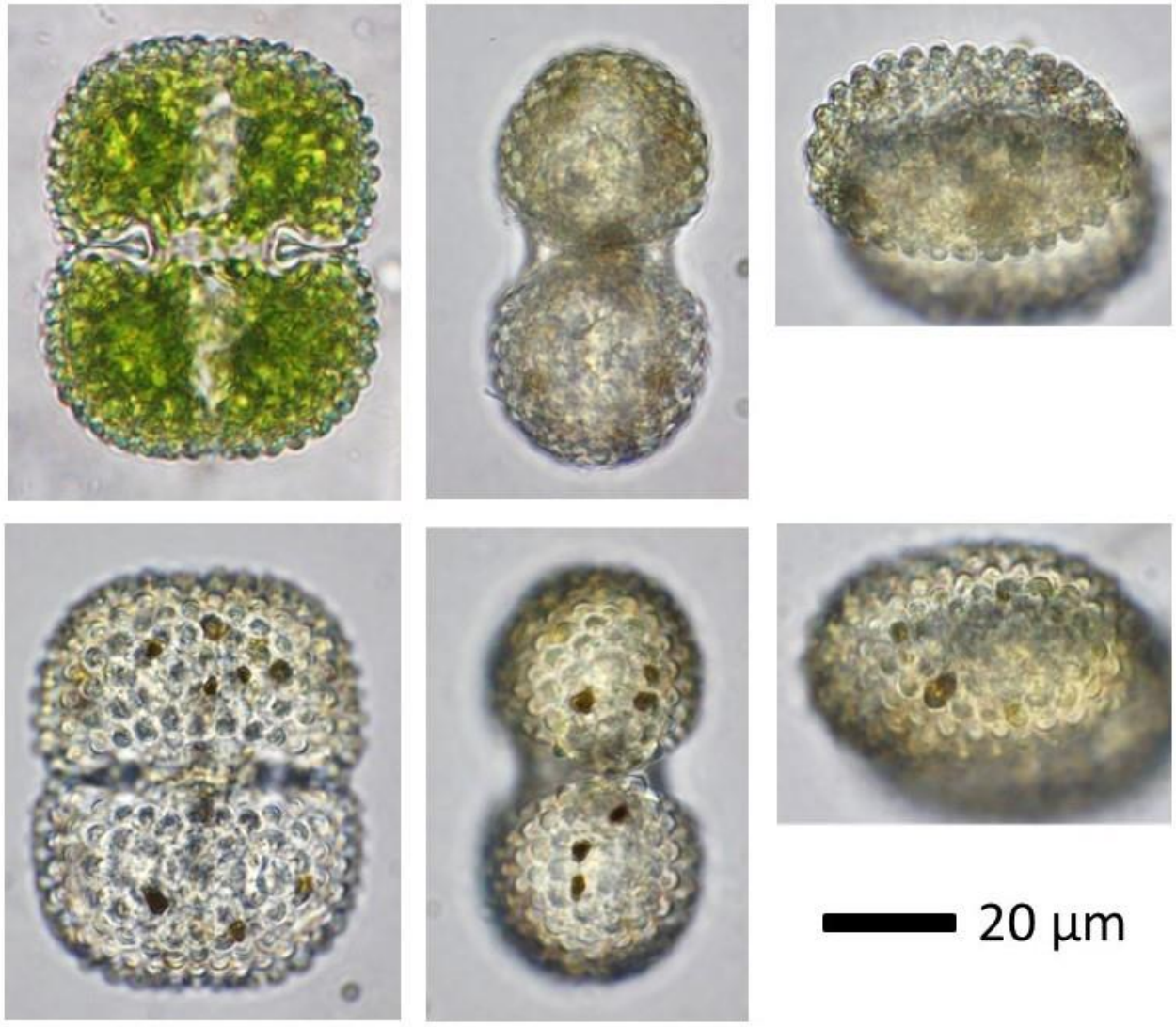

Fig. 16. Photographs of *Cosmarium margaritatum* (P. Lundell) J. Roy & Bisset 1886.

Cell dimensions: length – 65.22 µm,
breadth – 51.72 µm,
isthmus – 18.69 µm,
thickness – 34.93 µm

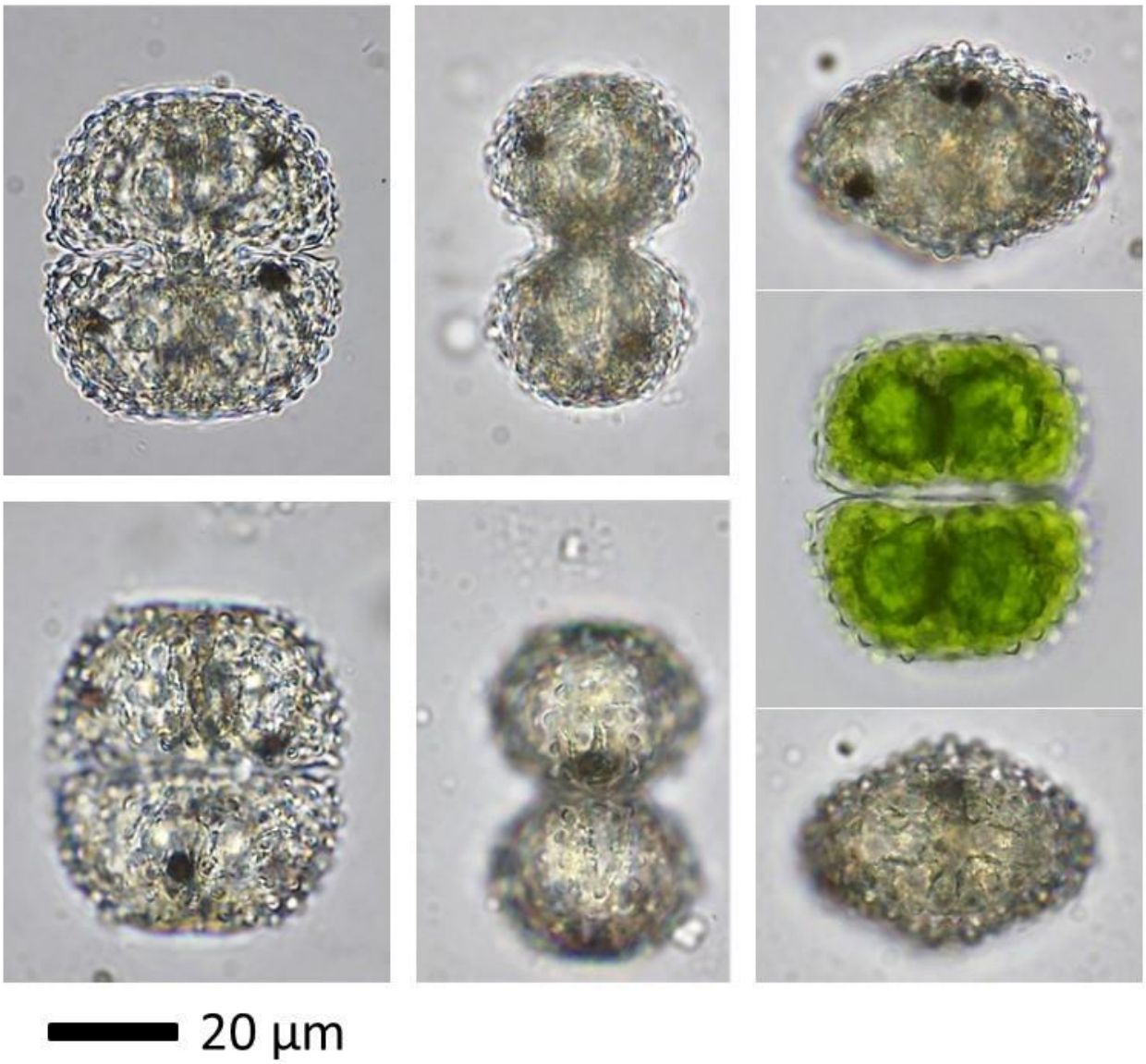

Fig. 17. Photographs of *Cosmarium margaritiferum* Meneghini ex Ralfs 1848.

Cell dimensions: length – 52.35 µm,
breadth – 47.30 µm,
isthmus – 14.90 µm,
thickness – 34.04 µm

Fig. 18. Photographs of *Cosmarium moniliforme* Ralfs 1848.

Cell dimensions: length – 25.32 µm,
breadth – 15.56 µm,
isthmus – 10.37 µm

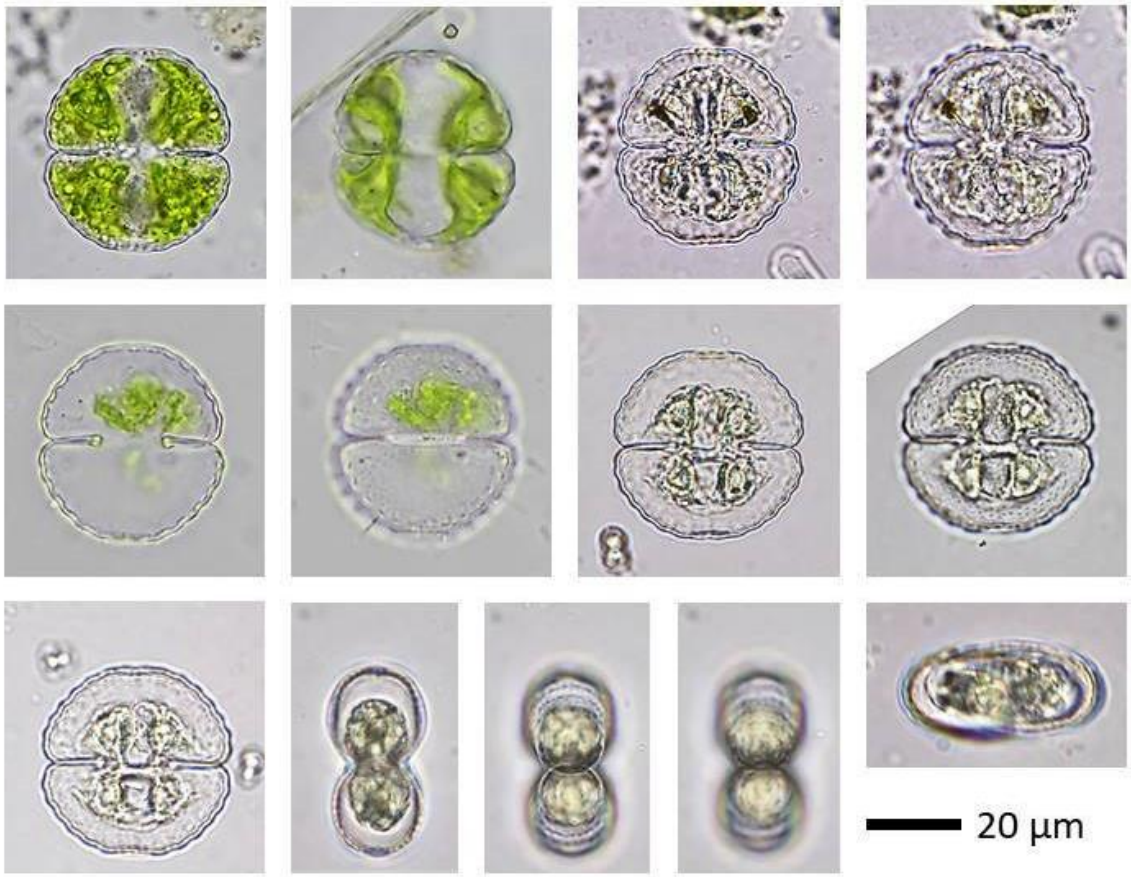

Fig. 19. Photographs of *Cosmarium obtusatum* (Schmidle) Schmidle 1898.
Cell dimensions: length – 42.20 µm, breadth – 38.33 µm,
isthmus – 15.04 µm, thickness – 20.65 µm

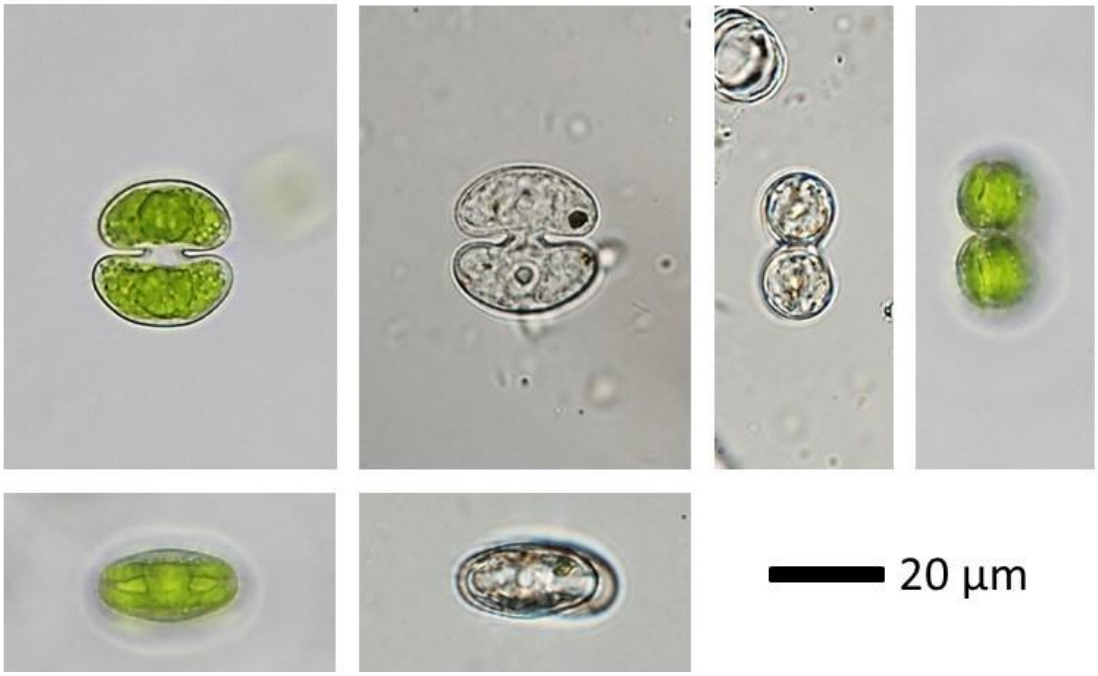

Fig. 20. Photographs of *Cosmarium phaseolus* var. *notatum* (Nordstedt) Coesel 1991 (synonym: *Cosmarium ocellatum* var. *notatum* (Nordstedt) Willi Krieger & Gerloff 1962).
Cell dimensions: length – 25.70 µm, breadth – 24.31 µm,
isthmus – 6.50 µm, thickness – 12.52 µm

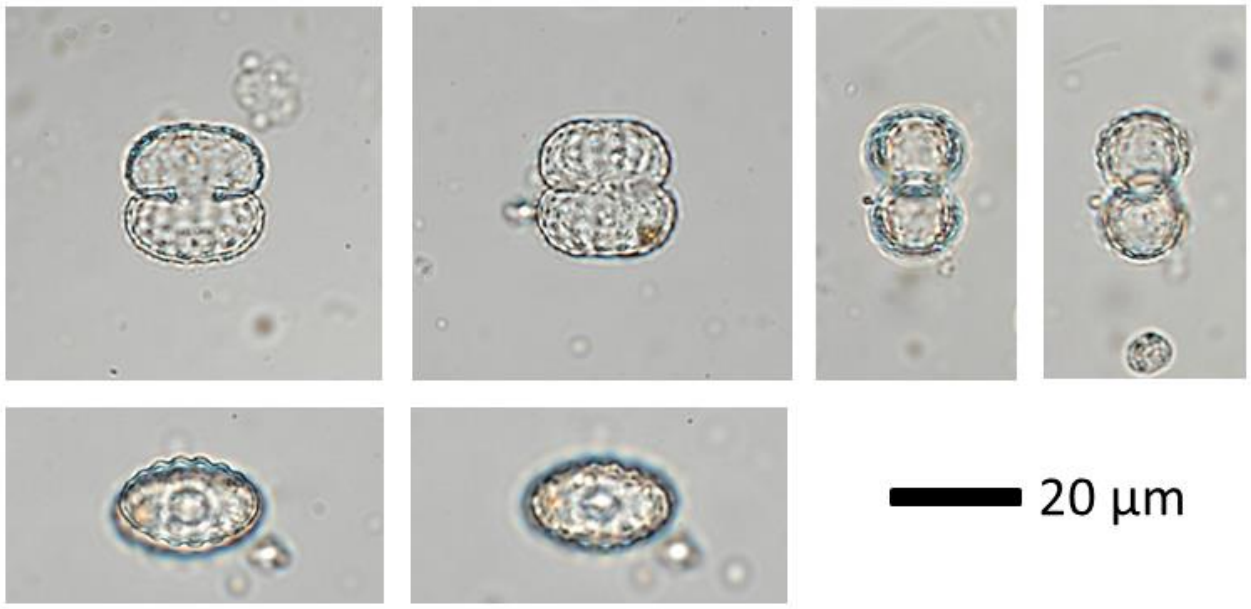

Fig. 21. Photographs of *Cosmarium ordinatum* (Børgesen) West & G.S.West 1896.

Cell dimensions: length – 22.07 µm, breadth – 21.19 µm,
isthmus – 7.63 µm, thickness – 13.78 µm

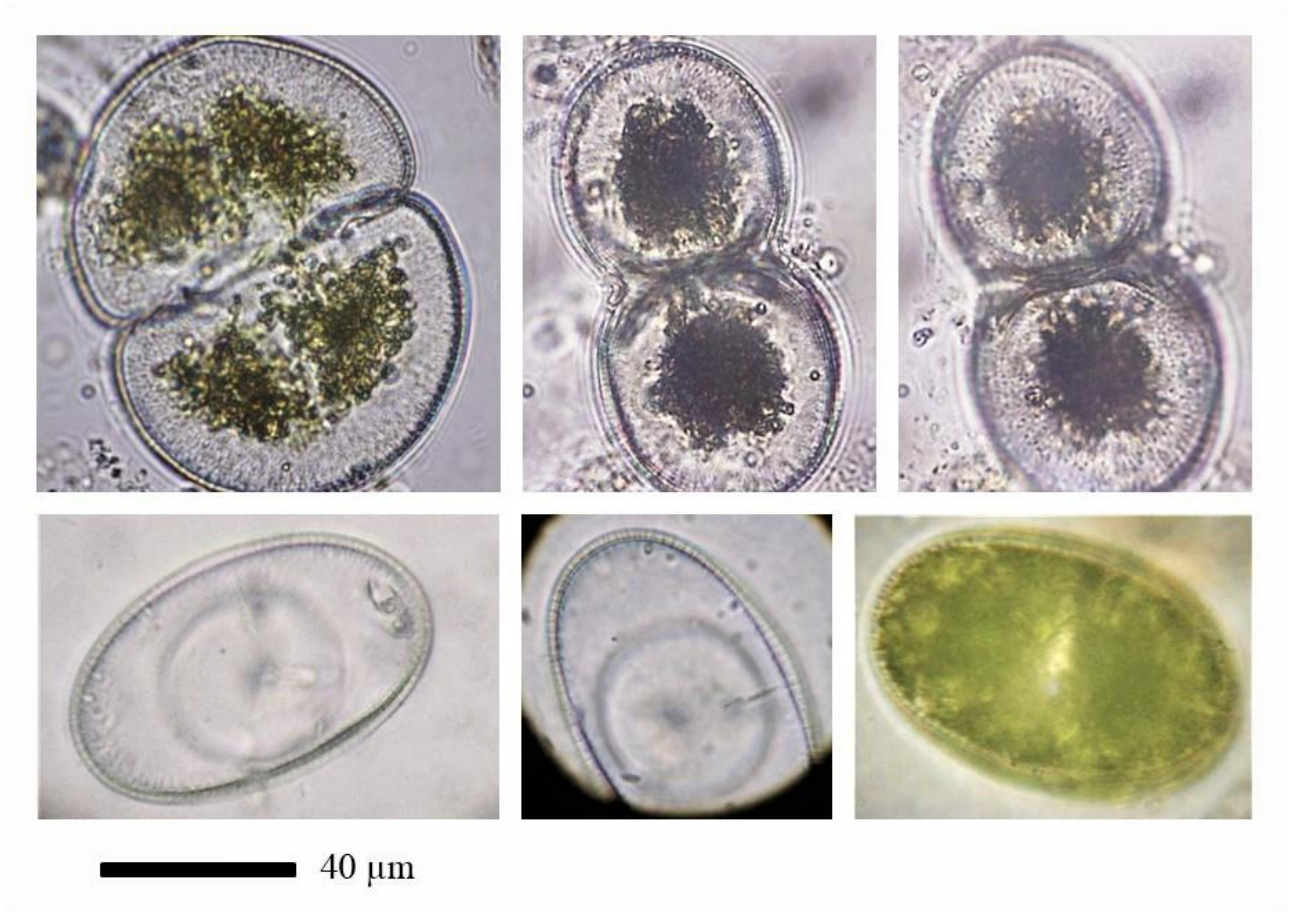

Fig. 22. Photographs of *Cosmarium pachydermum* P.Lundell 1871.

Cell dimensions: length – 95.39 µm, breadth – 74.94 µm,
isthmus – 34.07 µm, thickness – 53.17 µm

Fig. 23. Photographs of *Cosmarium pachydermum* P. Lundell 1871. Morphological variability of the cells

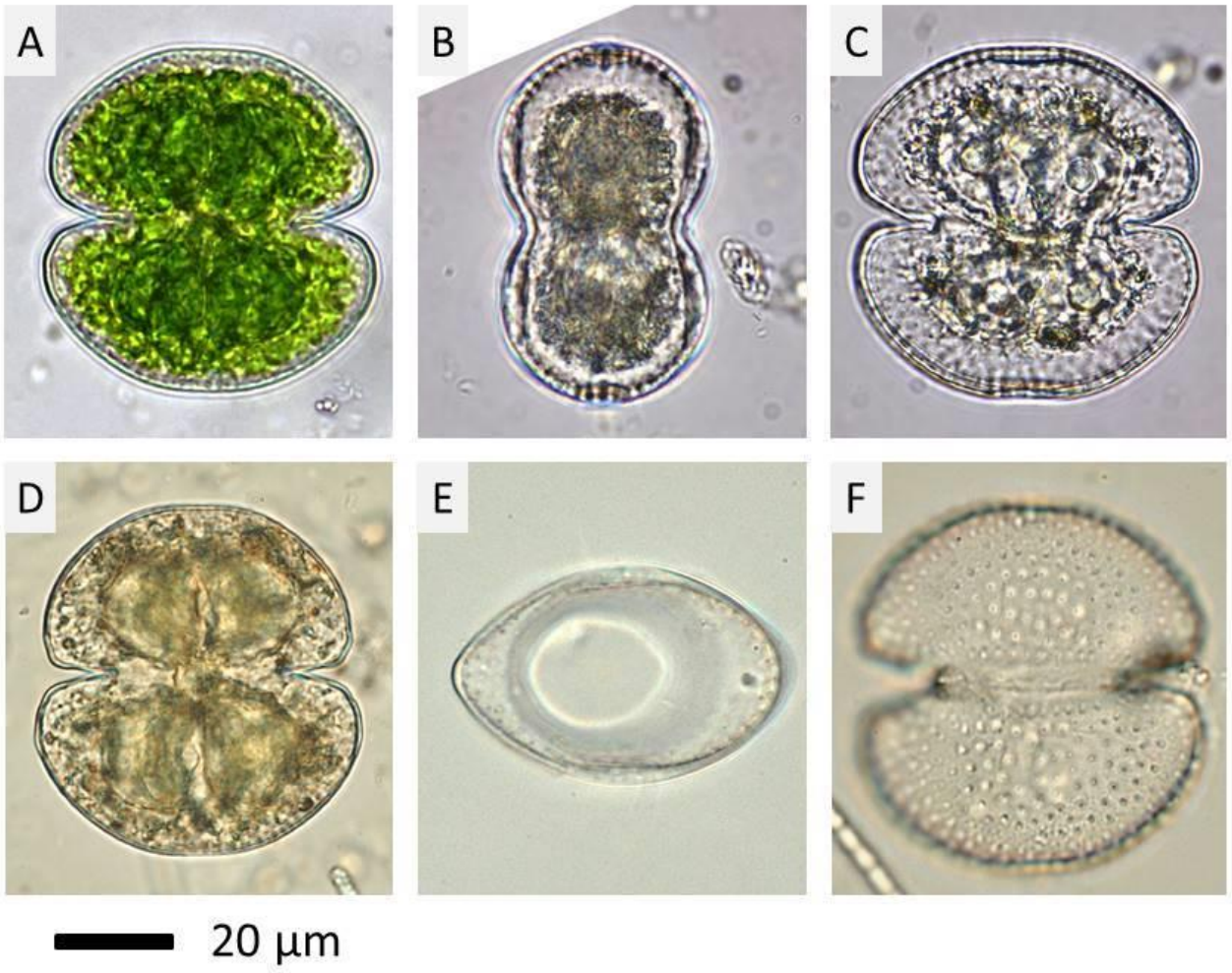

Fig. 24. Photographs of *Cosmarium perforatum* P. Lundell 1871.

Cell dimensions A (C): length – 58.19 (59.82) µm,
breadth – 55.97 (58.58) µm,
isthmus – 29.47 (32.92) µm

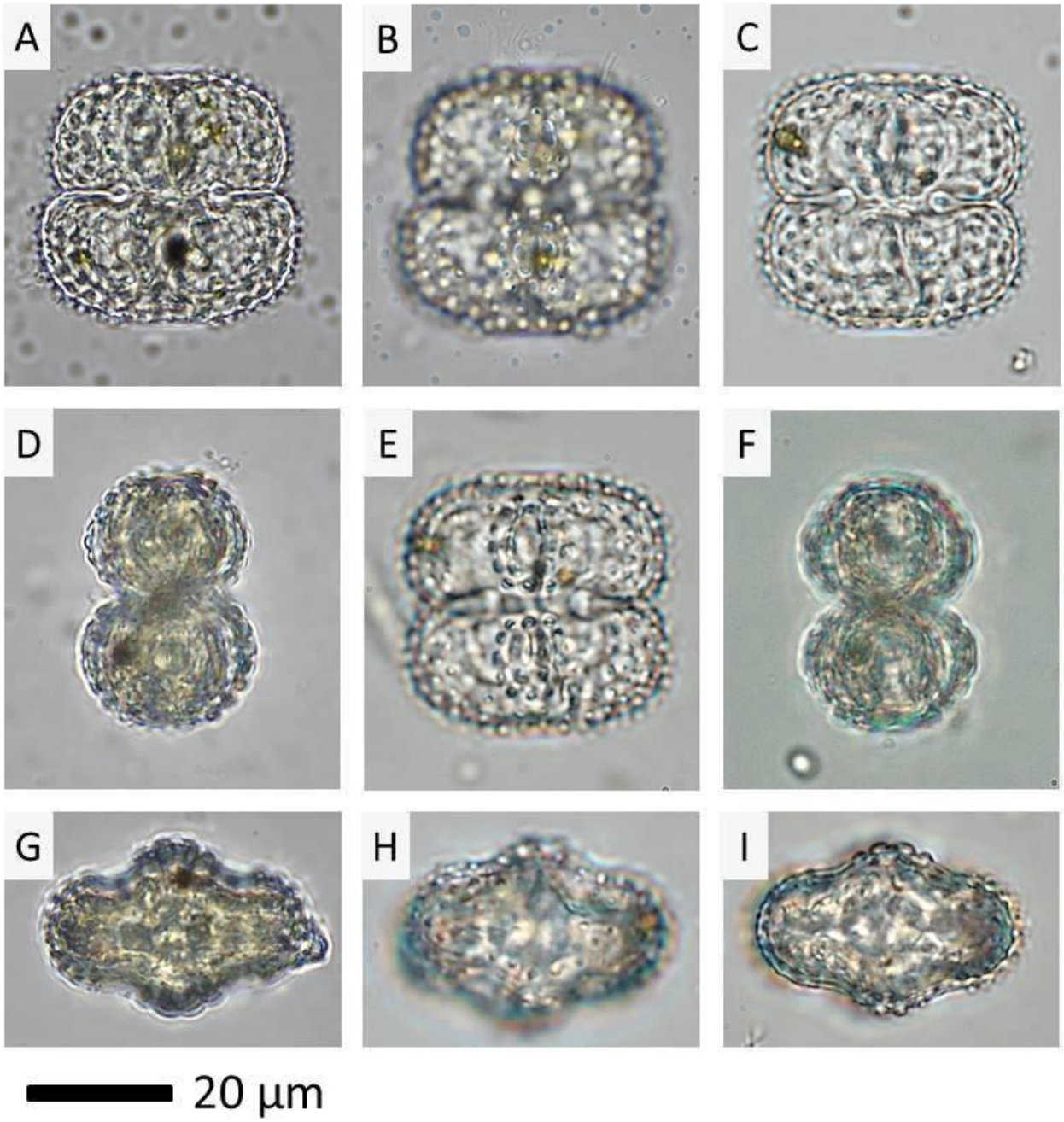

Fig. 25. Photographs of *Cosmarium pseudoornatum* B. Eichler & Gutwinski 1894.

Cell dimensions (A, B, D, G): length – 36.13 µm,
breadth – 37.11 µm,
isthmus – 13.13 µm

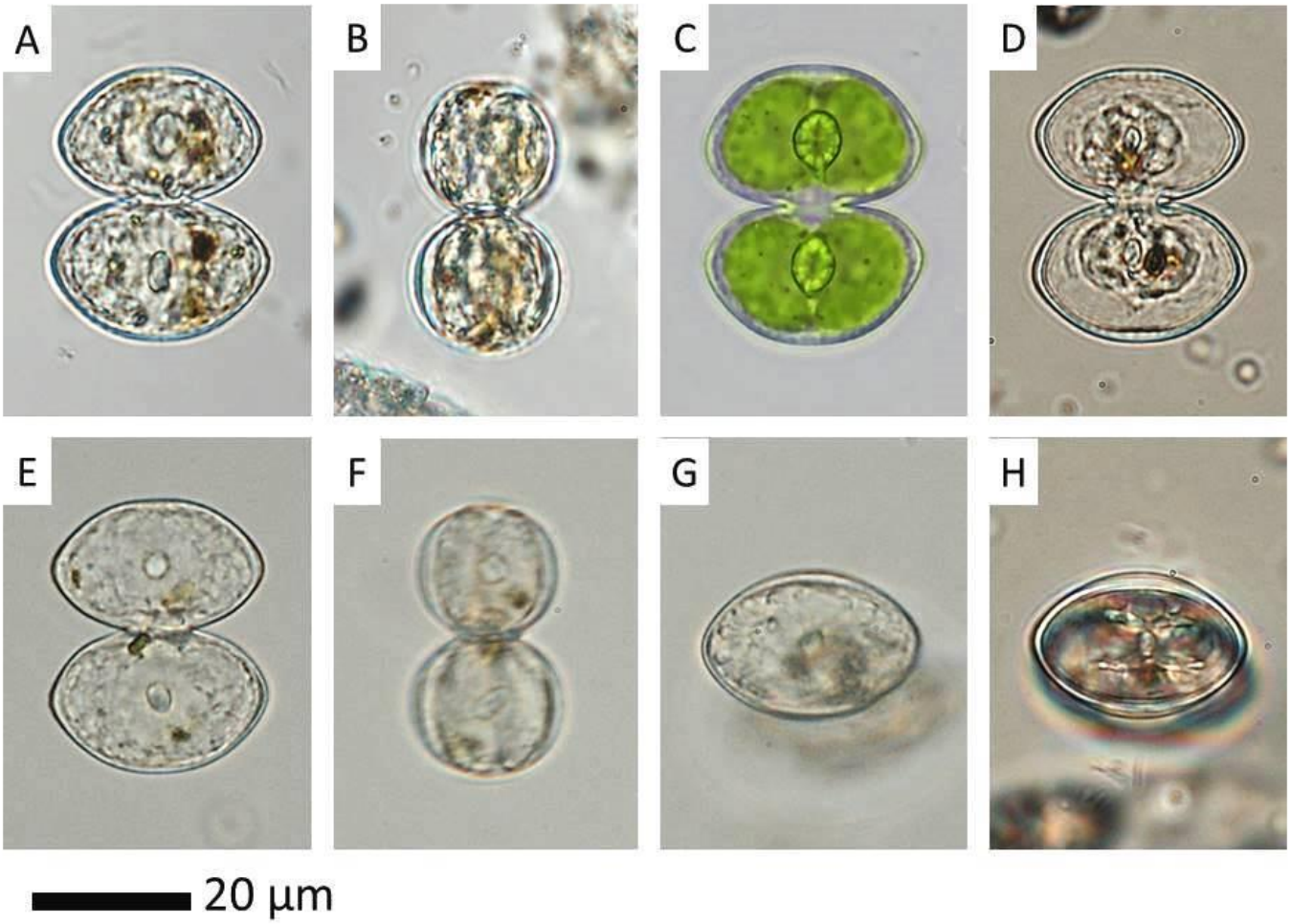

Fig. 26. Photographs of *Cosmarium pseudoprotuberans* var. *pseudoprotuberans* Kirchner 1878.

Cell dimensions C: length – 36.02 µm,
breadth – 28.18 µm,
isthmus – 7.94 µm

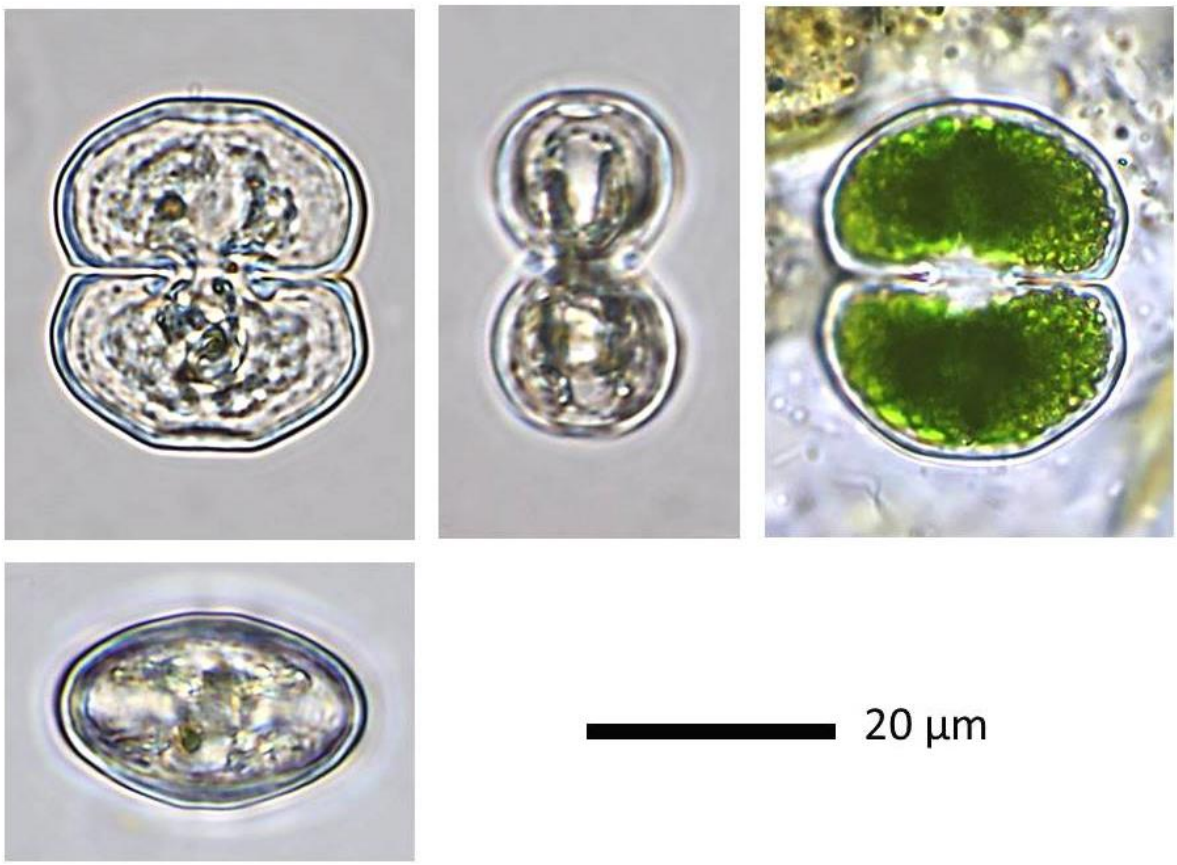

Fig. 27. Photographs of *Cosmarium pseudoprotuberans* var. *saxonicum* (Raciborski) Krieger & Gerloff 1965 (synonym: *Cosmarium elfvingii* var. *saxonicum* Raciborski 1889).

Cell dimensions: length – 29.11 µm, breadth – 25.41 µm, isthmus – 7.67 µm, thickness – 16.40 µm

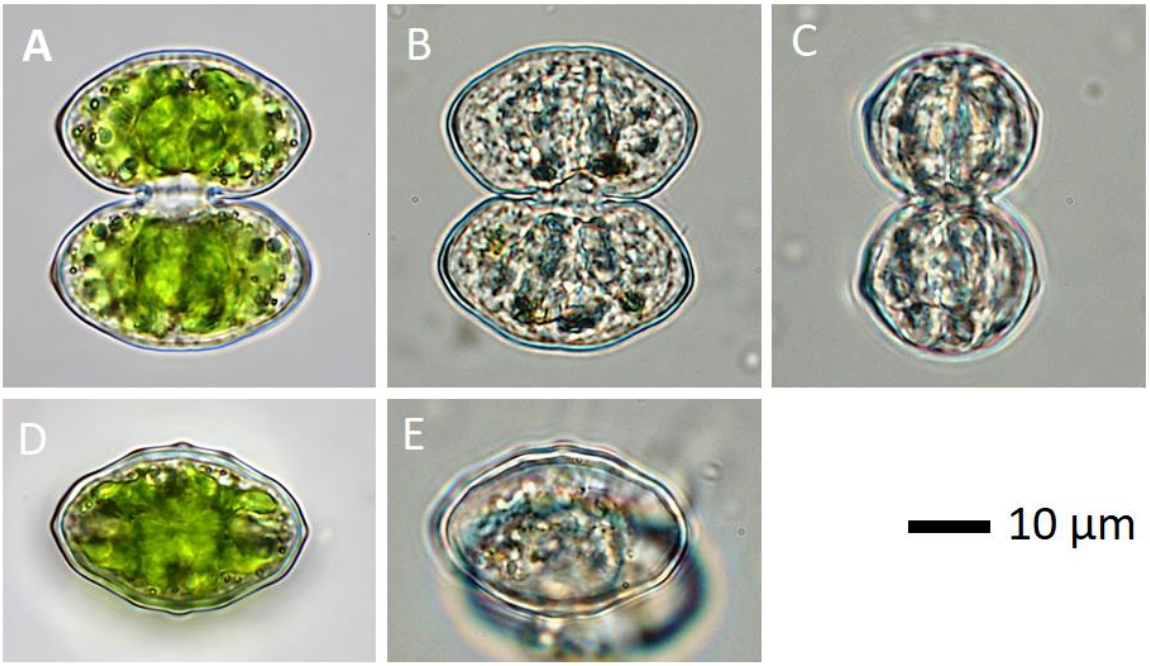

Fig. 28. Photographs of *Cosmarium pseudoprotuberans* var. *sulcatum* (Nordstedt) Coesel 1991.

Cell dimensions(A, D): length – 35.07 µm, breadth – 30.73 µm, isthmus – 9.43 µm, thickness – 20.53 µm

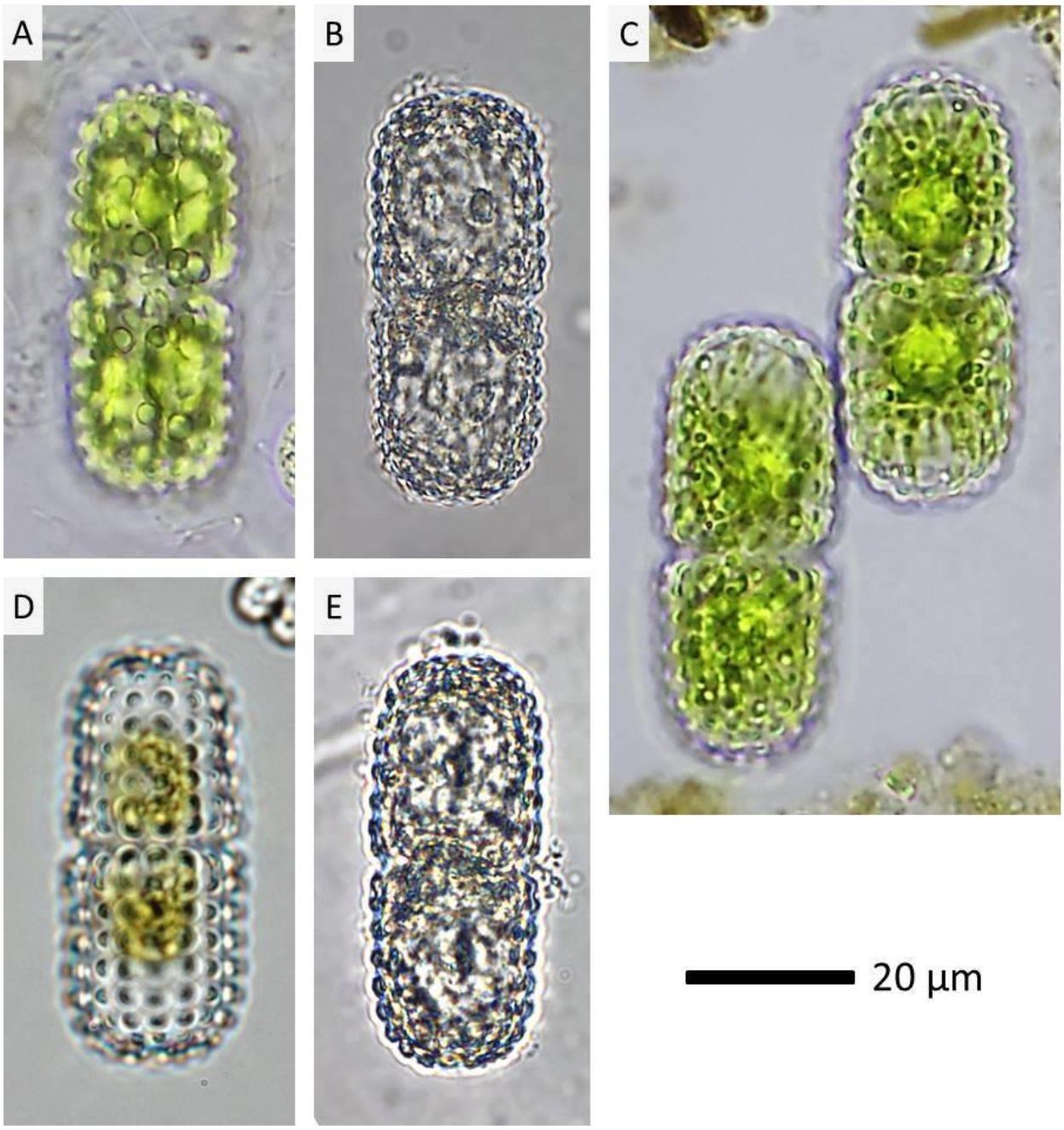

Fig. 29. Photographs of *Cosmarium simplicius* (W. & G.S. West) Grönblad 1931.

Cell dimensions A (C): length – 48.78 (48.88) µm,
breadth – 20.79 (20.42) µm,
isthmus – 16.26 (16.82) µm.

Front view with 2 pyrenoids (A, B), side view with visible one pyrenoid (C, E)

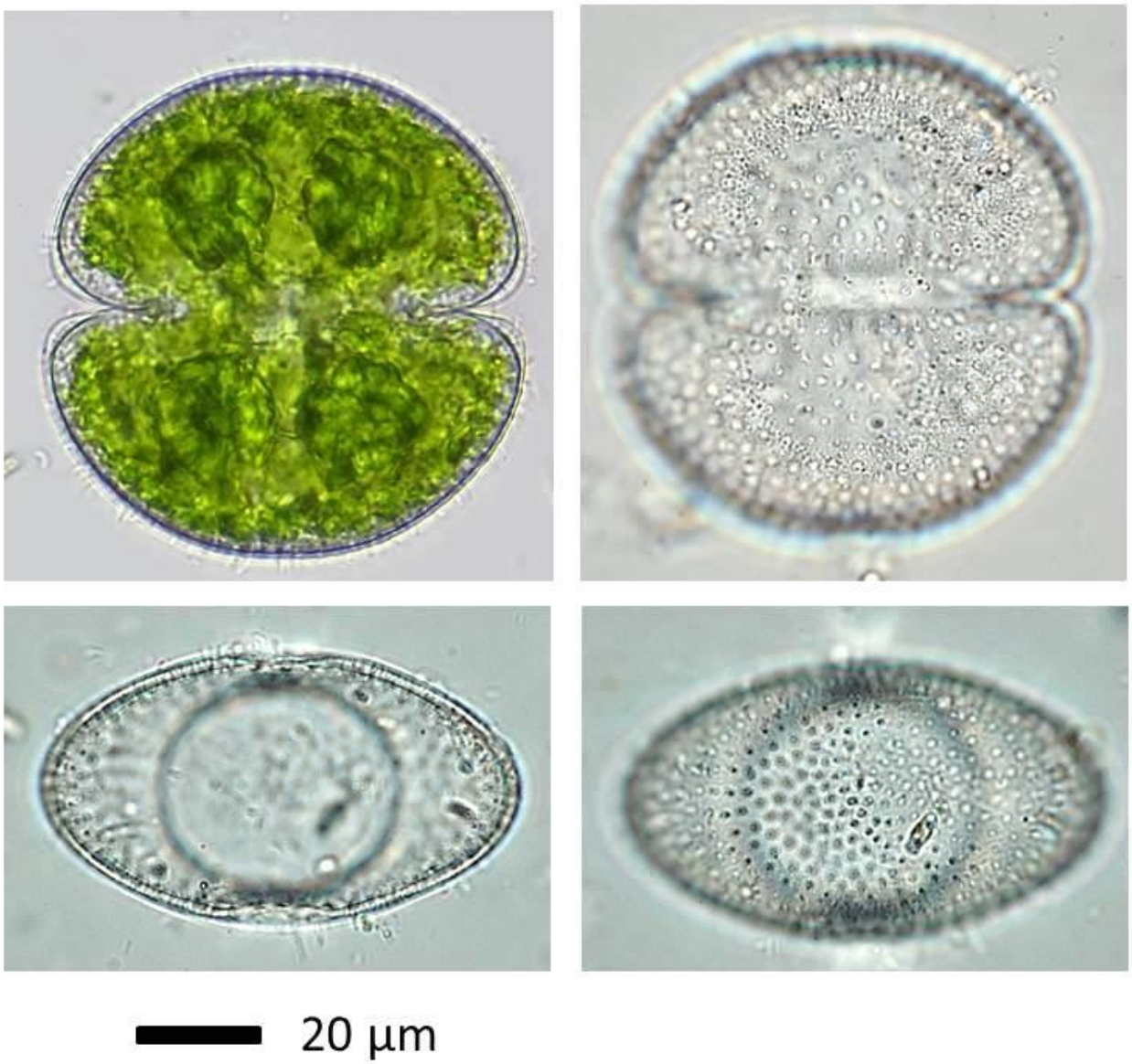

Fig. 30. Photographs of *Cosmarium tutum* Shyndanovina 2020.

Cell dimensions: length – 58.19 µm,
breadth – 55.97 µm,
isthmus – 29.47 µm,
thickness – 36.38 µm

Fig. 31. Photographs of *Pleurotaenium trabecula* var. *trabecula* Nägeli 1849.

Cell dimensions A (B): length – 462.18 (383.98) µm,
breadth – 33.73 (27.80) µm,
L/Br – 13.7 (13.8)

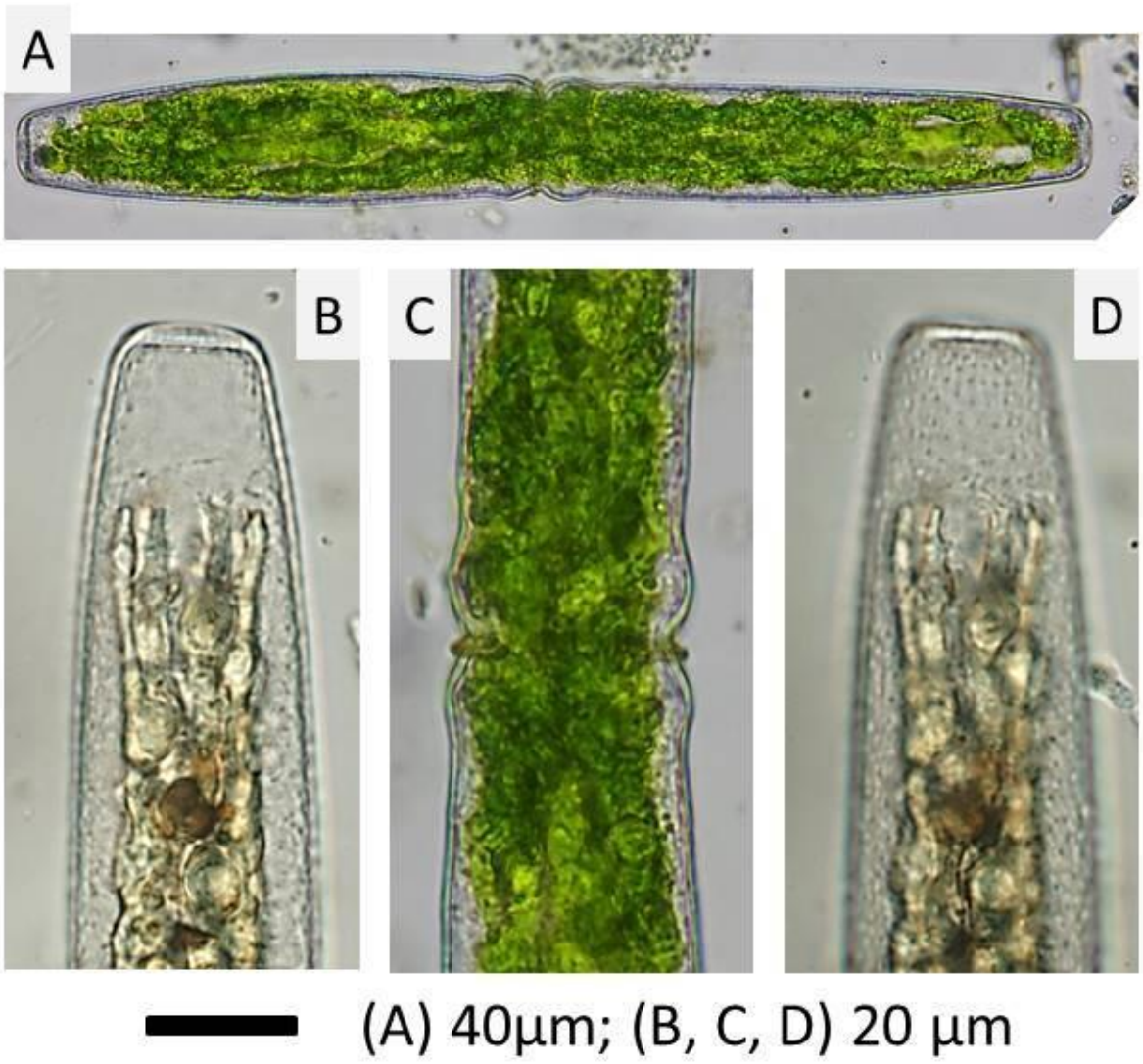

Fig. 32. Photographs of *Pleurotaenium trabecula* var. *crassum* Wittrock 1872.

Cell dimensions A: length – 285.46 µm,
breadth – 34.26 µm,
L/Br – 8,3.

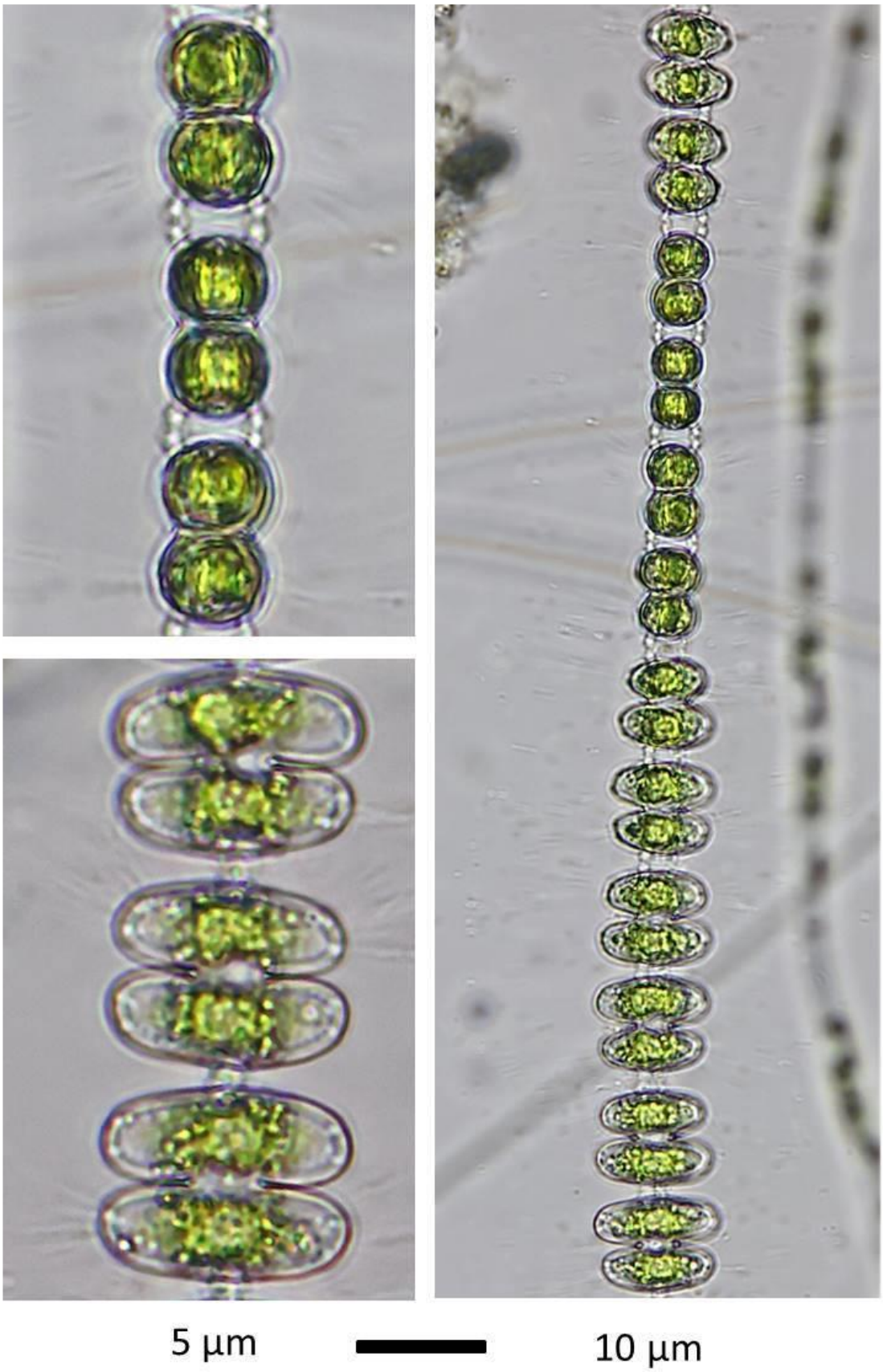

Fig. 33. Photographs of *Sphaerozosma vertebratum* var. *latius* West & G.S. West 1897.

Cell dimensions: length (without processes) – 7.78 µm,
breadth – 9.83 µm, thickness – 4.13 µm

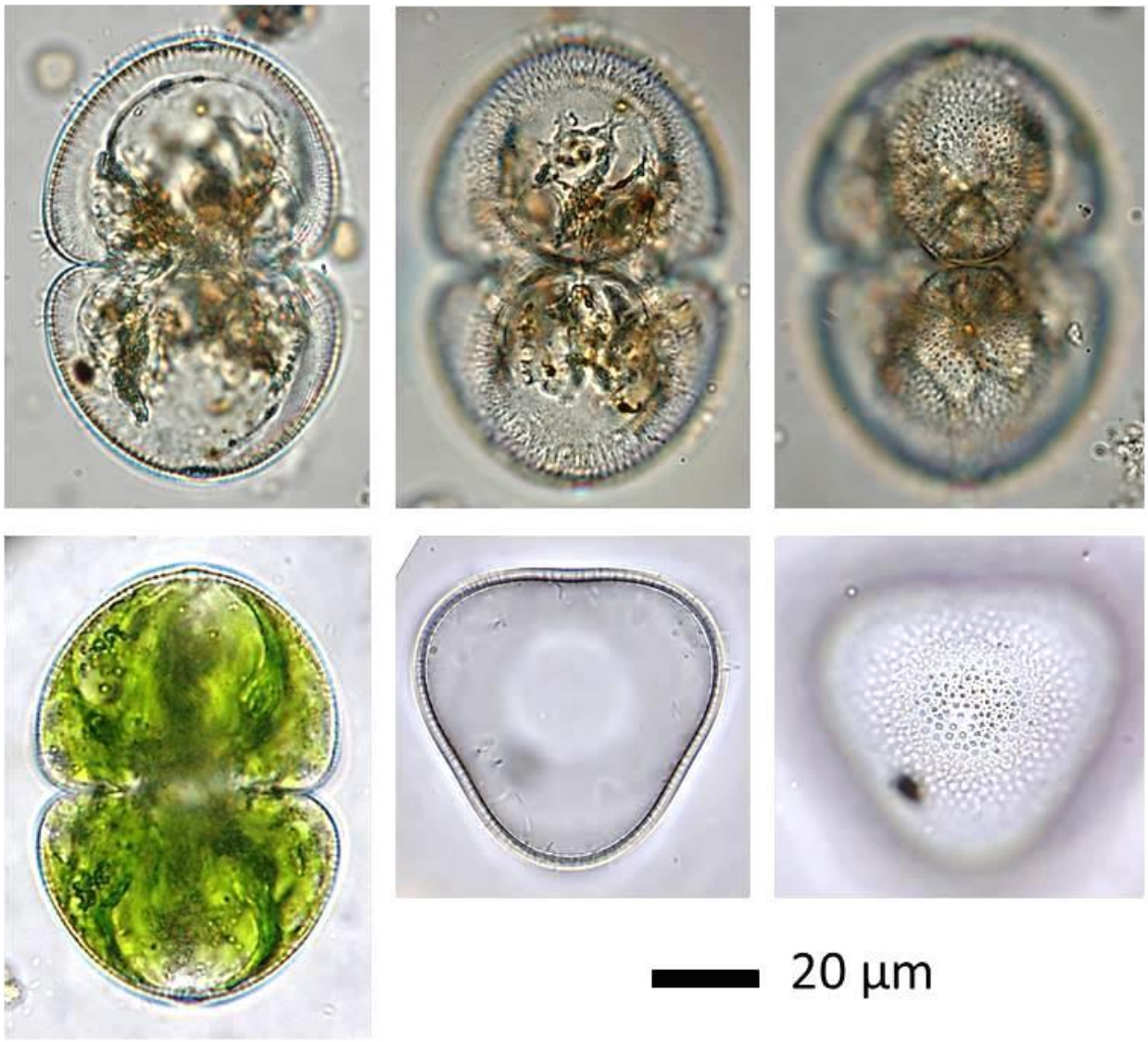

Fig. 34. Photographs of *Staurastrum cosmarioides* Nordstedt 1870.

Cell dimensions: length – 85.80 µm,
breadth – 57.46 µm,
isthmus – 23.69 µm,
thickness – 52.71 × 54.64 µm

Fig. 35. Photographs of *Gonatozygon aculeatum* Hastings 1892.

Cell dimensions A (B): length – 133.37 (76.21) μm,
breadth without spines and apexes – 7.55 (7.34) μm,
breadth with spines – 13.81 – 14.89 μm,
apex 1 – 8.42 (9.71) μm,
apex 2 – 8.63 (7.34) μm

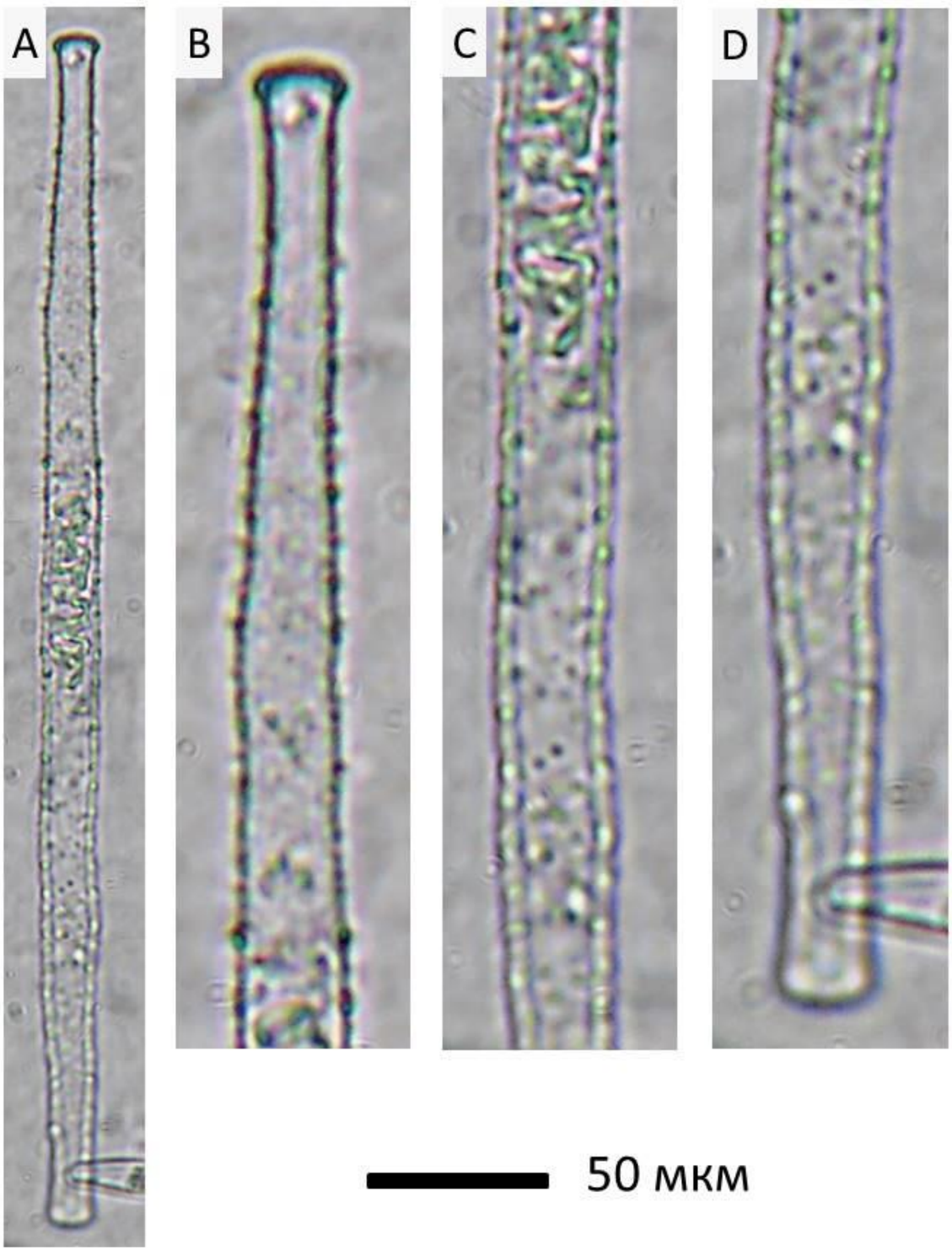

Fig. 36. Photographs of *Gonatozygon brebissonii* De Bary 1858.

Cell dimensions: length – 340.48 μm,
breadth in the middle – 17.36 μm,
apex 1 – 13.56 μm, apex 2 – 14.27 μm.
Scale for B, C, D ×2

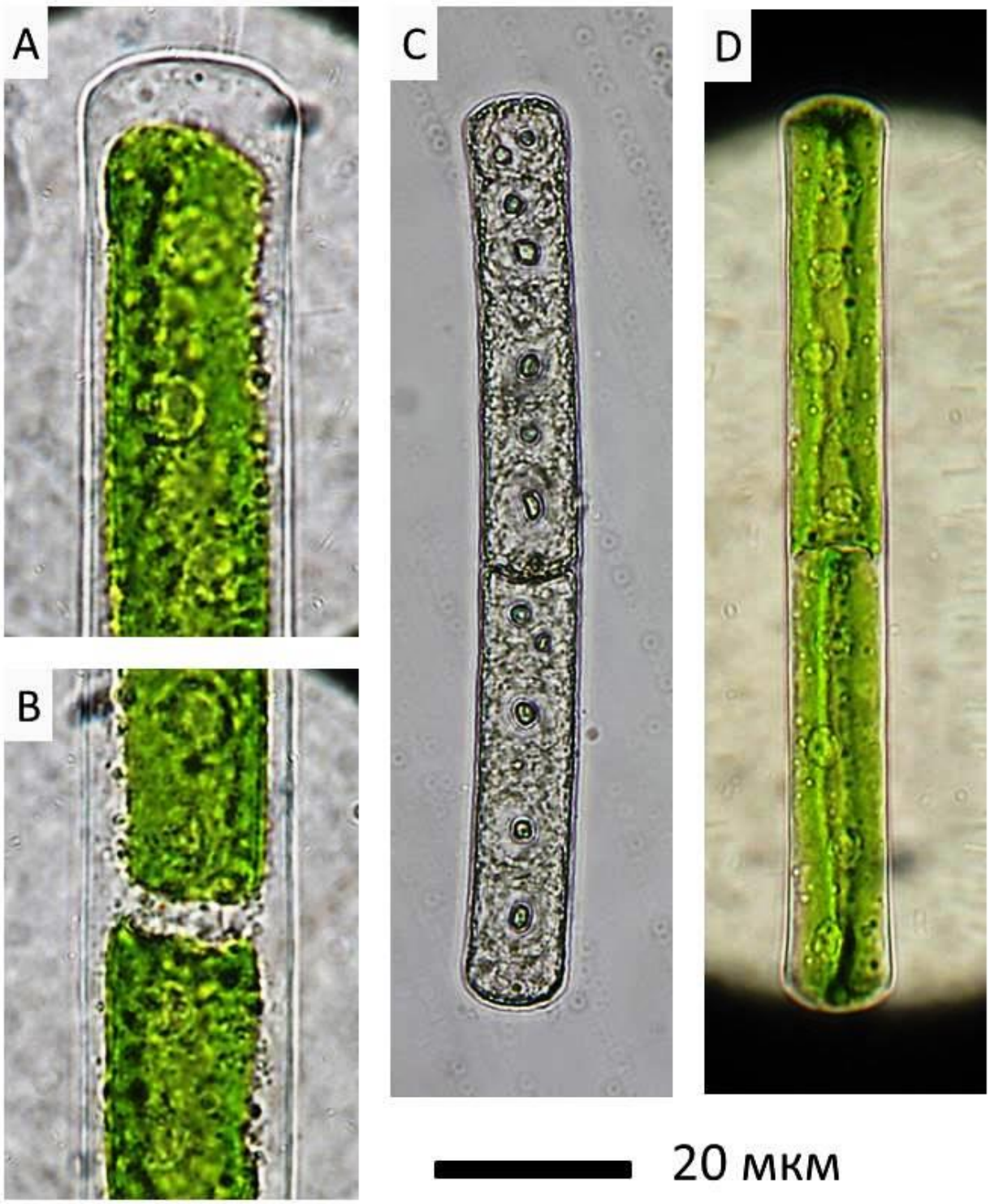

Fig. 37. Photographs of. *Gonatozygon kinahanii* (W.Archer) Rabenhorst 1868.

Cell dimensions: length – 340.48 μm,
breadth in the middle – 17.36 μm,
apex 1 – 13.56 μm,
apex 2 – 14.27 μm.
Scale for B, C, D ×2

Fig. 38. Photographs of *Gonatozygon monotaenium var. pilosellum* Wittrock & Nordstedt 1886.

Cell dimensions B: length – 86.87 μm,
breadth without spines and apices – 9.42 μm,
breadth with spines – 11.47 μm,
apex 1 – 10.79 μm, apex 2 – 10.28 μm

Conclusions

16 new taxa of desmids from Zavodske pond added to the Ukrainian desmidioflora, i.e.: *Actinotaenium americanum* (West & G.S. West) Coesel & Meesters 2023, *Actinotaenium perminutum* (G.S.West) Teiling 1954, *Cosmarium alpestre* J. Roy & Bisset 1893, *Cosmarium gibberulum* Lütkemüller 1910, *Cosmarium phaseolus* var. *notatum* (Nordstedt) Coesel 1991, *Cosmarium ordinatum* (Børgesen) West & G.S. West 1896, *Cosmarium pseudoornatum* B. Eichler & Gutwinski 1894, *Cosmarium pseudoprotuberans* var. *saxonicum* (Raciborski) Krieger & Gerloff 1965, *Cosmarium simplicius* (W. & G.S.West) Grönblad 1931, *Pleurotaenium trabecula* var. *crassum* Wittrock 1872, *Sphaerozosma vertebratum* var. *latius* West & G.S.West 1897, *Staurastrum cosmarioides* Nordstedt 1870, as well as previously published: *Cosmarium tutum* Shyndanovina 2020 (see Shyndanovina, 2020), and *Cosmarium pseudoprotuberans* var. *sulcatum* (Nordstedt) Coesel 1991, *Pleurotaenium simplicissimum* Grönblad 1920, *Gonatozygon aculeatum* Hastings 1892 (see Shyndanovina & Lukash, 2023).

All newly recorded and some other interesting taxa are illustrated with microphotographs. This publication includes 36 figures with illustrations of 37 taxa. The illustrations of the Ukrainian material of desmids are scares, and this publication presents the microphotographs of the Ukrainian populations taken for the first time. This data creates important basis for the morphological comparison and better species delineation in a very variable desmids with their sometimes confusing taxonomy.

Zavodske pond is a water body with extremely rich desmid diversity. A big part of Zavodske desmidiaflora consists of the new for Ukraine, rare and very rare taxa (see Shyndanovina & Lukash, 2023). Therefore, such hotspot of desmids diversity deserves close attention, protection and conservation of this habitat as part of the Ukrainian Polesie ecosystem.

The basics of the science of algae protection (algosozology) in Ukraine were developed by Doctor of Biological Sciences N.V. Kondratyeva (Kondratyeva & Tsarenko, 2008). She emphasized the need to accumulate primary information about the rare species for the purpose of creating algological reserves and conducting monitoring studies within them, as well as creating appropriate search and information systems that include previously accumulated and new information (Kondratyeva & Tsarenko, 2008).

I am planning to prepare the scientific substantiation for protection of Zavodske pond as valuable locality of desmid algae i.e. creation of a hydrological protected object «Algological reserve Desmidian Wealth».

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Заява про доступність даних / Data Availability Statement

Набір даних доступний за запитом до авторів / Dataset available on request from the authors.

Заява інституційної ревізійної ради / Institutional Review Board Statement

Не застосовується / Not applicable.

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Не застосовується / Not applicable.

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