Plant and Fungal Systematics 68(1): 1–206, 2023
DOI: https://doi.org/10.35535/pfsyst-2023-0001

ISSN 2544-7459 (print)
ISSN 2657-5000 (online)

Desmids of Gorce Mts. Geobotanical studies

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Article info

Received: 8 May 2023
Revision received: 26 June 2023
Accepted: 14 July 2023
Published: 31 July 2023

Associate Editor

Konrad Wołowski,
Magdalena Solarska

Abstract. The presented work is the first comprehensive study on the desmids of mountainous areas of the Gorce region in Poland. The Gorce Mts flora of the order *Desmidiales* comprises 20 genera and 247 species. The most diverse genera in the Gorce Mts are *Cosmarium* with 99 taxa, *Closterium* with 39 taxa, *Staurastrum* with 38 taxa and *Euastrum* with 17 taxa. All reported taxa are described and documented by original hand drawings and microphotographs. Environmental data with geographical coordinates are included for all studied sites. Among the recorded taxa, eight (*Actinotaenium borgeanum*, *Actinotaenium gelidum*, *Actinotaenium perminutum*, *Cosmarium alpestre*, *Cosmarium dispersum*, *Cosmarium paragranatoides*, *Closterium sublaterale*, *Staurastrum pyramidatum*) are new for the Polish flora. An important factor affecting the biodiversity of desmids in the Gorce area is human activity. In typically anthropogenic habitats, which in the study area include roads and paths, 157 species were found (63.7% of the Gorce desmid flora). Many montane species, such as *Closterium pusillum* and *Cosmarium decedens*, associated with wet moss on rocks, had secondary habitats there. A group of 21 species found only in anthropogenic habitats can be considered anthropophytes of the studied area. There are also semi-natural habitats in the form of meadows that persist only due to human activity. The situation is similar to that of vascular plants. Clearings used until the 1980s showed significantly higher species richness than clearings where grazing has been abandoned for a long time. Overall, human activity has contributed to an increase of desmid species diversity in the Gorce region.

Key words: biogeography, desmids, Gorce Mts, Poland, taxonomy

Introduction

At a time of far-reaching environmental transformations in Poland, which include the draining of wetlands and eutrophication of waterbodies, knowledge of the distribution of algal species in this country is especially needed, but the subject is insufficiently studied. The stations of many rare and interesting species may well be gone before they are recorded. Hence, the call for more floristic research. Modern floristic studies on algae in Poland are rare. One example is Wołowski's (1998) monograph on the *Euglenophyta* of southern Poland. For desmids, there is no study covering the entire geography of Poland. Few undertake the investigation of the local distribution of individual species.

The Gorce Mountains, unlike the nearby Tatras, have been neglected by phycologists. A work by Chudybowa (1964) on the benthos of a fragment of Lepietnica stream is the only study from that region. One purpose of this book is to supplement our knowledge of the distribution of desmids in the Carpathians.

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For many years, hydrobiologists were convinced that freshwater algae, especially the unicellular forms, were cosmopolitan. Such a belief had its origin in the methodology of determining material from outside Europe. Monographs of European areas were used for that purpose, but uncritically. To determine desmids, researchers used the fundamental works of the West brothers (West & West 1904, 1905, 1908, 1912, 1923). For many algal groups, the evidence is against cosmopolitan occurrence, for example in *Cyanophyta* (Komàrek 1985), *Rhodophyta* (Vis et al. 1996), *Heterocontophyta* (Vigna & Siver 2003; Foissner 2006) and *Bacillariophyta* (Kociolek & Spaulding 2000; Vyverman et al. 2007). Many biogeographic regularities in the distribution of numerous taxa of those groups have been found. Tyler (1996) noted endemism in the freshwater algae of Australia, and endemic taxa of algae have also been recorded in Siberian lakes (Mitrofanova & Kirillov 2006).

Heimans (1969) pointed to some similarities in the ranges of desmids and vascular plants. Besides the above-mentioned work from Australia, endemic species have been found in Indo-Malaysia-northern Australia (Vyverman 1996) and Africa (Coesel 2002). Coesel (1996)

drew attention to similarities between the algal floras of various tropical areas, and also noted the distinctiveness of the algal floras of mountain areas, suggesting that mountains may pose a barrier to their spread or may act as a refuge for certain species.

This monographie presents a full list of desmid taxa identified so far in the Gorce Mountains, examines regularities in their local distribution, and describes similarities and differences with other Carpathian ranges and the well-studied foreland. It also considers the similarities and differences in distribution between desmids and vascular plants.

Research area

The Gorce Mountains, which cover ~550 km^2, lie in the Western Carpathians, part of the Outer Carpathians. To the south, they border the Orava-Nowy Targ Basin (Dorzecze Orawsko-Nowotarska) and the Pieniny Mts; the border is formed by the Dunajec River and the lower section of Krośnica stream. To the east, they border the Beskid Sądecki and Beskid Wyspowy Mts; the border is formed by the Dunajec River, the lower section of Kamienica stream, and Mszanka stream. To the north, they border the Beskid Wyspowy Mts; the border is formed by the Rabka River. To the west, the mountains border the Beskid Wysoki Mts; the border is formed by the upper section of the Raba River and the lower section of Lepietnica stream.

Geomorphologically, the Gorce Mts consist of two ranges. The Turbacz range occupies the largest area. Its centrally situated peak, Mt. Turbacz (1300 m), is the highest peak of the Gorce Mts. Ridges spread from it in all directions, the longest coursing east-west. The highest peaks of the Gorce Mts are along the Turbacz range: Jaworzyna Kamieniecka (1288 m), Kiczora (1284 m), Kudłoń (1276 m), Czoło Turbacza (1270 m), Mostownica (1244 m) and Gorc Kamieniecki (1230 m), and most of them are near Mt. Turbacz. The Lubań range occupies a much smaller area. It has a single ridge and its highest peak is Mt. Lubań (1225 m). The longest valleys are the Lepietnica stream valley, Kamienica stream valley, Ochotnica River valley and Krośnica stream valley. The valley cross-sections are mostly V-shaped. The Gorce Mts are generally classified as low mountains with mostly gentle slopes; only 1% of their area rises above 1200 m a.s.l.

The Gorce Mts are built mostly of Cretaceous to Paleogene flysch. The Cretaceous forms include slate and sandstone. The Paleogene forms include the sandstone of Mt. Magura and its foothills. Calcite inclusions occur frequently in the Gorce Mts (Książkiewicz 1953). The soils are montane and mostly shallow. They were created through weathering of marl-silicate and quartz-silicate flysch, and range from endoeutric cambisols to weakly podzolized soils, often with acidic pH, especially in the upper mountain parts. Alluvial soils occasionally occur in the river valleys (Medwecka-Kornaś 1955; Adamczyk 1966; Kornaś & Medwecka-Kornaś 1967).

The Gorce region is covered with a network of mountain streams. Most of them emerge from ridges, especially in the Turbacz area. Very few streams occur in the northern part of the area. Most of them follow a latitudinal course and belong to the Dunajec River drainage basin. The upper parts of the streams are steeply inclined and have many waterfalls. The lower parts accumulate rock shoals with numerous puddles and dead branches. The Gorce Mts have very few waterbodies, but a large number of helocrenic springs, especially in the upper parts of the Turbacz range.

The Gorce region has three climate zones: temperate warm (up to 750 m a.s.l., mean annual temperature above 6°C), temperate cold (up to 1100 m a.s.l., mean temp. 4–6°C) and cold (up to 1310 m a.s.l.) mean temp. below 4°C) (Klein 1985). July and August are the warmest months, and January and February the coldest (Nowak & Kostuch 1966).

Precipitation in the Gorce Mts is abundant and sometimes sudden. Most rainfall occurs between June and August. Annual precipitation is 750–900 mm at lower elevations and exceeds 1000 mm at the highest elevations, reaching 1200 mm on Mt. Turbacz (Jarosz 1935; Nowak & Kostuch 1966; Obrębska-Starklowa 1970; Miczyński 2006). Precipitation is higher in the western part. Drier climate dominates the Ochotnica River valley and the Lubań range, which are in a rain shadow.

Material and methods

Samples were collected from the whole Gorce Mts area in 2000–2005 from May to September inclusive. Desmids were collected from all possible habitats, the most important being polyhumic waterbodies, *Sphagnum* puddles, puddles on slope roads, moist soil on slope roads, puddles on trails, wet mosses of the *Bryidae* class in marshes, puddles on marshes, old wells in marshes, and oxbows of streams. Stream springs and habitats directly related to streams, such as waterfalls, temporary waterbodies, fish ponds and moist soil on paths were less important. Elevation above sea level was determined with a barometric altimeter, the pH of each sample was recorded, and, when possible, ionic conductivity was measured with an electronic meter model HANNA. The material was collected from 79 localities in the Turbacz range and 330 localities in Turbacz range. Efforts were made to visit each locality twice during the course of the study. During the whole study period, ~1200 samples containing desmids were collected and immediately preserved in 4% formaldehyde solution, transferred to the laboratory, viewed with a light microscope (Zeiss Axioscop II) and documented by photographs. For samples in which more than 50 desmid cells were identified in three consecutive preparations, the percentage of each species in the sample was determined. All the material from each locality in the Gorce was documented with 5,400 photographic images of the desmids. These images served as the basis for drawiing this monograph's illustrations of the species. The monographs of the following authors were used for determining the material: Compére (2001), Coesel (1983, 1985, 1991, 1994, 1997), Croasdale & Flint (1986, 1988), Croasdale et al. (1994), Dillard (1990, 1991, 1991a, 1993),

Förster (1982), Hirano (1955, 1956, 1957, 1957a, 1959, 1959a), Kossinskaja (1952, 1960), Krieger & Gerloff (1962, 1965, 1969), Lenzenweger (1996, 1997, 1999), Palamar-Mordvintseva (1982), Prescott et al. (1972, 1975, 1981, 1982, 1983), Růžička (1977, 1981), Teiling (1967) and West & West (1904, 1905, 1908, 1912, 1923). The iconotheca of the Department of Phycology of the Władysław Szafer Institute of Botany (Polish Academy of Sciences) in Krakow provided valuable comparative material.

Bibliographic works (Siemińska 1990; Siemińska & Pająk 1992) and the catalogue of algal species, names from the register of the above-mentioned Department of Phycology (Siemińska & Wołowski 2003) supplied very useful information on the distribution of desmids in Poland. The floristic data were collected in a database, which was used to create a map of the distribution of each species in the Gorce area in 2 × 2 km ATPOL grid squares. The distribution maps were analyzed by standard phytogeographical methods. A combined map for the mountain taxa was drawn in the RAR program used in ATPOL methodology.

Each entry in the geographical names index includes the site number (bolded), ATPOL grid square (e.g., EG 2142), site description, elevation (meters above sea level, in parentheses) and geographic coordinates.

Localities

The Lubań Range

1. EG 2142 – Knurowski Potok stream, bottom of the valley (tributary of Dunajec River), west from Knurów (640–650 m): 49°29′29″N, 20°10′15″E.
2. EG 2142 – Cyrla peak near Knurów (780 m): 49°29′26″N, 20°10′50″E.
3. EG 2142 – Przełęcz Knurowska pass area (780–800 m): 49°30′00″N, 20°10′30″E.
4. EG 2142 – Przełęcz Knurowska pass, area near Knurów (700–720 m): 49°29′29″N, 20°10′30″E.
5. EG 2143 – Valley of the stream, east from Knurów (left tributary of Knurowski Potok stream) (610–660 m): 49°29′11″N, 20°11′30″E.
6. EG 2144 – Kotelnica peak near Huba (840 m): 49°29′19″N, 20°13′35″E.
7. EG 2144 – Mostkowe hamlet near Ochotnica Górna (770–850 m): 49°29′44″N, 20°14′00″E.
8. EG 2144 – Studzionki hamlet near Ochotnica Górna (920 m): 49°29′44″N, 20°13′00″E.
9. EG 2230 – Jeziorko Iwankowskie pond near Ochotnica Górna (650 m): 49°30′15″N, 20°15′10″E.
10. EG 2230 – Jeziorko Zawadowskie pond near Ochotnica Górna (660 m): 49°30′11″N, 20°15′05″E.
11. EG 2230 – Jeziorko Iwankowskie pond, area near Ochotnica Górna (650 m): 49°30′15″N, 20°15′10″E.
12. EG 2230 – Zawadowski Potok stream, meadow (750 m) in the valley (tributary of the Ochotnica River): 49°30′23″N, 20°15′35″E.
13. EG 2230 – Zawadowski Potok stream, springs (tributary of the Ochotnica River) (850 m): 49°30′08″N, 20°15′36″E.
14. EG 2231 – Potok Jurkowski stream, lower part of the valley (tributary of the Ochotnica River) (700 m): 49°30′49″N, 20°16′50″E.
15. EG 2231 – Bukowina meadow in the upper part of valley of the Jurkowski Potok stream (tributary of the Ochotnica River) (870 m): 49°30′16″N, 20°17′13″E.
16. EG 2232 – Jackowa (Czerniawa) meadow in the upper part of the valley of the Kudowski Potok stream (tributary of the Ochotnica River) (730 m): 49°30′16″N, 20°18′00″E.
17. EG 2232 – Muszyna meadow under the Jaworzyny Ochotnickie meadow (880 m): 49°30′05″N, 20°19′25″E.
18. EG 2232 – Kudowski Potok stream, middle part (Kudów) (tributary of the Ochotnica River) (660–670 m): 49°30′24″N, 20°18′30″E.
19. EG 2233 – Lubański Potok stream, lower part of the valley (tributary of the Ochotnica River) (580 m): 49°30′49″N, 20°20′25″E.
20. EG 2233 – Lubański Potok stream, middle part of the valley (tributary of the Ochotnica River) (740 m): 49° 30′13″N, 20°20′00″E.
21. EG 2234 – Jeziorne peatland on the Tokarnia meadow near Ochotnica (870 m): 49°30′13″N, 20°21′50″E.
22. EG 2234 – Rolnicki Potok stream, lower part of the valley (tributary of the Ochotnica River) (650–660 m): 49°31′00″N, 20°21′30″E.
23. EG 2234 – Tokarnia meadow upper part, near Ochotnica (1000 m): 49°30′10″N, 20°21′50″E.
24. EG 2234 – Tokarnia meadow (730 m) in the area of Jeziorne peatland: 49°30′16″N, 20°21′50″E.
25. EG 2234 – Brysiecki Potok stream, springs (tributary of the Ochotnica River) (830 m): 49°30′16″N, 20°22′15″E.
26. EG 2241 – Limierzyska Potok stream, upper part of the valley (tributary of the Dunajec River) (840–900 m): 49°29′06″N, 20°17′40″E.
27. EG 2241 – Jurkowski Potok stream, upper part of the valley (tributary of the Ochotnica River) (850–890 m): 49°29′58″N, 20°16′38″E.
28. EG 2241 – Morgi meadow in the upper part of the valley of the Jurkowski Potok stream (tributary of the Ochotnica River) (920 m): 49°29′42″N, 20°16′38″E.
29. EG 2242 – Kluszkowianka stream valley, upper part (tributary of the Dunajec River) (930 m): 49°29′13″N, 20°19′24″E.
30. EG 2242 – Czerteż meadow – springs of the stream flowing through „Skalisty Brzeżek" (800 m): 49°29′13″N, 20°18′43″E.
31. EG 2242 – Jaworzyny Ochotnickie meadow from the side of the Dunajec River (1040 m): 49°29′24″N, 20°19′10″E.
32. EG 2242 – Morgi meadow near Ochotnica Dolna (1080 m): 49°29′44″N, 20°18′23″E.
33. EG 2243 – „Upłaz" on the Lubań peak (1070 m): 49°29′16″N, 20°20′38″E.
34. EG 2243 – Lubań peak (1210 m): 49°29′19″N, 20°20′38″E.
35. EG 2243 – Lubański Potok stream valley upper part (tributary of the Ochotnica River) (890 m): 49°30′00″N, 20°19′50″E.
36. EG 2243 – Meadow (1050 m) on the ridge between the Krośnica stream and the Potok Lubań stream valleys: 49°29′06″N, 20°20′15″E.
37. EG 2243 – Lubański Potok stream valley – upper part, Kosarzysko meadow in the (tributary of the Ochotnica River) (920–930 m): 49°30′03″N, 20°20′15″E.
38. EG 2243 – Krośnicki Certes (Czerteż) meadow in the vicinity of the Lubań peak (1120 m): 49°29′07″N, 20°20′43″E.
39. EG 2243 – Lubań peak (1150 m) – the south slope, Wyrobki meadow: 49°29′16″N, 20°20′30″E.

40. EG 2243 – Lubański Potok, stream valley – upper part, Soskowa Polana meadow (tributary of the Ochotnica River) (820 m): 49°29′54″N, 20°19′40″E.

41. EG 2243 – The Lubań peak slope, near Kluszkowianka stream valley (tributary of the Dunajec River) (1020 m): 49°29′16″N, 20°19′50″E.

42. EG 2244 – Tylmanowa, Kosarki (Wyrobek) meadow (930–980 m): 49°29′52″N, 20°22′25″E.

43. EG 2244 – Burdelski Potok stream valley, Mraźnica meadow (tributary of the Dunajec River) (930 m): 49°29′00″N, 20°22′00″E.

44. EG 2244 – Rolnicki Potok stream valley – upper part, Rysztoki meadow (tributary of the Ochotnica River) (730–810 m): 49°29′57″N, 20°21′18″E.

45. EG 2244 – Burdelski Potok stream, near the springs Tokarnia meadow (tributary of the Dunajec River) (1000 m): 49°29′36″N, 20°21′25″E.

46. EG 2330 – „Gabrysie" near Tylmanowa (530–550 m): 49°30′23″N, 20°23′30″E.

47. EG 2330 – Basznia and Makowica peaks, depression, near Tylmanowa (520 m): 49°30′39″N, 20°23′30″E.

48. EG 2340 – Burdelski Potok stream valley „Zawakopa" (tributary of the Dunajec River) (520 m): 49°29′16″N, 20°23′18″E.

49. EG 2340 – Ziemiankowy Potok stream valley „Ziemianki" (tributary of the Dunajec River) (560 m): 49°29′00″N, 20°23′50″E.

50. EG 2340 – Burdelski Potok stream valley, bottom (tributary of the Dunajec River) (660 m): 49°29′13″N, 20°22′50″E.

51. EG 2340 – Burdelski Potok stream – vicinity, Cyrhla meadow (tributary of the Dunajec River) (670 m): 49°29′37″N, 20°23′25″E.

52. EG 3104 – Dunajec River tributary – stream valley, east from Huba (710–720 m): 49°29′00″N, 20°14′15″E.

53. EG 3104 – Potok Graniczny stream valley (tributary of the Dunajec River) west from Szlembark (690 m): 49°28′54″N, 20°12′50″E.

54. EG 3104 – Huba – village in the valley of the Dunajec River (640 m): 49°28′26″N, 20°13′45″E.

55. EG 3104 – Szlembark in the valley of the Dunajec River (730 m): 49°29′00″N, 20°13′28″E.

56. EG 3200 – Poddziankówka stream valley near Łysa Góra (600 m): 49°28′00″N, 20°15′40″E.

57. EG 3200 – Piekiełko stream valley – lower part (tributary of the Dunajec River) (610 m): 49° 28′00″N, 20°15′40″E.

58. EG 3201 – Limierzyska Potok stream valley – lower part (tributary of the Dunajec River) (640–680 m): 49°28′19″N, 20°16′43″E.

59. EG 3202 – „Szeroka Dolina" in the Mizerzanka stream valley (tributary of the Dunajec River) (660 m): 49°28′00″N, 20°18′15″E.

60. EG 3202 – Mizerzanka stream valley, Średnie Koszary meadow (tributary of the Dunajec River) (700 m): 49°28′24″N, 20°18′00″E.

61. EG 3202 – Kluszkowianka stream valley – middle part (tributary of the Dunajec River) (740 m): 49°28′16″N, 20°19′15″E.

62. EG 3203 – Meadow (890 m) on the ridge between the Krośnica stream and the Potok Lubań stream valleys: 49°28′13″N, 20°20′50″E.

63. EG 3203 – Krośnica stream and the Potok Lubań stream valleys – meadow (940 m) on the ridge: 49°28′32″N, 20°20′33″E.

64. EG 3204 – The Potok Lubań stream valley, upper part (tributary of the Krośnica stream) (860 m): 49°28′26″N, 20°21′20″E.

65. EG 3204 – Burdelski Potok stream valley – Wyżna Hala meadow (tributary of the Dunajec River) (1000 m): 49°28′52″N, 20°21′48″E.

66. EG 3204 – Grywałd vinicity – the Podjaworzyna meadow (970): 49°28′39″N, 20°21′50″E.

67. EG 3212 – Kluszkowianka stream valley – lower part (tributary of the Dunajec River) near the Wdżar peak (590 m): 49°27′32″N, 20°19′00″E.

68. EG 3213 – Kluszkowianka stream valley – middle part (tributary of the Dunajec River) near the Wdżar peak (640 m): 49°27′49″N, 20°19′25″E.

69. EG 3213 – Drzyślawa pass between the Wdżar and Krzywonośne peaks (720 m): 49°27′41″N, 20°19′30″E.

70. EG 3213 – Krośnica stream valley – middle part of the (tributary of the Dunajec River) (680 –700 m): 49°27′45″N, 20°20′10″E.

71. EG 3214 – Potok Dziadowe Kąty stream valley (tributary of the Krośnica stream) (690 m): 49°27′50″N, 20°21′58″E.

72. EG 3214 – Potok Lubań stream valley, lower part (tributary of the Krośnica stream) (690–680): 49°27′36″N, 20°21′38″E.

73. EG 3300 – Marszałek peak near Krościenko (810 m): 49°27′58″N, 20°24′15″E.

74. EG 3300 – Wyżnie Polany meadow near Krościenko (850 m): 49°28′19″N, 20°23′10″E.

75. EG 3301 – Wzorowy Potok stream valley (tributary of the Dunajec River) near the Marszałek peak (680 m): 49°27′52″N, 20°25′00″E.

76. EG 3310 – „Koci Zamek" hamlet of Kąty wilage, in the Potok Dziadowe Kąty stream valley (tributary of the Krośnica stream) (590 m): 49°27′19″N, 20°23′00″E.

77. EG 3310 – Czarna Krośnica stream valley (tributary of the Krośnica stream) (610 m): 49°27′32″N, 20°23′00″E.

78. EG 3310 – Kotelnica stream valley (tributary the Czarna Krośnica stream) (590 m): 49°27′24″N, 20°23′50″E.

79. EG3202 – Skalisty Brzeżek in the vicinity of the Mizerzanka stream valley (tributary the Krośnica stream) (690): 49°28′16″N, 20°18′13″E.

The Turbacz Range

80. DG 1934 – Pocieszna Woda stream valley (tributary of the Raba River) (520–530 m): 49°35′41″N, 19°57′00″E.

81. DG 1934 – Rabka – the Poniczanka Stream valley (tributary of the Raba River) (500 m): 49°36′13″N, 19°57′38″E.

82. DG 1934 – Rabka – Traczykówka (520 m): 49°35′45″N, 19°57′50″E.

83. DG 1943 – Chabówka (500 m): 49°35′19″N, 19°56′00″E.

84. DG 2903 – Rokiciny – Gawlikówka (570 m): 49°34′00″N, 19°56′10″E.

85. DG 2904 – Piątkowa peak near the Poniczanka stream valley (tributary of the Raba River) (660–680 m): 49°34′32″N, 19°56′50″E.

86. DG 2904 – Rdzawka – Dudkówka hamlet (650 m): 49°34′00″N, 19°57′15″E.

87. DG 2904 – Rdzawka – Rusnakówka hamlet (630 m): 49°33′36″N, 19°57′00″E.

88. DG 2904 – Rdzawka – Srokówka hamlet (670 m): 49°33′36″N, 19°58′00″E.

89. DG 2913 – Jamne near the Rabska Góra peak (750 m): 49°33′13″N, 19°55′20″E.

90. EG 1003 – Stare Wierchy peak (850 m) – the Wyżnia meadow: 49°33′49″N, 20°03′15″E.

91. EG 1004 – Mszana Górna – slope of the Spyrkowa peak (510 m): 49°38′49″N, 20°16′20″E.
92. EG 1014 – Spyrkowa peak near Mszana Górna (700 m): 49°38′16″N, 20°06′00″E.
93. EG 1014 – Podobin – the Poręba stream valley (tributary of the Mszanka stream) (460 m): 49°38′09″N, 20°05′00″E.
94. EG 1020 – Bania peak near Rabka (580 m): 49°36′55″N, 19°58′25″E.
95. EG 1020 – Grzebień peak near Rabka (650 m): 49°36′45″N, 19°59′15″E.
96. EG 1020 – Rabka vicinity – saddle between the Bania and Grzebień peaks (570 m): 49°37′00″N, 19°59′00″E.
97. EG 1021 – Groń peak near Skaliste streem (540 m): 49°36′57″N, 20°00′30″E.
98. EG 1021 – Skaliste streem near Olszówka village (480 m): 49°37′13″N, 20°00′30″E.
99. EG 1024 – Witów peak near Witów village (610–640 m): 49°37′39″N, 20°06′20″E.
100. EG 1024 – Niedźwiedź village – Moskały hamlet (550 m): 49°37′13″N, 20°05′00″E.
101. EG 1030 – Koninki – Borek hamlet (580–600 m): 49°35′41″N, 19°59′40″E.
102. EG 1031 – Rabka vicinity, the Groń peak near the Grzebień peak (610 m): 49°36′39″N, 20°00′10″E.
103. EG 1032 – Stawiska between Olszówka and Poręba Wielka (600 m): 49°36′31″N, 20°03′00″E,
104. EG 1032 – Groń peak near Olszówka village (580 m): 49°36′00″N, 20°02′40″E.
105. EG 1032 – Krzyżowa peak near Olszówka village (620–690 m): 49°35′39″N, 20°01′50″E.
106. EG 1032 – Ostra peak near Olszówka village (590 m): 49°35′50″N, 20°02′10″E.
107. EG 1032 – Olszówka – Barany hamlet (570 m): 49°36′16″N, 20°01′40″E.
108. EG 1033 – Koninki – bottom of the Koninka stream valley (tributary of the Poręba stream) (560 m): 49°35′52″N, 20°04′10″E.
109. EG 1034 – Równie – glade near the Wasielka peak (680 m): 49°35′45″N, 20°06′20″E.
110. EG 1034 – Maciejków (Maciejkowy) Potok stream valley (tributary of the Konina stream) (570 m): 49°36′19″N, 20°05′48″E.
111. EG 1034 – Podgronie – hamlet near Poręba Wielka (620 m): 49°36′28″N, 20°05′00″E.
112. EG 1034 – Tomusiowa meadow under the Bukowina Waksmundzka meadow (1010 m): 49°36′18″N, 20°06′15″E.
113. EG 1040 – Tatarów peak near Rabka (610 m): 49°35′32″N, 19°59′00″E.
114. EG 1041 – Bardo peak near Rabka (850 m): 49°34′41″N, 20°01′00″E.
115. EG 1041 – Ridge of the Szumiąca peak in the Słonka stream valley (660 m): 49°35′00″N, 20°00′20″E.
116. EG 1042 – Do Klucza stream valley (tributary of the Poręba stream) (680–700 m): 49°34′49″N, 20°02′25″E.
117. EG 1042 – Szumiąca peak near springs of the Słonka stream (700–740 m): 49°35′00″N, 20°01′25″E.
118. EG 1042 – Jasionów near Poręba Górna (710–750 m): 49°35′03″N, 20°01′35″E.
119. EG 1042 – Poręba Górna – Chlipały (650–680 m): 49°35′00″N, 20°02′25″E.
120. EG 1042 – Poręba Górna – Jopki (610 m): 49°35′19″N, 20°02′50″E.
121. EG 1042 – Poręba Górna – Misiury (700 m): 49°35′00″N, 20°03′20″E.
122. EG 1043 – Barczana peak (Ostry Groń) near Koninki (680 m): 49°35′26″N, 20°04′15″E.
123. EG 1043 – Galaska meadow near the Tobołów peak (900 m): 49°34′32″N, 20°03′55″E.
124. EG 1043 – Tobołów meadow on the Tobołów peak (960 m): 49°34′32″N, 20°04′05″E.
125. EG 1043 – Poręba Górna – hamlet Halamy (720 m): 49°35′06″N, 20°03′40″E.
126. EG 1043 – Saddle between the Barczana peak (Ostry Groń) and the Tobołów peak near Koninki (720 m): 49°35′16″N, 20°04′00″E.
127. EG 1044 – Gąsiorowska meadow on the Wasielka peak (840 m): 49°35′06″N, 20°05′30″E.
128. EG 1044 – Młynarska meadow on the Wasielka peak (780 m): 49°35′10″N, 20°05′24″E.
129. EG 1044 – Oberówka meadow in the Turbacz stream valley (tributary of the Koninka stream) (700 m): 49°34′41″N, 20°05′20″E.
130. EG 1044 – Vicinity of Hucisko in the Koninka stream valley (tributary of the Poręba stream) (650–700 m): 49°34′41″N, 20°05′05″E.
131. EG 1120 – Depression between the Mszanka stream and the Konina stream valleys (580–600 m): 49°37′00″N, 20°08′00″E.
132. EG 1121 – Marki Potok valley (tributary of the Mszanka stream) (540 m): 49°37′00″N, 20°08′50″E.
133. EG 1121 – Rychłowiec stream valley (tributary of the Mszanka stream) (610–620 m): 49°36′42″N, 20°09′25″E.
134. EG 1121 – Kobylica peak near Lubomierz (610 m): 49°36′39″N, 20°08′50″E.
135. EG 1121 – Lubomierz – Marki locality (520 m): 49°37′08″N, 20°09′30″E.
136. EG 1130 – Czechowa peak near Frączków the Groń peak (680 m): 49°35′55″N, 20°06′25″E.
137. EG 1130 – Frączków Groń peak near the Domagałów Potok stream valley (tributary of the Konina stream) (610–650 m): 49°36′16″N, 20°06′50″E.
138. EG 1130 – Upper part of the Migrąd stream valley (tributary of the Dunajec River) (690 m): 49°35′41″N, 20°07′00″E.
139. EG 1130 – Konina – Natanki hamlet (620–650 m): 49°36′00″N, 20°07′50″E.
140. EG 1132 – Rosoch Potok stream valley (Lubomierz – Kozyry) (tributary of the Mszanka stream) (610 m): 49°36′19″N, 20°11′00″E.
141. EG 1132 – Rychłów stream valley (tributary of the Mszanka stream) (630 m): 49°36′11″N, 20°10′08″E.
142. EG 1133 – Redykacz stream valley (tributary of the Mszanka stream) (700 m): 49°36′00″N, 20°12′20″E.
143. EG 1133 – Kobyla Głowa peak near Lubomierz (680 m): 49°36′00″N, 20°12′00″E.
144. EG 1134 – Czubak peak in the Kamienica stream valley near the Przełęcz Przysłop pass (700–710 m): 49°35′41″N, 20°14′13″E.
145. EG 1134 – Polana Wiatrówki meadow in the Kamienica stream valley near the Przełęcz Przysłop pass (660 m): 49°36′24″N, 20°14′13″E.
146. EG 1140 – Pod Basielkę in the upper part of the Domagałów Potok stream valley (tributary of the Konina stream) (870 m): 49°35′07″N, 20°06′30″E.
147. EG 1140 – Roztoka stream valley (tributary of the Konina stream) (750–770 m): 49°34′32″N, 20°07′40″E.
148. EG 1140 – Turbaczyk meadow on the Turbaczyk peak (1050 m): 49°34′49″N, 20°06′55″E.
149. EG 1140 – Spalony stream valley (tributary of the Roztoka stream) (870 m): 49°34′32″N, 20°07′24″E.
150. EG 1141 – Konina – Halamy hamlet (660–690 m): 49°35′24″N, 20°08′00″E.

151. EG 1141 – Kopa meadow on the Kopa peak (1020 m): 49°34′32″N, 20°09′05″E.
152. EG 1142 – Kosarzysko meadow near the Kudłoń peak (1000 m): 49°34′49″N, 20°10′10″E.
153. EG 1142 – Pyzówka meadow near the Kudłoń peak (1050 m): 49°34′36″N, 20°10′13″E.
154. EG 1143 – Jaworzynka peak near the Przełęcz Przysłop Pass (1000 m): 49°35′10″N, 20°12′00″E.
155. EG 1143 – Gorcowy Potok stream valley, upper part (tributary of the Kamienica stream) (850 m): 49°34′57″N, 20°12′00″E.
156. EG 1143 – Adamówka (Jadamówka) meadow near the Polana Gorc Troszacki meadow (1070 m): 49°34′41″N, 20°11′29″E.
157. EG 1143 – Pod Skały meadow near the Polana Gorc Troszacki (1000 m); 49°35′00″N, 20°11′30″E.
158. EG 1144 – Porąbki clearing in the Kamienica Stream valley under the Przełęcz Przysłop pass (720 m): 49°35′13″N, 20°13′30″E.
159. EG 1144 – Gorcowy Potok stream valley – lower part (tributary of the Kamienica stream) (750 m): 49°34′41″N, 20°13′00″E.
160. EG 1144 – Polana Lanckorona meadow in the Kamienica stream valley near the Przełęcz Przysłop pass (770–780 m): 49°35′16″N, 20°14′13″E.
161. EG 1144 – Polana Trusiówka meadow in the Kamienica stream valley near the Przełęcz Przysłop Pass (720 m): 49°35′00″N, 20°13′20″E.
162. EG 1144 – Spaleniec stream valley (tributary of the Kamienica stream) near border with the Gorce National Park (820–880 m): 49°34′52″N, 20°13′43″E.
163. EG 1220 – Slope of the Wielki Wierch peak above the Polana Kasperówka meadow (760–780 m): 49°37′03″N, 20°16′00″E.
164. EG 1220 – Szczawa village – the Kamienica stream valley opposite Równiny clearing (620 m): 49°37′36″N, 20°15′35″E.
165. EG 1221 – Polanki clearing near Szczawa in the Głębieniec stream valley (tributary of the Kamienica stream) (700–780 m): 49°36′36″N, 20°17′00″E.
166. EG 1221 – Slope of the Wielki Wierch peak under „Polanki" in the Kamienica stream valley (690 m): 49°37′00″N, 20°17′05″E.
167. EG 1221 – Szczawa – the Kamienica stream valley opposite „Bukówki" (550–600 m): 49°37′23″N, 20°17′00″E.
168. EG 1230 – Polana Faronówki meadow near the Głębieniec stream valley (tributary of the Kamienica stream) (840 m): 49°35′41″N, 20°15′40″E.
169. EG 1230 – Polana Jeziorne meadow near the Wielki Wierch peak (920–940 m): 49°36′26″N, 20°15′40″E.
170. EG 1230 – Polana Magorzyca meadow near the Głębieniec stream valley (tributary of the Kamienica stream) (820 m): 49°35′32″N, 20°16′00″E.
171. EG 1230 – Polana Podkiczory meadow near the Głębieniec stream valley (tributary of the Kamienica stream) (860 m): 49°35′50″N, 20°15′38″E.
172. EG 1230 – Slope of the Wielki Wierch peak above the Polana Wiatrówki meadow (810–820 m): 49°36′24″N, 20°15′00″E.
173. EG 1231 – Głębieniec stream valley, lower part (tributary of the Kamienica stream) (Szczawa – Gardonie) (570–590 m): 49°35′49″N, 20°17′30″E.
174. EG 1231 – Głębieniec stream valley, middle part (tributary of the Kamienica stream) below the Groń peak (620–640 m): 49°35′32″N, 20°17′00″E
175. EG 1240 – Głębieniec stream valley upper part (tributary of the Kamienica stream) (710–840 m): 49°35′00″N, 20°16′00″E.
176. EG 1240 – Zasadne stream valley upper part (tributary of the Kamienica stream) (760 m): 49°34′28″N, 20°16′15″E.
177. EG 1240 – Polana Karczówka meadow near the Gorc Kamieniecki peak (1080 m): 49°34′26″N, 20°15′30″E.
178. EG 1240 – Nowa Polana meadow near the Głębieniec stream valley (tributary of the Kamienica stream) (870 m): 49°34′55″N, 20°15′00″E.
179. EG 1240 – Pod Magorzycę meadow near the Głębieniec stream valley (tributary of the Kamienica stream) (860 m): 49°35′19″N, 20°15′25″E.
180. EG 1240 – Area of the Polana Lanckorona meadow in the Kamienica stream valley near the Przełęcz Przysłop pass (850 m): 49°35′00″N, 20°14′38″E.
181. EG 1241 – Podstrzelne Stream valley, lower part (tributary of the Zasadne stream) (660–700 m): 49°34′41″N, 20°17′30″E.
182. EG 1241 – Farony near Zasadne (660–680 m): 49°34′58″N, 20°17′15″E.
183. EG 1241 – Upper part of the Podstrzelne stream valley (tributary of the Zasadne stream) (890 m): 49°34′26″N, 20°17′00″E.
184. EG 1242 – Kurzejówka near Zasadne (500 m): 49°35′00″N, 20°19′00″E.
185. EG 1242 – Polana Skrzyńczyńska meadow near Przełęcz Wierch Młynne pass (770 m): 49°34′32″N, 20°18′10″E.
186. EG 1242 – Zasadniaki in the Zasadne stream valley (tributary of the Kamienica stream) (600 m): 49°35′00″N, 20°18′15″E.
187. EG 1243 – Kamienica – vicinity of the Ciepielniki stream valley (tributary of the Kamienica stream) (470 m): 49°34′28″N, 20°20′19″E.
188. EG 1243 – Kamienica – Słotwina hamlet (590 m): 49°34′23″N, 20°20′04″E.
189. EG 2000 – Dział near the Ponice peak (650 m): 49°34′16″N, 19°59′25″E.
190. EG 2000 – Ponice – Sołtysówka hamlet (620 m): 49°34′00″N, 19°59′30″E.
191. EG 2000 – Ponice – Worwówka hamlet (580 m): 49°34′31″N, 19°59′00″E.
192. EG 2000 – Świńska Góra peak near Ponice village (700 m): 49°33′32″N, 19°59′00″E
193. EG 2001 – Ponice – Gładyszówka hamlet (660 m): 49°33′29″N, 20°00′38″E.
194. EG 2001 – Ponice – meadow (620 m): 49°33′49″N, 20°01′00″E.
195. EG 2002 – Groniki peak near the Stare Wierchy peak (1010 m): 49°33′28″N, 20°02′38″E.
196. EG 2002 – Jaworzyna peak near the Poniczanka stream valley (800 m): 49°34′00″N, 20°01′38″E.
197. EG 2002 – Pośrednia meadow near the Przełęcz Pośrednia pass near the Stare Wierchy peak (930 m): 49°33′49″N, 20°02′15″E.
198. EG 2002 – Szeroka meadow near the Stare Wierchy peak (850 m): 49°33′49″N, 20°02′55″E.
199. EG 2003 – „Kopana Droga" near the Obidowiec peak (980 m): 49°33′41″N, 20°03′50″E.
200. EG 2003 – Poręba stream valley, upper part (tributary of the Mszanka stream) (760–850 m): 49°34′00″N, 20°03′28″E.
201. EG 2003 – Młynarska meadow between the Stare Wierchy peak and the Obidowiec peak (1030 m): 49°33′32″N, 20°03′15″E.

202. EG 2003 – Obidowiec meadow near the top of the Obidowiec peak (1070–1090 m): 49°33′32″N, 20°04′15″E.
203. EG 2003 – Starmaszka meadow near the Tobołów peak (960 m): 49°34′21″N, 20°04′05″E.
204. EG 2003 – Suchora meadow between the Obidowiec peak and the Suchora peak (950 m): 49°33′52″N, 20°04′10″E.
205. EG 2004 – Koninka stream valley, bottom (tributary of the Poręba stream) (680 m): 49°34′10″N, 20°04′50″E.
206. EG 2010 – Kułakowy Wierch peak near the Lepietnica stream valley (tributary of the Dunajec River) (810 m): 49°32′26″N, 19°59′00″E.
207. EG 2010 – Świńska Góra peak near Rdzawka (730 m): 49°33′29″N, 19°58′55″E.
208. EG 2011 – Jaworzyna peak near the Lepietnica stream valley (tributary of the Dunajec River) (910 m): 49°33′03″N, 20°00′40″E.
209. EG 2011 – Skałka peak near the Lepietnica stream valley (tributary of the Dunajec River) (850–860 m): 49°32′45″N, 20°00′00″E.
210. EG 2012 – Stare Wierchy peak near the Lepietnica stream valley (tributary of the Dunajec River) (940 m): 49°33′28″N, 20°02′00″E.
211. EG 2012 – Średni Wierch peak under the Polana Stusy meadow (940 m): 49°32′49″N, 20°02′30″E.
212. EG 2012 – Polana Michałówka meadow near the Obidowiec stream valley (tributary of the Lepietnica stream) (820 m): 49°33′03″N, 20°02′38″E.
213. EG 2012 – Polana Stusy meadow near Średni Wierch (980 m): 49°32′45″N, 20°02′50″E.
214. EG 2012 – Polana Tynowe meadow near Średni Wierch (1020 m): 49°32′45″N, 20°02′15″E.
215. EG 2012 – Przygnatówka in the Lepietnica stream valley (tributary of the Dunajec River) (790–930 m): 49°32′49″N, 20°02′10″E.
216. EG 2012 – Slope of the Bukowina Obidowska peak near the Lepietnica stream valley (tributary of the Dunajec River) (860–920 m): 49°32′39″N, 20°02′00″E.
217. EG 2013 – Obidowiec stream valley, bottom (tributary of the Lepietnica stream) (820–880 m): 49°33′08″N, 20°03′15″E.
218. EG 2013 – Polana Kałużna meadow near the Średni Wierch peak (1100–1120 m): 49°32′50″N, 20°04′30″E.
219. EG 2013 – Polana Matuskowa meadow near the Obidowiec peak (990 m): 49°33′19″N, 20°04′20″E.
220. EG 2013 – Pod Solnisko meadow in the Lepietnica stream valley (tributary of the Dunajec River) (1140 m): 49°32′36″N, 20°04′10″E.
221. EG 2013 – Polana Spalone meadow near the top of the Średni Wierch peak (1080 m): 49°32′26″N, 20°03′50″E.
222. EG 2014 – Turbacz peak above the Rozdziele meadow („Suche Młaki") (1230 m): 49°32′49″N, 20°06′15″E.
223. EG 2014 – Lepietnica stream valley, middle part (tributary of the Dunajec River) (910–920 m): 49°32′24″N, 20°04′40″E.
224. EG 2014 – Lepietnica stream valley, upper part (tributary of the Dunajec River) (930 m): 49°32′24″N, 20°04′40″E.
225. EG 2014 – Kałużna meadow in the Lepietnica stream valley (tributary of the Dunajec River) (1120 m): 49°32′45″N, 20°04′50″E.
226. EG 2014 – Kocurka meadow between the Obidowiec peak and the Turbacz peak (1050 m): 49°33′13″N, 20°05′30″E.
227. EG 2020 – Klikuszowa – „Za Dworem" (670–690 m): 49°31′24″N, 19°58′25″E.
228. EG 2021 – „Suchy Dział" near the Lepietnica stream valley (tributary of the Dunajec River) (760–770 m): 49°31′32″N, 20°00′55″E.
229. EG 2022 – Ridge of the Bukowina Obidowska peak in the Lepietnica stream valley (tributary of the Dunajec River) (970 m): 49°32′00″N, 20°02′25″E.
230. EG 2022 – Polana Bernardowa meadow near the Bukowina Obidowska peak (800–810 m): 49°31′36″N, 20°02′30″E.
231. EG 2022 – Polana Kotlarka meadow near the Bukowina Obidowska peak (860–900 m): 49°31′49″N, 20°02′28″E.
232. EG 2022 – Polana Łapsowa Niżna meadow near the Bukowina Obidowska peak (880–890 m): 49°31′42″N, 20°01′50″E.
233. EG 2022 – Polana Łapsowa Wyżna near the Bukowina Obidowska peak (980–990 m): 49°31′58″N, 20°01′55″E.
234. EG 2022 – Polana Rożnowa meadow in the Lepietnica stream valley (tributary of the Dunajec River) (920–940 m): 49°32′00″N, 20°01′45″E.
235. EG 2023 – Potok Gazdy stream valley (tributary of the Kowaniec stream) (750–800 m): 49°31′19″N, 20°04′00″E.
236. EG 2023 – Polana Dermowa meadow in the Lepietnica stream valley (tributary of the Dunajec River) (920 m): 49°31′53″N, 20°03′20″E.
237. EG 2023 – Fenikowa Łąka meadow in the Lepietnica stream valley (tributary of the Dunajec River) (840 m): 49°32′10″N, 20°03′40″E.
238. EG 2023 – Fenikowa meadow in the Lepietnica stream valley (tributary of the Dunajec River) (890 m): 49°32′16″N, 20°04′13″E.
239. EG 2023 – Hudobowa meadow in the Lepietnica stream valley (tributary of the Dunajec River) (810–930 m): 49°32′10″N, 20°03′00″E.
240. EG 2023 – Polana Płowowa meadow in the Lepietnica stream valley (tributary of the Dunajec River) (990–1030 m): 49°31′52″N, 20°03′40″E.
241. EG 2023 – Polana Sepułowa meadow in the Lepietnica stream valley (tributary of the Dunajec River) (1090 m): 49°31′55″N, 20°03′40″E.
242. EG 2024 – Kowaniec Wielki stream valley, upper part (tributary of the Kowaniec stream) (1060 m): 49°31′41″N, 20°06′00″E.
243. EG 2024 – Bukowina Miejska meadow in the Lepietnica stream valley (tributary of the Dunajec River) (1150 m): 49°32′00″N, 20°05′25″E.
244. EG 2024 – the Bukowina Waksmundzka meadow near Kowaniec (1080 m): 49°31′24″N, 20°06′00″E.
245. EG 2024 – Kowaniec Wielki stream middle part, valley (tributary of the Kowaniec Stream) (900–1010 m): 49°31′24″N, 20°05′18″E.
246. EG 2030 – Klikuszowa – „Pod Gościńcem" (740 m): 49°31′00″N, 19°58′30″E.
247. EG 2031 – Buflak near Nowy Targ (720–750 m): 49°31′00″N, 20°01′00″E.
248. EG 2031 – Zadział near Nowy Targ (720 m): 49°30′26″N, 20°01′00″E.
249. EG 2032 – Ridge between the Potok Robów stream and the Potok Gazdy stream valleys (tributaries of the Kowaniec stream) (810–880 m): 49°31′00″N, 20°02′00″E.
250. EG 2033 – Bottom of the Kowaniec stream valley (tributary of the Dunajec River) under the Długa Polana meadow (690 m): 49°30′16″N, 20°04′00″E.
251. EG 2033 – Polana Dziubasówki meadow in the Kowaniec Wielki stream valley (tributary of the Kowaniec stream) (870 m): 49°31′00″N, 20°04′02″E.
252. EG 2034 – „Upłaz" in the Mały Kowaniec stream valley (tributary of the Kowaniec stream) (720 m): 49°30′19″N, 20°04′50″E.

253. EG 2034 – Lower part of the Kowaniec Wielki stream valley (tributary of the Kowaniec stream) (740–810 m): 49°31′00″N, 20°05′00″E.

254. EG 2034 – Czuba Ostrowska peak near Kowaniec (850 m): 49°30′24″N, 20°05′40″E,

255. EG 2034 – Polana Brożek meadow in the Mały Kowaniec stream valley (tributary of the Kowaniec stream) (930–950 m): 49°30′49″N, 20°05′30″E.

256. EG 2034 – Polana Sralówki meadow above the Polana Brożek meadow (960 m): 49°31′03″N, 20°05′45″E.

257. EG 2034 – Meadow on the bottom of the Mały Kowaniec stream valley (tributary of the Kowaniec stream) under Czuba Ostrowska (780 m): 49°30′21″N, 20°05′15″E.

258. EG 2034 – Meadow on the bottom of the Mały Kowaniec stream valley (tributary of the Kowaniec stream) above „Upłaz" (750 m): 49°30′21″N, 20°05′15″E.

259. EG 2034 – Junction of the Mały Kowaniec stream and the Wielki Kowaniec stream valleys (initial section of the Kowaniec stream) (710 m): 49°30′19″N, 20°04′35″E.

260. EG 2043 – Przełęcz Czarnotówka pass near the Czuba Ostrowska peak (740 m): 49°30′00″N, 20°04′00″E.

261. EG 2044 – Waksmundzki Potok stream valley (tributary of the Dunajec River) (620–640 m): 49°29′32″N, 20°04′43″E.

262. EG 2044 – Styrek peak near the Czuba Ostrowska peak (780 m): 49°29′49″N, 20°05′20″E.

263. EG 2100 – Saddle between the Spalone peak and the Kopieniec peak (1020 m): 49°34′10″N, 20°07′00″E.

264. EG 2100 – Area of the Trzemucha meadow near the Polana Gorc Troszacki meadow (1160–1190 m): 49°34′29″N, 20°06′30″E.

265. EG 2100 – The Pańskie Skole meadow near the Zielenica meadow (950 m): 49°33′45″N, 20°07′50″E.

266. EG 2101 – Mały Borek near the Przełęcz Borek pass in the Kamienica stream valley (980 m): 49°33′35″N, 20°09′00″E.

267. EG 2101 – Pod Przysłopek in the upper part of the Konina stream (tributary of the Poręba stream) (980 m): 49°34′00″N, 20°08′40″E.

268. EG 2101 – Jaworzyna Kamieniecka peak – near the top of the mountain (1210 m): 49°34′16″N, 20°09′25″E.

269. EG 2101 – Suchora peak near the Koninka stream valley (tributary of the Poręba stream) (800 m): 49°34′00″N, 20°09′35″E.

270. EG 2101 – Podmostownica meadow below the Mostownica meadow (970 m): 49°34′00″N, 20°08′15″E.

271. EG 2101 – Przysłopek meadow near the Przełęcz Borek pass (1100 m): 49°33′58″N, 20°09′15″E.

272. EG 2101 – Ustępne meadow on the Gorc Kamieniecki peak (960 m): 49°33′49″N, 20°08′50″E.

273. EG 2101 – The area of „Łysiny" on the Gorc Kamieniecki peak in the Kamienica stream valley (1000 m): 49°34′23″N, 20°08′50″E.

274. EG 2101 – The area of the Ustępne meadow on the Gorc Kamieniecki peak near the Kamienica stream valley (1000 m): 49°33′47″N, 20°09′10″E.

275. EG 2101 – Z Pod Figurek stream valley (tributary of the Konina stream) (930 m): 49°34′16″N, 20°08′40″E.

276. EG 2101 – The area of the Przełęcz Borek pass in the Kamienica stream valley (1000–1020 m): 49°33′34″N, 20°08′40″E.

277. EG 2102 – Las Zrąb near the Polanczyca meadow on the Kudłoń peak (1150 m): 49°33′58″N, 20°10′00″E.

278. EG 2102 – Miazgowa Młaka pool near The Stawieniec meadow in the Kamienica Stream valley (1050 m): 49°33′52″N, 20°11′00″E.

279. EG 2102 – Wspólne Młaki pool on the Kudłoń peak in the Kamienica stream valley (1010 m): 49°33′52″N, 20°10′40″E.

280. EG 2102 – Jaworzyna Kamieniecka peak near the Kamienica stream valley (960 m): 49°33′32″N, 20°10′00″E.

281. EG 2102 – the Kudłoń peak near the Konina stream valley (tributary of the Poręba stream) (1160 m): 49°34′08″N, 20°09′50″E.

282. EG 2102 – The area between Morskie Oko pond and the spring of the Wspólny Potok stream (tributary of the Kamienica stream) on the Kudłoń peak (1230 m): 49°34′16″N, 20°10′30″E.

283. EG 2102 – Between the Stawieniec stream and the Wspólny Potok stream (tributary of the Kamienica stream) (960 m): 49°33′36″N, 20°11′00″E.

284. EG 2102 – Near top of the Kudłoń peak (1240 m): 49°34′16″N, 20°10′15″E.

285. EG 2102 – Polana Gorc Troszacki meadow on the Kudłoń peak (1200 m): 49°34′23″N, 20°11′15″E.

286. EG 2102 – the Pod Kudłoniem meadow near top of the Kudłoń peak (1200 m): 49°34′26″N, 20°10′25″E.

287. EG 2102 – The area of Miazgowa Młaka pool on the Kudłoń peak (1100 m): 49°33′54″N, 20°11′00″E.

288. EG 2102 – Morskie Oko pond near the top of the Kudłoń peak (1240 m): 49°34′16″N, 20°10′43″E.

289. EG 2103 – „Do Staszka" below the Polanki Ganadrowe meadows in the Kamienica stream valley (800 m): 49°33′42″N, 20°12′30″E.

290. EG 2103 – Gorc Porębski meadow near the Gorc Troszacki meadow on the Kudłoń peak (1160 m): 49°34′19″N, 20°11′48″E.

291. EG 2103 – Stawieniec meadow in the Kamienica stream valley (1060 m): 49°33′54″N, 20°11′25″E.

292. EG 2103 – Polanki Ganadrowe meadows below the Gorc Porębski meadow in the Kamienica stream valley (1060 m): 49°33′57″N, 20°12′08″E.

293. EG 2104 – „Autobus" in the Kamienica stream valley below „Papieżówka" (750 m): 49°34′24″N, 20°14′10″E.

294. EG 2104 – „Do Żłobów" above the Ustępne meadow in the Kamienica stream (880 m): 49°33′32″N, 20°13′30″E.

295. EG 2104 – Upper part of the Ustępny Potok valley (tributary of the Kamienica stream) (970 m): 49°34′00″N, 20°14′30″E.

296. EG 2110 – Mostownica peak from the side of the Hala Turbacz meadow (1230 m): 49°33′08″N, 20°07′30″E.

297. EG 2110 – Turbacz peak from the side of the Kamienica stream valley (1250–1270 m): 49°32′36″N, 20°06′45″E.

298. EG 2110 – Turbacz peak in the area of the Hala Turbacz meadow from the side of the Rozdziele peak (1240 m): 49°32′49″N, 20°06′30″E.

299. EG 2110 – Czoło Turbacza meadow in the area of the Czoło Turbacza peak (1200 m): 49°33′16″N, 20°06′45″E.

300. EG 2110 – Długa Hala meadow near the Turbacz peak (1250): 49°32′41″N, 20°07′35″E.

301. EG 2110 – Hala Turbacz meadow near the Czoło Turbacza peak (1220 m): 49°33′00″N, 20°07′00″E.

302. EG 2110 – Area of the Jaworzyna Obidowska meadow between the Długie Młaki meadow and the Rozdziele peak (1230 m): 49°32′26″N, 20°07′25″E.

303. EG 2110 – Springs of the Olszowy Potok stream (tributary of the Koninka stream) on the Czoło Turbacza peak (1220 m): 49°33′03″N, 20°06′50″E.

304. EG 2111 – „Zielone Młaki" in the area of the Gabrowska meadow near the Kamienica stream valley (1260 m): 49°32′39″N, 20°08′50″E.

305. EG 2111 – Kiczora Kamieniecka peak near the Turbacz peak from the side of the Gabrowska meadow (1270 m): 49°32′29″N, 20°08′55″E.
306. EG 2111 – Kiczora Kamieniecka peak („Trzy Kopce") near the Turbacz peak (1260 m): 49°32′32″N, 20°09′00″E.
307. EG 2111 – Gabrowska meadow on the Kiczora Kamieniecka peak near the Turbacz peak (1200 m): 49°32′32″N, 20°08′40″E.
308. EG 2111 – Mostownica meadow on the Mostownica peak (1220 m): 49°33′19″N, 20°09′00″E.
309. EG 2111 – Wzorowa meadow near the Turbacz peak (1220 m): 49°32′41″N, 20°08′00″E.
310. EG 2111 – Chyżniocka meadow near the Gorc Kamieniecki peak (1070 m): 49°33′19″N, 20°08′30″E.
311. EG 2111 – Gabrowska meadow on the Kiczora Kamieniecka peak near the Turbacz peak (1260 m) locality: 49°32′32″N, 20°08′30″E.
312. EG 2112 – „Pod Dużym Mierdzyskiem" in the upper part of the Forędówka stream (tributary of the Ochotnica River) (1170 m): 49°32′41″N, 20°09′50″E.
313. EG 2112 – „Za Przechybkę" in the upper part of the Forędówka stream (tributary of the Ochotnica River) (1050 m): 49°32′26″N, 20°10′50″E.
314. EG 2112 – Jaworzyna Kamieniecka peak near the Kamienica stream valley (1150 m) locality: 49°33′00″N, 20°10′00″E.
315. EG 2112 – Jaworzyna Kamieniecka meadow on the Jaworzyna Kamieniecka peak (1200 m): 49°33′13″N, 20°09′38″E.
316. EG 2112 – Średniak meadow locality near the Jaworzyna Kamieniecka peak (1180 m): 49°33′00″N, 20°11′00″E.
317. EG 2112 – Polana Gorc Troszacki meadow near the Kudłoń peak (1230 m): 49°33′16″N, 20°10′50″E.
318. EG 2113 – Duże Jaszcze stream valley (tributary of the Jaszcze stream) (850 m): 49°32′19″N, 20°12′00″E.
319. EG 2113 – Duże Jaszcze stream valley (tributary of the Jaszcze stream) below the mouth of the Głęboki stream (900 m): 49°32′19″N, 20°11′40″E.
320. EG 2113 – Głęboki stream valley (tributary of the Duże Jaszcze stream) (1050 m): 49°32′49″N, 20°12′00″E.
321. EG 2113 – Bieniowe meadow in the Kamienica stream valley (1100 m): 49°33′10″N, 20°12′40″E.
322. EG 2113 – Borysówka meadow in the Duże Jaszcze stream valley (tributary of the Jaszcze stream) (980 m): 49°32′32″N, 20°12′00″E.
323. EG 2113 – Łonna meadow in the Duże Jaszcze stream valley (tributary of the Jaszcze stream) (850 m); 49°32′23″N, 20°11′15″E.
324. EG 2113 – Przysłop Górny meadow between the Jaworzyna Kamieniecka peak and the Gorc Kamieniecki peak (1120 m): 49°33′00″N, 20°11′30″E.
325. EG 2113 – Przysłop meadow between the Jaworzyna Kamieniecka and Gorc Kamieniecki peaks (1150 m): 49°33′00″N, 20°12′00″E.
326. EG 2114 – Świnkówka meadow in the area of Gorc Kamieniecki (1070 m): 49°33′11″N, 20°14′30″E.
327. EG 2114 – Skałka peak in the Jamne stream valley (triburary of the Ochotnica River) (1010 m) locality: 49°33′06″N, 20°13′20″E.
328. EG 2114 – Sołtysówka in the Jamne stream valley locality (triburary of the Ochotnica River) (740–760 m): 49°32′19″N, 20°14′15″E.
329. EG 2120 – Łopuszna stream valley (tributary of the Dunajec River) (790 m): 49°31′28″N, 20°07′25″E.
330. EG 2120 – Długie Młaki meadow in the area of the Turbacz peak (1230 m): 49°32′16″N, 20°06′40″E.
331. EG 2120 – Polana Świderowa meadow locality below the Długie Młaki meadow near the Turbacz peak (1180 m): 49°32′00″N, 20°06′25″E.
332. EG 2120 – Zadek meadow in the Łopuszna stream valley locality (tributary of the Dunajec River) (980 m): 49°31′24″N, 20°06′38″E.
333. EG 2121 – Dzigowa meadow near the Zielenica meadow (1100 m): 49°31′41″N, 20°08′30″E.
334. EG 2121 – Hala Młyńska (Cioski Łopuszańskie) meadow in the area of the Kiczora Kamieniecka peak near Turbacz peak (1220 m): 49°32′10″N, 20°09′00″E.
335. EG 2121 – Jonkówki (Jankówki) meadow near the Zielenica meadow (1080 m): 49°31′32″N, 20°08′20″E.
336. EG 2121 – Kułachowa meadow locality near the Zielenica meadow (1050 m): 49°31′39″N, 20°08′13″E.
337. EG 2121 – Polana Nowa meadow near the Hala Młyńska meadow in the area of the Kiczora Kamieniecka peak near the Turbacz peak (1220 m): 49°32′08″N, 20°08′45″E.
338. EG 2121 – Zielenica meadow in the area of the Kiczora Kamieniecka peak near the Turbacz peak (1200 m): 49°31′49″N, 20°08′45″E.
339. EG 2122 – Forędówka stream valley bottom (tributary of the Ochotnica River) above the Polana Sarnia meadow (900–920 m): 49°31′36″N, 20°10′25″E.
340. EG 2122 – Magurki peak near the Forędówka stream valley (tributary of the Ochotnica River) (960–1010 m): 49°31′36″N, 20°10′55″E.
341. EG 2122 – Polana Sarnia meadow in the Forędówka stream valley (tributary of the Ochotnica River) (840–850 m): 49°31′36″N, 20°10′25″E.
342. EG 2122 – Szlagowa meadow in the Duże Jaszcze stream valley locality (tributary of the Ochotnica River) (1050 m): 49°31′52″N, 20°11′10″E.
343. EG 2122 – Wierch Znaki peak in the Forędówka stream valley (tributary of the Ochotnica River) (840–910 m): 49°31′32″N, 20°10′00″E.
344. EG 2123 – Borsuczyny peak from the side of the Forędówka stream valley (tributary of the Ochotnica River) (900 m): 49°31′16″N, 20°12′00″E.
345. EG 2123 – Borsuczyny peak from the side of the Jaszcze stream valley (tributary of the Ochotnica River) (770–930 m): 49°31′19″N, 20°12′20″E.
346. EG 2123 – Magurki meadow in the Duże Jaszcze stream valley (tributary of the Jaszcze stream) (1070 m): 49°31′45″N, 20°11′40″E.
347. EG 2124 – Jaszcze stream valley bottom (tributary of the Ochotnica River) (700–760): 49°31′41″N, 20°13′00″E.
348. EG 2124 – Skalisty Gronik peak in the Jamne stream valley locality (tributary of the Ochotnica River) (760–800 m): 49°31′19″N, 20°14′00″E.
349. EG 2130 – Łopuszna stream valley bottom (tributary of the Dunajec River) (700–750 m): 49°30′52″N, 20°07′30″E.
350. EG 2130 – Polana Cyrlica meadow in the Łopuszna stream valley (tributary of the Dunajec River) (900 m): 49°30′54″N, 20°07′00″E.
351. EG 2130 – Polana Haneczkowa meadow in the area of the Mały Kowaniec stream valley (tributary of the Kowaniec stream) (900 m): 49°30′49″N, 20°06′23″E.
352. EG 2130 – Polana Kunkowa meadow below the Polana Rejcówki meadow (890 m): 49°30′49″N, 20°06′15″E.
353. EG 2130 – Rejcówki meadow in the Mały Kowaniec stream valley (tributary of the Kowaniec stream) (950 m): 49°31′00″N, 20°06′15″E.
354. EG 2130 – Meadow under the Wysznia meadow in the Łopuszna stream valley (tributary of the Dunajec River) (840 m): 49°30′49″N, 20°07′40″E.

355. EG 2131 – „Błędowa Młaka" near Stawek Pucołowski pond (920 m): 49°31′00″N, 20°08′40″E.
356. EG 2131 – Chłapkowy Potok stream valley (tributary of the Łopuszna stream) (950 m): 49°31′00″N, 20°08′50″E.
357. EG 2131 – Fiedorówka meadow in the Furcówka stream valley (tributary of the Ochotnica River) (930–950 m): 49°31′08″N, 20°09′10″E.
358. EG 2131 – Polana Homelka meadow in the Furcówka stream valley (tributary of the Ochotnica River) (910–920 m): 49°31′13″N, 20°09′23″E.
359. EG 2131 – Meadow below Stawek Pucołowski pond in the Łopuszna stream valley (tributary of the Dunajec River) (920 m): 49°30′57″N, 20°08′15″E.
360. EG 2131 – Stawek Pucołowski pond in the Łopuszna stream valley (tributary of the Dunajec River) (970 m): 49°30′57″N, 20°08′30″E.
361. EG 2132 – Bartoszówka locality in the Furcówka stream valley (tributary of the Ochotnica River) (910–930 m): 49°31′13″N, 20°09′38″E.
362. EG 2132 – Mouth of the Furcówka stream locality (tributary of the Ochotnica River) (780–820 m): 49°30′39″N, 20°10′45″E.
363. EG 2133 – Ochotnica Górna – the area of Ustrzyk (670 m): 49°30′32″N, 20°11′40″E.
364. EG 2140 – Migrąd stream valley lower part (tributary of the Dunajec River) (660 m): 49°29′10″N, 20°07′10″E.
365. EG 2140 – Migrąd stream valley upper part (tributary of the Dunajec River) (690–710 m): 49°29′29″N, 20°07′00″E.
366. EG 2141 – Chorobowska peak near Koszary Harklowskie in the vicinity of Knurów (810–830 m): 49°30′10″N, 20°09′25″E.
367. EG 2141 – Łopuszna village near Nowy Targ – fish ponds (630 m): 49°29′39″N, 20°08′15″E.
368. EG 2142 – „Ruwinki" near Koszary Harklowskie in the vicinity of Knurów (740 m): 49°29′24″N, 20°10′00″E.
369. EG 2142 – Koszary Harklowskie – area in the vicinity of Knurów (750–830 m): 49°29′49″N, 20°09′35″E.
370. EG 2200 – Hale Gorcowskie – meadow above the Hale Gorcowe meadow in the Gorcowy Potok stream valley (tributary of the Ochotnica River) (1080 m): 49°33′32″N, 20°15′05″E.
371. EG 2200 – Polana Gorc Młynieński – meadow on the Gorc Kamieniecki peak (1060 m): 49°34′00″N, 20°16′00″E.
372. EG 2200 – Mraźnica meadow in the area of the Gorc Kamieniecki peak (1100 m): 49°33′57″N, 20°15′45″E.
373. EG 2200 – Springs of the Głębieniec stream („Do Smoka") (tributary of the Kamienica stream) (1100 m): 49°34′19″N, 20°14′40″E.
374. EG 2201 – Łąka Rąbańczyska – meadow below the ridge of Strzelowskie in the Młynne stream valley (tributary of the Ochotnica River) (750 m): 49°33′26″N, 20°17′25″E.
375. EG 2201 – Polana Tokarka – meadow on the Lelonek peak near the Gorc Kamieniecki peak (980 m): 49°34′06″N, 20°16′30″E.
376. EG 2201 – Meadow above the Przełęcz Wierch Młynne pass near the Gorc Kamieniecki peak (800 m): 49°34′16″N, 20°17′30″E.
377. EG 2201 – Meadow on the ridge of Strzelowskie in the Młynne stream valley (tributary of the Ochotnica River) (800 m): 49°33′32″N, 20°17′00″E.
378. EG 2202 – „Kotelniki" below the ridge of Strzelowskie in the Młynne stream valley (tributary of the Ochotnica River) (680 m): 49°33′32″N, 20°18′00″E.
379. EG 2202 – Młynne stream valley – bottom (tributary of the Ochotnica River) below the Przełęcz Wierch Młynne pass (660–690): 49°33′49″N, 20°18′15″E.
380. EG 2202 – Żdżar peak above Chrobaki hamlet (Ochotnica Dolna – Młynne) (700 m): 49°33′50″N, 20°18′50″E.
381. EG 2202 – Żdżar peak near the Twarogi peak in the vicinity of Kamienica (720 m): 49°34′10″N, 20°19′13″E.
382. EG 2202 – Przełęcz Wierch Młynne pass near Ochotnica Dolna (730 m): 49°34′16″N, 20°18′00″E.
383. EG 2203 – Podkąty hamlet of the Kamienica village – (620 m): 49°34′08″N, 20°20′20″E.
384. EG 22031 – Klikuszowianka stream valley (tributary of the Dunajec River) (700–750 m): 49°30′46″N, 20°00′25″E.
385. EG 2210 – Hale Gorcowe meadow in the Gorcowy stream valley (tributary of the Ochotnica River) (980–1030 m): 49°33′15″N, 20°15′18″E.
386. EG 2210 – Gorc Kamieniecki meadow on the Gorc Kamieniecki peak (1130 m): 49°33′10″N, 20°15′15″E.
387. EG 2212 – Gorcowy Potok stream valley – sacred spot Dzieliki (tributary of the Kamienica stream) (640–650 m): 49°32′19″N, 20°18′25″E.
388. EG 2213 – Cisowy Potok stream valley upper part – Zawiersze (tributary of the Ochotnica River) (580 m): 49°33′10″N, 20°20′13″E.
389. EG 2213 – Bukowina meadow in the upper part of the Górkowy Potok stream (tributary of the Kamienica stream) (700–710 m): 49°32′40″N, 20°19′55″E.
390. EG 2213 – Kamienica village – Kleniny hamlet near the Żdżar peak (600–640 m): 49°33′12″N, 20°19′48″E.
391. EG 2214 – Cisowy Potok stream valley (tributary of the Ochotnica River) – Zagródki (510 m): 49°33′02″N, 20°21′17″E.
392. EG 2220 – Stefankowa valley in Ochotnica Górna (600–650 m): 49°31′24″N, 20°15′53″E.
393. EG 2221 – „Cycyniówka" sacred spot in the Skrodne Potok stream valley (tributary of the Ochotnica River) (680–690 m): 49°31′55″N, 20°17′30″E.
394. EG 2221 – Skrodne Potok stream valley lower part (tributary of the Ochotnica River) (550 m): 49°31′32″N, 20°17′30″E.
395. EG 2221 – Ochotnica River valley – bottom (tributary of the Dunajec River) near the border of Ochotnica Dolna and Ochotnica Górna (550 m): 49°31′10″N, 20°17′00″E.
396. EG 2221 – Skrodne Potok stream valley – upper part (tributary of the Ochotnica River) (710–740 m): 49°31′55″N, 20°16′40″E.
397. EG 2221 – Świnie Czoło meadow in the Łopuszna stream valley (tributary of the Dunajec River) (1010 m): 49°31′41″N, 20°16′40″E.
398. EG 2222 – Gorcowy stream valley – lower part (tributary of the Ochotnica River) (550 m): 49°32′00″N, 20°18′25″E.
399. EG 2222 – Ochotnica River valley in the area of the mouth of the Młynne stream (530 m): 49°31′32″N, 20°19′00″E.
400. EG 2223 – Ochotnica River valley – lower part (440–470 m): 49°31′41″N, 20°21′00″E.
401. EG 2224 – Ochotnica Dolna – Rola, locality (500–540 m): 49°31′49″N, 20°22′00″E.
402. EG 2224 – Osobie hamlet of the Ochotnica Dolna village locality (600 m): 49°31′55″N, 20°22′30″E.
403. EG 2224 – Twarogi hamlet of the Ochotnica Dolna village locality (760 m): 49°32′06″N, 20°22′00″E.
404. EG 2230 – Ochotnica River valley – bottom, in Ochotnica Górna (600 m): 49°30′42″N, 20°15′00″E.
405. EG 2320 – Buciory hamlet of Ochotnica Dolna village (540 m): 49°32′00″N, 20°23′00″E.
406. EG 2320 – Tylmanowa – valley of the left tributary of the Ochotnica River (430 m): 49°31′16″N, 20°23′40″E.
407. EG 2331 – Dunajec River valley area of Wietrznice near Tylmanowa (390 m): 49°31′00″N, 20°25′00″E.

408. EG 3004 – Ściekły Potok stream valley (tributary of the Dunajec River) near Ostrowsko (590 m): 49°29′00″N, 20°06′00″E.
409. EG 3100 – Zawodzie hamlet of the Ostrowsko village – near Nowy Targ (580): 49°28′49″N, 20°06′33″E.

List of taxa

Remarks on the list of taxa

1. Systematics follow Tomaszewicz (1988). Within genera, species are given in alphabetical order.

2. Current species nomenclature was taken from the works cited above, and also Algaebase (Guiry & Guiry 2015) and Index Nominum Algarum (University Herbarium, University of California, Berkeley). Current names of taxa are italicized and bolded. Synonyms corresponding to a given species (including its varieties) from Polish territory are given in square brackets.

3. Species descriptions are given as follows:

(a) the most important diagnostic characters of each species are described from specimens collected in the Gorce Mts. They include: cell length (L), cell width (W), ratio (L/W) and, where needed, the width of the isthmus (I) and apex (Ap). If the cell has spines, their dimensions are given in parentheses and are not included in the dimensions of whole cell (e.g., *Actinotaenium spinospermum*, *Closterium calosporum*, *Euastrum elegans*, *Micrasterias papillifera*);

b) scale bars are included with each microphotograph according to which drawings were elaborated;

c) for occurrence in Poland, species cited in more than 20 publications from Poland are described as very often reported, and those cited in 10–20 publications (Wołowski & Siemińska 2003) are described as often reported. For less frequent species the list gives the macroregions in which they were found and the authors reporting them last;

d) habitat characteristics include the type of habitat in which the species was found, pH range, and elevation above sea level;

e) the number of stations in the Gorce Mts in which the particular species were found is given, followed by the number of stations in the foothill zone (FZ), lower montane zone (LMZ), upper montane zone (UMZ), Turbacz range (TR) and Lubań range (LR). The frequency of occurrence in the Gorce area, in particular ranges, and in particular zones, are given in parentheses. These frequency values are ratios of the number of stations of a given species to the sum of all localities in which the desmids were identified in the whole Gorce area (409 total localities), Lubań range (79), Turbacz range (330), foothill zone (48), lower montane zone (322) and upper montane zone (39);

f) for species that are rare in the Gorce Mts (up to 10 stations), all stations are given. For the rest, one station is given per 10 × 10 km grid square. Their range of elevation above sea level is given.

4. All localities (bolded) are numbered in the index of geographical names. These are the ordinal numbers used in the list of localities, grouped within their 2 × 2 km ATPOL grid squares.

5. The distribution maps of the desmid species in the Gorce area are given in alphabetical order (see Appendix 1).

Abbreviations of generic names: *Ac.* – *Actinotaenium*, *C.* – *Cylindrocystis*, *Ca.* – *Calocylindrus*, *Cl.* – *Closterium*, *Co.* – *Cosmarium*, *Cos.* – *Cosmoastrum*, *Dy.* – *Dysphinctum*, *D* – *Desmidium*, *Eu.* – *Euastrum*, *G.* – *Gonatozygon*, *Ho.* – *Holacanthum*, *Hy.* – *Hyalotheca*, *M.* – *Mesotaenium*, *Mc.* – *Micrasterias*, *Nt.* – *Netrium*, *P.* – *Penium*, *Pl.* – *Pleurotaenium*, *Pls.* – *Pleurotaeniopsis*, *St.* – *Staurastrum*, *Std.* – *Staurodesmus*, *T.* – *Tetmemorus*.

Actinotaenium (Nägeli) Teiling

Actinotaenium borgeanum (Skuja) Kouwets et Coesel [*P. borgeanum* Skuja] (Figs 1: 11; 2: 11a–b; Map 1)

Description. Cells cylindrical, tapering to rounded apices. Girdle bands absent. Chloroplasts plate-shaped, with single pyrenoid. Cell wall with fine longitudinal striae. L: 25, W: 12.5, L/W: 2.0.

Distribution in Poland. Not recorded.

Habitat. *Sphagnum* puddles, moist soil on roads, wet mosses of *Bryidae* class in marshes, pH range 6.5, altitude range 580–1090 m.

Number of localities in the Gorce Mts: 5 (0.012).
Turbacz range: 5 (0.012): **94**, **241**, **244**, **375**, **382**.
Lubań range: Not recorded.
Foothill zone: 1 (0.021), Lower montane zone: 4 (0.013).

Actinotaenium cruciferum (de Bary) Teiling [*P. cruciferum* (de Bary) Wittrock] (Figs 1: 6, 6a; 2: 6a–b; Map 2)

Description. Cells cylindrical to elliptical, slightly constricted. Sinus very shallow. Semicells semi-elliptical, with slightly convex margins and apices. Chloroplast star-shaped, with single pyrenoid. Cell wall smooth. L: 15–25, W: 10–12.5, L/W: 1.5–2.0.

Distribution in Poland. Mazovian Lowland (Tomaszewicz 1988), Pomeranian Lakeland (Torka 1913).

Habitat. *Sphagnum* puddles, puddles on roads, wet mosses of *Bryidae* class, puddles in marshes, pH range 6.0–6.5, altitude range 800–1220 m.

Number of localities in the Gorce Mts: 5 (0.012).
Turbacz range: 4 (0.012): **185**, **301**, **357**, **359**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 4 (0.012), Upper montane zone: 1 (0.021).

Actinotaenium cucurbita (Brébisson ex Ralfs) Teiling [*Ca. cucurbita* (Brébisson) Kirch- ner, *Co. cucurbita* Brébisson in Ralfs, *Dy. cucurbita* (Brébisson) Reinsch in Bayley] (Figs 1: 8, 8a; 2: 8a–b; Map 3)

Description. Cells elliptical, very slightly constricted. Sinus very shallow. Semicells semi-elliptical, with parallel or slightly convex margins and convex apices. Chloroplasts plate-shaped, with single pyrenoid. Cell wall punctate. L: 25–55, W: 10–25, L/W: 1.5–2.8.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles and moist soil on roads and paths, wet mosses of *Bryidae* class, puddles, old wells in marshes, oxbow lakes, temporary waterbodies, fish ponds, pH range 4.7–8.5, altitude range 430–1230 m.

Number of localities in the Gorce Mts: 61 (0.149).
Turbacz range: 53 (0.161): **85**, **95**, **160**, **176**, **234**.
Lubań range: 8 (0.101): **3**, **21**, **69**.
Foothill zone: 5 (0.104), Lower montane zone: 47 (0.146), Upper montane zone: 9 (0.231).

Actinotaenium cucurbitinum (Bisset) Teiling [*P. cucurbitinum* Bisset] (Figs 1: 7; 2: 7a–b; Map 4)

Description. Cells cylindrical, very slightly constricted. Sinus very shallow. Semicells semi-elliptical, with strongly convex apices and slightly convex margins. Chloroplasts star-shaped, with single pyrenoid. Cell wall punctate. L: 55–90, W: 25–40, L/W: 1.8–3.0.

Distribution in Poland. Carpathian Mts (Gutwiński 1909), Southern Wielkopolska Lowland (Lesiak 1990), Mazovian Lowland (Tomaszewicz 1988).

Habitat. Puddles and moist soil on roads and paths, wet mosses of *Bryidae* class, puddles, old wells in marshes, oxbow lakes, fish ponds, pH range 5.5–8.6, altitude range 430–1220 m.

Number of localities in the Gorce Mts: 72 (0.176).
Turbacz range: 59 (0.179): **106**, **160**, **181**, **252**, **406**.
Lubań range: 13 (0.165): **3**, **28**, **52**, **69**.
Foothill zone: 9 (0.186), Lower montane zone: 60 (0.186), Upper montane zone: 3 (0.077).

Actinotaenium curtum (Brébisson ex Ralfs) Teiling [*Co. curtum* Brébisson ex Ralfs, *Ca. attenuatus* (Brébisson) Raciborski, *Ca. curtus* (Brébisson) Kirchner, *Dy. curtum* (Brébisson) Nägeli, *P. curtum* (Brébisson) Brébisson in Kützing] (Figs 1: 3; 2: 3; Map 5)

Description. Cells elliptical, very slightly constricted. Sinus very shallow. Semicells semicircular, with strongly convex apices and margins. Chloroplasts star-shaped, with single pyrenoid. Cell wall punctate. L: 25, W: 17, L/W: 1.5.

Notes. Only specimens belonging to var. *globosa* Wille fo. minor Wille were recorded in the material.

Distribution in Poland. Sudety Mts (Schröder 1896), Carpathian Mts (Wasylik 1971), Silesian Lowland (Schröder 1895).

Habitat. Moist soil on road, pH range 7.4, altitude range 700 m Number of localities in the Gorce Mts: 1 (0.002).

Turbacz range: 1 (0.003): **165**.
Lubań range: Not recorded.
Lower montane zone: 1 (0.003).

Actinotaenium didymocarpum (P. Lundell) Coesel et Delfos [*P. didymocarpum* P. Lundell] (Figs 1: 12; 2: 12; Map 6)

Description. Cells elliptico-cylindrical, with broadly rounded apices and single girdle band. Chloroplasts plate-shaped, with single pyrenoid. Cell wall smooth, without ornamentation. L: 27.5, W: 12.5, L/W: 2.2.

Distribution in Poland. Carpathian Mts (Gutwiński 1895), Pomeranian Lakeland (Bohr 1967).

Habitat. *Sphagnum* puddles, puddles in marshes, pH range 6.0–7.2, altitude range 870–1030 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 1 (0.003): **240**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 2 (0.006).

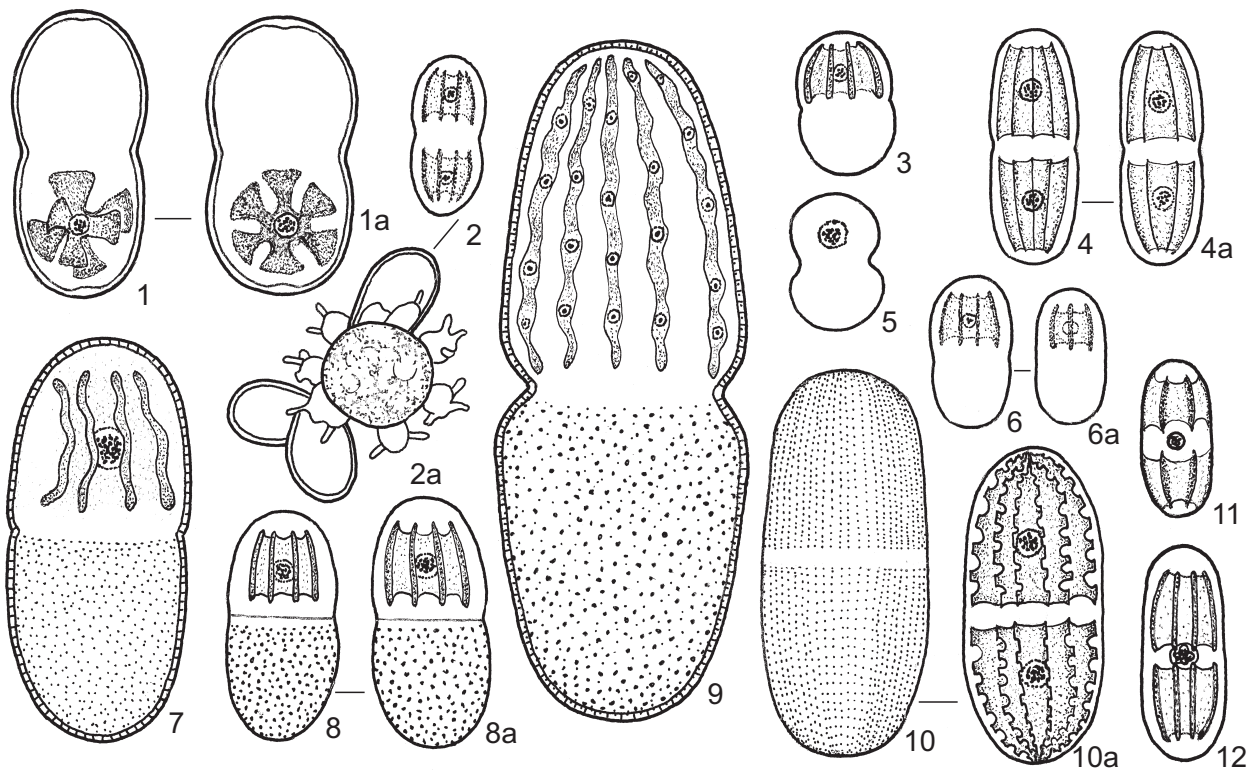

Figure 1. *Actinotaenium*. 1, 1a – *Actinotaenium diplosporum*; 2, 2a – *Ac. spinospermum*; 3 – *Ac. curtum*; 4, 4a – *Ac. gelidum*; 5 – *Ac. perminutum*; 6, 6a – *Ac. cruciferum*; 7 – *Ac. cucurbitinum*; 8, 8a – *Ac. cucurbita*; 9 – *Ac. turgidum*; 10, 10a – *Ac. silvae-nigrae;* 11 – *Ac. borgeanum*; 12 – *Ac. didymocarpum*. Drawings E. Nowotarska.

Actinotaenium diplosporum (P. Lundell) Teiling [*C. americana* P. Lundell, *C. diplosporum* P. Lundell] (Figs 1: 1, 1a; 2: 1a–b; Map 7)

Description. Cells cylindrical or guitar-shaped, very slightly constricted. Sinus very shallow. Semicells semi-elliptical, with convex apices and parallel or slightly convex margins. Chloroplasts star-shaped, with single pyrenoid. Cell wall punctate. L: 40–45, W: 20–30, L/W: 2.0–2.8.

Distribution in Poland. Lublin Upland (Eichler 1892), Masurian Lakeland (Szymańska 1984).

Habitat. *Sphagnum* puddles, puddles on roads and paths, moist soil on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes, pH range 5.1–7.8, altitude range 470–1230 m.

Number of localities in the Gorce Mts: 87 (0.213).
Turbacz range: 81 (0.245): **80**, **84**, **115**, **160**, **176**, **259**, **382**.
Lubań range: 6 (0.076): **3**, **53**, **65**, **73**.
Foothill zone: 6 (0.125), Lower montane zone: 76 (0.236), Upper montane zone: 5 (0.128).

Actinotaenium gelidum (Wittrock ex De Toni) Růžička & Pouzar (Figs 1: 4, 4a; 2: 4a–b; Map 8)

Description. Cells cylindrical, very slightly constricted. Sinus very shallow. Semicells semi-elliptical, with convex apices and margins. Chloroplasts plate-shaped, pectinate, with single pyrenoid. Cell wall punctate. L: 30–45, W: 12.5–15, L/W: 2.4–3.0.

Distribution in Poland. Not recorded.

Habitat. Polyhumic pond, wet mosses of *Bryidae* class in marshes, pH range 4.3–5.5, altitude range 800–1230 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 2 (0.006): **230**, **288**.
Lubań range: Not recorded.
Lower montane zone: 1 (0.003), Upper montane zone: 1 (0.026).

Actinotaenium perminutum (G. S. West) Teiling (Figs 1: 5; 2: 5; Map 9)

Description. Cells guitar-shaped, slightly constricted. Sinus widely open. Semicells semicircular, with convex apices and margins. Chloroplasts plate-shaped, with single pyrenoid. Cell wall smooth. L: 20–35, W: 10–12.5, L/W: 2.0–3.0.

Distribution in Poland. Not recorded.

Habitat. *Sphagnum* puddles, puddles and moist soil on roads, puddles and wet mosses of *Bryidae* class in marshes, pH range 4.9–7.4, altitude range 610–1210 m.

Number of localities in the Gorce Mts: 9 (0.022).
Turbacz range: 8 (0.024): **133**, **134**, **185**, **206**, **227**, **251**, **340**, **359**.
Lubań range: 1 (0.013): **34**.
Lower montane zone: 8 (0.025), Upper montane zone: 1 (0.026).

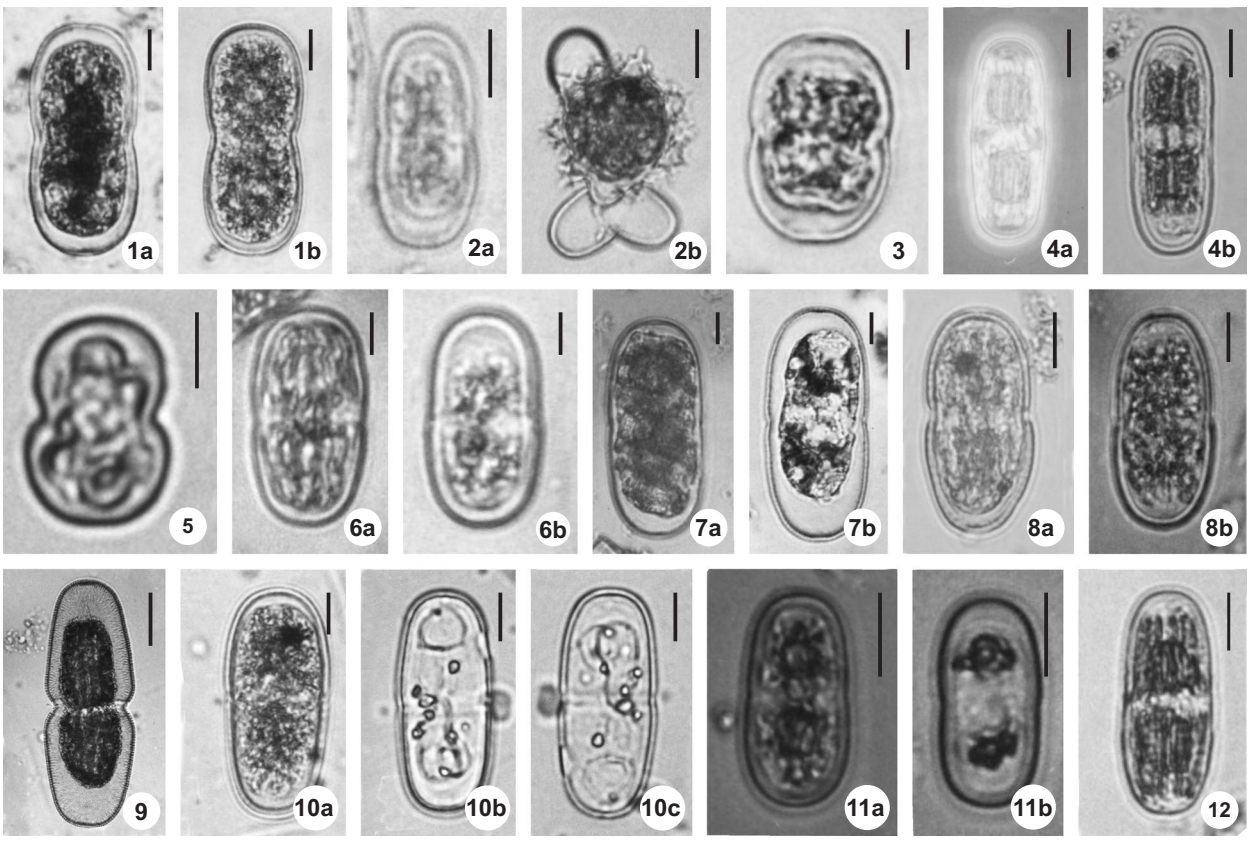

Figure 2. *Actinotaenium*. 1a–b – *Actinotaenium diplosporum*; 2a–b – *Ac. spinospermum*; 3 – *Ac. curtum*; 4a–b – *Ac. gelidum*; 5 – *Ac. perminutum*; 6a–b – *Ac. cruciferum*; 7a–b – *Ac. cucurbitinum*; 8a–b – *Ac. cucurbita*; 9 – *Ac. turgidum*; 10a–c – *Ac. silvae-nigrae*; 11a–b – *Ac. borgeanum*; 12 – *Ac. didymocarpum*; Scales: 1a–b, 2a, 4a–b, 7a–b, 8a–b, 10a–c, 11a–b, 12 = 10 µm; 2b = 20 µm; 3, 5, 6a–b = 5 µm; 9 = 50 µm. LM by M. Wayda.

Actinotaenium silvae-nigrae (Rabanus) Kouwets et Coesel [*P. silvae-nigrae* Rabanus]
(Figs 1: 10, 10a; 2: 10a–c; Map 10)

Description. Cells cylindrical, very slightly constricted. Sinus very faintly visible. Semicells semi-cylindrical, with rounded apices. Chloroplasts star-shaped, with single pyrenoid. Cell wall very delicate, longitudinal striae. L: 20–35, W: 10–12.5, L/W: 2.0–3.0.

Distribution in Poland. Southern Wielkopolska Lowland (Lesiak 1990), Mazovian Lowland (Tomaszewicz 1988), Pomeranian Lakeland (Bohr 1967).

Habitat. *Sphagnum* puddles, puddles and moist soil on roads, wet mosses of *Bryidae* class in marshes, pH range 5.5–7.5, altitude range 740–1270 m.

Number of localities in the Gorce Mts: 7 (0.02).
Turbacz range: 4 (0.008): **179**, **202**, **297**, **396**.
Lubań range: 3 (0.038): **21**, **34**, **66**.
Lower montane zone: 5 (0.016), Upper montane zone: 2 (0.05).

Actinotaenium spinospermum (Joshua) Kouwets et Coesel [*P. spinospermum* Joshua]
(Figs 1: 2, 2a; 2: 2a–b; Map 11)

Description. Cells cylindrical, very slightly constricted. Semicells semi-cylindrical, with rounded apices. Chloroplasts star-shaped, with single pyrenoid. Cell wall punctate. Round zygospores with cylindrical apices furnished with spines. L: 20–35, W: 10–12.5, L/W: 2.0–3.0.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. *Sphagnum* puddles, puddles and moist soil on roads, wet mosses of *Bryidae* class in marshes, pH range 5.8–7.5, altitude range 600–840 m.

Number of localities in the Gorce Mts: 8 (0.02).
Turbacz range: 8 (0.024): **134**, **137**, **167**, **175**, **176**, **192**, **260**, **382**.
Lubań range: Not recorded.
Lower montane zone: 8 (0.025).

Actinotaenium turgidum (Brébisson ex Ralfs) Teiling [*Ca. turgidus* (Brébisson) Kirchner, *Co. turgidum* (Brébisson) Hansgirg, *Pls. turgida* (Brébisson) De Toni]
(Figs 1: 9; 2: 9; Map 12)

Description. Cells elliptical to broadly rounded, fusiform; moderately constricted. Sinus widely open. Semicells semi-elliptical, with slightly convex margins and broadly rounded apices. Chloroplasts parietal, in the form of longitudinal bands with many pyrenoids. Cell wall punctate. L: 220–230, W: 80–95, L/W: 2.3–2.7.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic pond, pH range 5.5–7.1, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded. Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Closterium Nitzsch ex Ralfs

Closterium abruptum West
(Figs 3: 1, 1a; 4: 1a–b; Map 13)

Description. Cells slightly curved, in mid-region cylindrical, sometimes slightly constricted, and gradually attenuating towards ends. Apices truncately rounded, without endopores. Chloroplasts contain central row of pyrenoids. Girdle bands present. Cell wall smooth, sometimes with fine longitudinal striae. Zygospores spherical, with smooth wall; 30 µm in diameter. L: 100–250, W: 15–20, Ap: 7.5–12.5, L/W: 6.7–17.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads and paths, moist soil on roads, wet mosses of *Bryidae* class, puddles and old wells in marshes, stream springs, pH range 5.0–7.5, altitude range 600–1270 m.

Number of localities in the Gorce Mts: 36 (0.108).
Turbacz range: 35 (0.106): **103**, **137**, **185**, **240**, **351**.
Lubań range: 1 (0.013): **41**.
Lower montane zone: 26 (0.081), Upper montane zone: 10 (0.256).

Closterium acerosum Ehrenberg ex Ralfs
(Figs 3: 2, 2a; 4: 2a–b; Map 14)

Description. Cells nearly straight, sometimes slightly curved in mid-region; cylindrical, tapering to conical and often recurved apices; without endopores. Chloroplasts contain central row of pyrenoids. Girdle bands absent. Cell wall smooth, sometimes with fine longitudinal brownish striae. L: 225–700, W: 30–50, Ap: 10–12.5, L/W: 6–15.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Puddles, moist soil on roads, wet mosses of *Bryidae* class, puddles and old wells in marshes, streams (springs, oxbow lakes, lotic habitats among *Cladophora*), temporary waterbodies, fish ponds, pH range 5.1–8.5, altitude range 440–1270 m.

Number of localities in the Gorce Mts: 100 (0.244).
Turbacz range: 92 (0.279): **81**, **86**, **92**, **143**, **182**, **256**, **409**.
Lubań range: 8 (0.101): **1**, **10**, **47**, **67**, **78**.
Foothill zone: 14 (0.292), Lower montane zone: 77 (0.238), Upper montane zone: 9 (0.231).

Closterium acutum Brébisson [*Cl. linea* Perty, *Cl. pseudospirotaenium* Lemmermann]
(Figs 3: 5, 5a; 4: 5; Map 15)

Description. Cells nearly straight, gradually tapering to acutely rounded apices. Endopores absent. Chloroplasts contain central row of pyrenoids. Girdle bands absent. Cell wall smooth. L: 85–150, W: 5–7.5, Ap: 1, L/W: 17–20.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads, pH range 6.0–7.2, altitude range 730–990 m.

Number of localities in the Gorce Mts: 5 (0.012).
Turbacz range: 5 (0.015): **219**, **360**, **357**, **369**, **382**.
Lubań range: Not recorded.
Lower montane zone: 5 (0.016).

Closterium baillyanum (Brébisson ex Ralfs) Brébisson [*Cl. didymotocum* Ralfs var. *baillyanum* Brébisson in Ralfs] (Figs 5: 4; 6: 4; Map 16)

Description. Cells very slightly curved in mid-region, with parallel margins, gradually tapering to truncate apices with rounded angles. Endopores absent. Chloroplasts contain central row of pyrenoids. Girdle bands absent. Cell wall punctate, denser near apices. L: 115, W: 10, Ap: 2.5, L/W: 12.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. *Sphagnum* puddles, pH range 5.5–6.0, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**. Lower montane zone: 1 (0.003).

Closterium calosporum Wittrock (Figs 7: 7, 7a; 8: 7a–b; Map 17)

Description. Cells strongly curved, gradually tapering to abrupt apices with distinct endopores. Chloroplasts contain central row of pyrenoids. Girdle bands absent. Cell wall smooth. Zygospores globular, with firm conical spines; 30 μm in diameter. L: 115, W: 10, Ap: 2.5, L/W: 12.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. *Sphagnum* puddles, pH range 6.0–6.8, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Closterium closterioides (Ralfs) A. Louis et Peeters [*Cl. libellula* Focke ex Nordstedt, *P. libellula* Focke ex Nordstedt, *P. closterioides* Ralfs] (Figs 3: 7; 4: 7; Map 18)

Description. Cells straight, fusiform, with broadly rounded apices without endopores. Chloroplasts contain central row of pyrenoids. Girdle bands absent. Cell wall smooth. L: 115–250, W: 25–40, Ap: 10, L/W: 4.6–6.3.

Notes. Specimens belonging to var. *intermedium* (R. Roy et Bisset) Růžička were also recorded in the material. The variety is smaller and occurs together with the typical form.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, pH range 5.5–7.1, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Closterium cornu Ehrenberg ex Ralfs (Figs 7: 3; 8: 3; Map 19)

Description. Cells very slightly curved, gradually tapering to rounded apices without endopores. Chloroplasts contain central row of pyrenoids. Girdle bands absent. Cell wall smooth. L: 65–137.5, W: 5–10, Ap: 2.5, L/W: 13–17.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Puddles and moist soil on roads, pH range 7.4–8.1, altitude range 660–970 m.

Number of localities in the Gorce Mts: 3 (0.007).
Turbacz range: 3 (0.009): **146**, **227**, **239**.
Lubań range: Not recorded.
Lower montane zone: 3 (0.009).

Closterium costatum Corda ex Ralfs [*Cl. wagae* Gutwiński] (Figs 5: 6; 6: 6; Map 20)

Description. Cells moderately curved, gradually tapering to conical, sometimes capitate apices without en- dopores. Chloroplasts contain central row of pyrenoids. False girdle bands present. Cell wall coarsely costate. L: 250–320, W: 30–35, Ap: 10–15, L/W: 8–11.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on paths, old wells in marshes, pH range 4.9–7.0, altitude range 750–970 m.

Number of localities in the Gorce Mts: 4 (0.01).
Turbacz range: 3 (0.009): **272**, **293**, **360**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 4 (0.012).

Closterium cynthia De Notaris (Figs 9: 7, 7a; 10: 7a–c; Map 21)

Description. Cells strongly curved, gradually tapering to rounded apices with endopores. Chloroplasts contain central row of pyrenoids. Girdle bands present. Cell wall finely striated. L: 95–155, W: 15, Ap: 5, L/W: 6.3–10.3.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, puddles in marshes, pH range 6.0–7.4, altitude range 720–870 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 1 (0.003): **158**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 2 (0.006).

Closterium dianae Ehrenberg ex Ralfs [*Cl. arcuatum* Brébisson in Ralfs, *Cl. pseudodianae* R. Roy, *Cl. acuminatum* Kützing] (Figs 9: 3, 3a; 10: 3a–c; Map 22)

Description. Cells strongly curved, gradually tapering to elongated, abrupt apices with prominent endopores.

Chloroplasts contain central row of pyrenoids. Girdle bands absent. Cell wall smooth. L: 115–225, W: 12.5–25, Ap: 5, L/W: 9–18.

Notes. Forms belonging to var. *pseudodianae* (R. Roy) Krieger, which is more slender, and var. *minus* Hieronim, which is smaller than the typical variety, were recorded in the material.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, moist soil on roads, wet mosses of *Bryidae* class and puddles in marshes, pH range 6.0–7.2, altitude range 580–970 m.

Number of localities in the Gorce Mts: 6 (0.015).
Turbacz range: 5 (0.015): **115**, **234**, **283**, **360**, **388**.
Lubań range: 1 (0.013): **21**.
Foothill zone: 1 (0.021).
Lower montane zone: 5 (0.016).

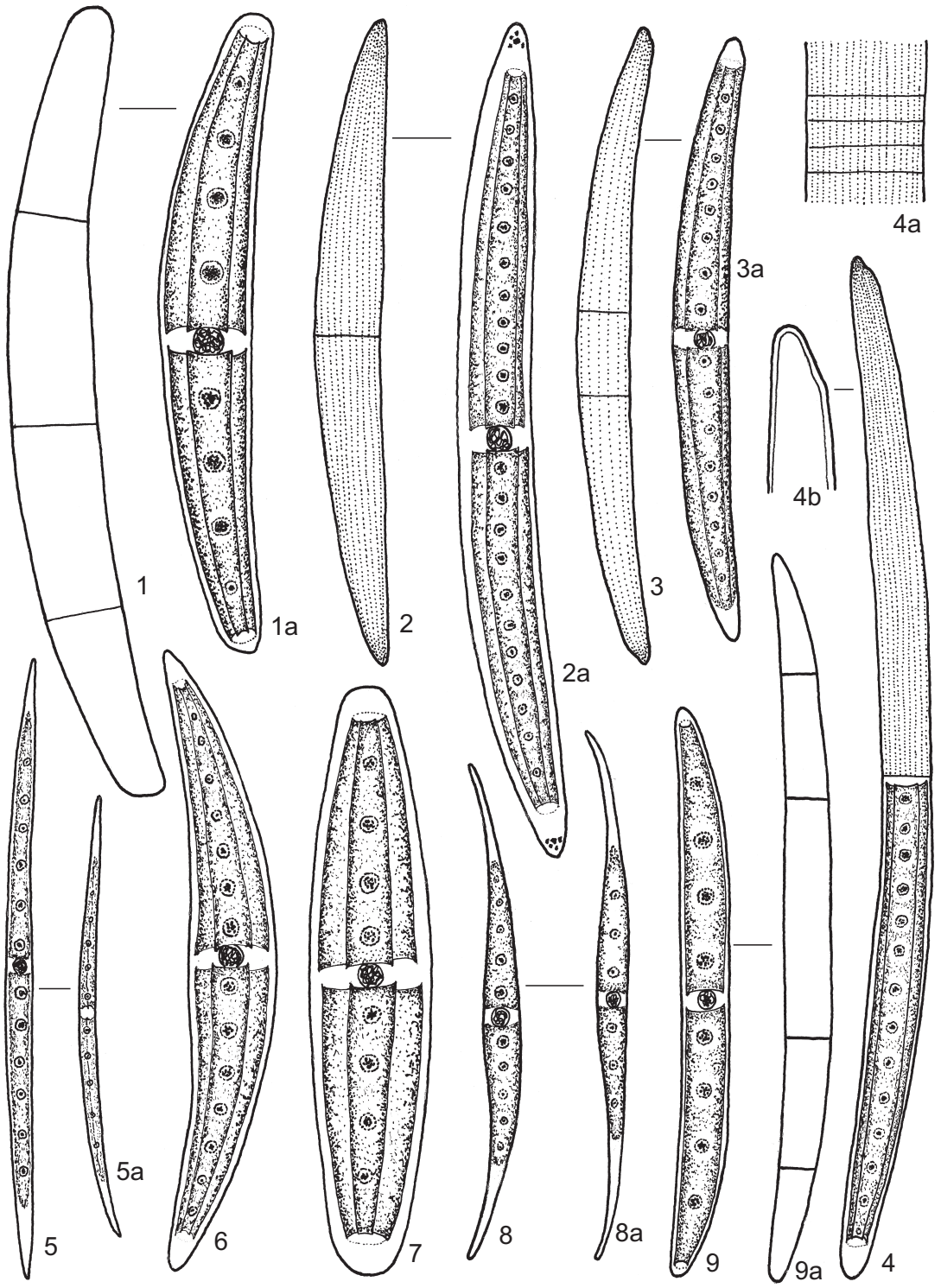

Figure 3. *Closterium*. 1, 1a – *Closterium abruptum*; 2, 2a – *Cl. acerosum*; 3, 3a – *Cl. praelongum* var. *brevius*; 4, 4a–b – *Cl. praelongum* var. *praelongum*; 5, 5a – *Cl. acutum*; 6 – *Cl. littorale*; 7 – *Cl. closterioides*; 8, 8a – *Cl. kuetzingii*; 9, 9a – *Cl. juncidum*. Drawings E. Nowotarska.

Closterium ehrenbergii Meneghini ex Ralfs [*Cl. moniliferum* (Bory) Ehenberg ex Brébisson var. *ehrenbergii* Meneghini ex Ralfs] (Figs 9: 2; 10: 2; Map 23)

Description. Cells strongly curved, gradually tapering to broadly rounded apices without endospores, ventral side of mid-region often flattened. Chloroplasts contain many small dispersed pyrenoids. Girdle bands absent. Cell wall smooth. L: 175–400, W: 40–55, Ap: 10–15, L/W: 4–7.5.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic waterbodies, puddles on roads and paths, moist soil on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes, oxbow lakes, pH range 6.7–8.7, altitude range 390–1270 m.

Number of localities in the Gorce Mts: 63 (0.154).
Turbacz range: 51 (0.155): **99**, **140**, **178**, **217**, **407**.
Lubań range: 12 (0.152): **3**, **21**, **67**.
Foothill zone: 3 (0.063), Lower montane zone: 46 (0.143), Upper montane zone: 14 (0.359).

Closterium exile West. et G. S. West (Figs 9: 10; 10: 10a–b; Map 24)

Description. Cells moderately curved, gradually tapering to acute apices without endopores. Chloroplasts contain two pyrenoids. Girdle bands absent. Cell wall smooth. L: 75, W: 8, Ap: 2.5, L/W: 9.4.

Distribution in Poland. Carpathian Mts (Kawecka 1965).

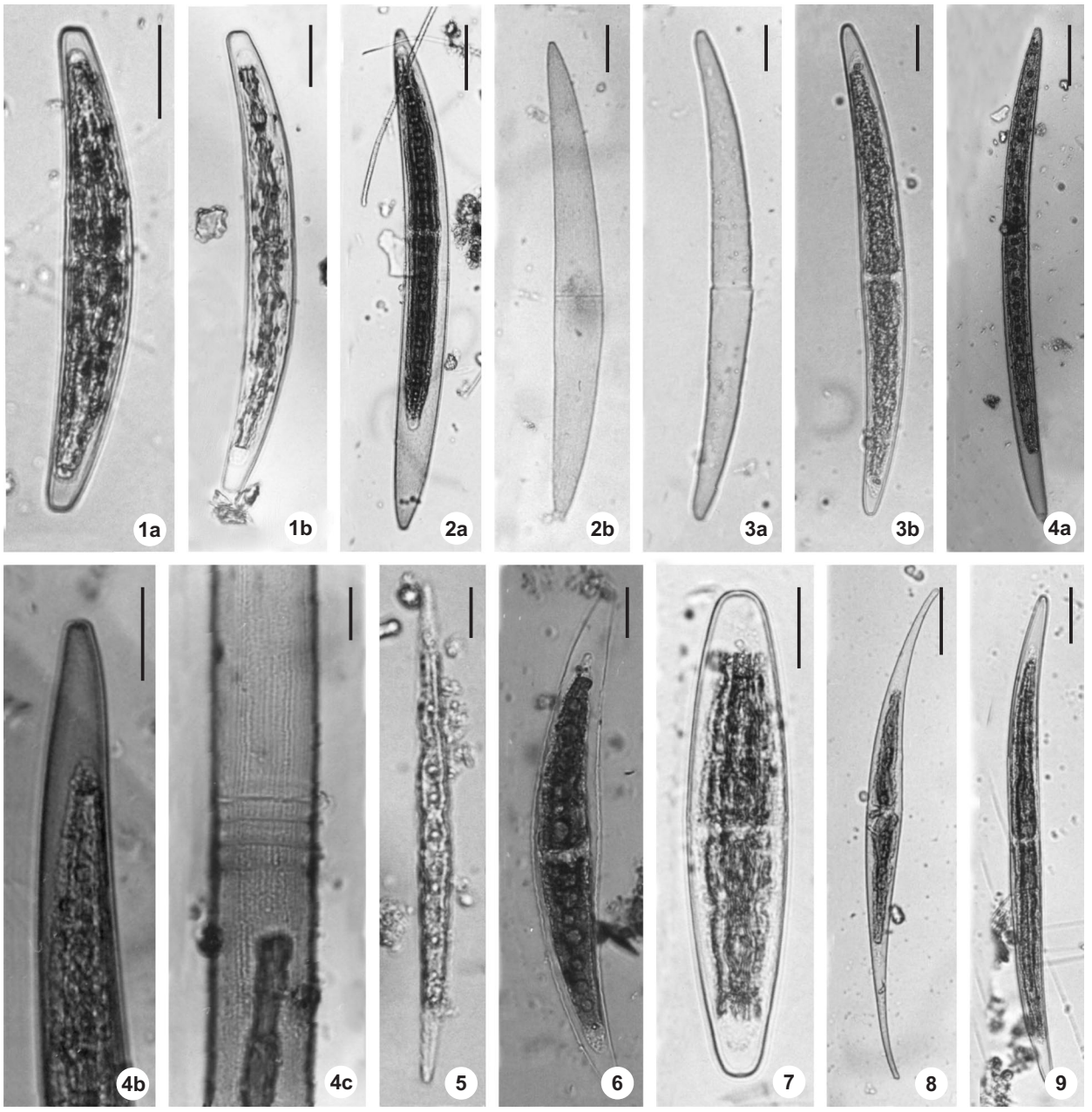

Figure 4. *Closterium*. 1a–b – *Closterium abruptum*; 2a–b – *Cl. acerosum*; 3a–b – *Cl. praelongum* var. *brevius*; 4a–c – *Cl. praelongum* var. *praelongum*; 5 – *Cl. acutum*; 6 – *Cl. littorale*; 7 – *Cl. closterioides*; 8 – *Cl. kuetzingii*; 9 – *Cl. juncidum*. Scales: 1a–b, 3a–b, 4b, 6–7, 9 = 20 µm; 2a–b, 4a, 8 = 50 µm; 4c, 5 = 10 µm. LM by M. Wayda.

Habitat. *Sphagnum* puddles, pH range 5.7, altitude range 1240 m Number of localities in the Gorce Mts: 1 (0.002).

Turbacz range: 1 (0.003): **296**. Lubań range: Not recorded.
Upper montane zone: 1 (0.026).

Closterium idiosporum West. et G. S. West
(Figs 9: 6; 10: 6; Map 25)

Description. Cells straight, sometimes slightly curved, tapering to elongate, rounded apices without endopores. Chloroplasts contain central row of pyrenoids. Girdle bands absent. Cell wall smooth. Cells often form flocculent colonies. L: 125–200, W: 7.5–12.5, Ap: 2.5 –5, L/W: 10–17.

Distribution in Poland. Mazovian Lowland (Tomaszewicz 1988), Pomeranian Lakeland (Oleksowicz 1986).

Habitat. Puddles and moist soil on roads, puddles and old wells in marshes, pH range 5.1–7.7, altitude range 700–1060 m.

Number of localities in the Gorce Mts: 5 (0.012).
Turbacz range: 3 (0.009): **129**, **155**, **292**.
Lubań range: 2 (0.026): **3**, **4**.
Lower montane zone: 5 (0.016).

Closterium intermedium Ralfs
(Figs 5: 1, 1a–b; 6: 1a–b; Map 26)

Description. Cells moderately curved, cylindrical in mid-region (sometimes slightly constricted), gradually ta- pering to truncately rounded apices without endopores. Chloroplasts contain central row of pyrenoids. Girdle bands present. Cell wall densely striate. L: 225–390, W: 20–35, Ap: 10–12.5, L/W: 7.5–14.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads and paths, moist soil on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes,

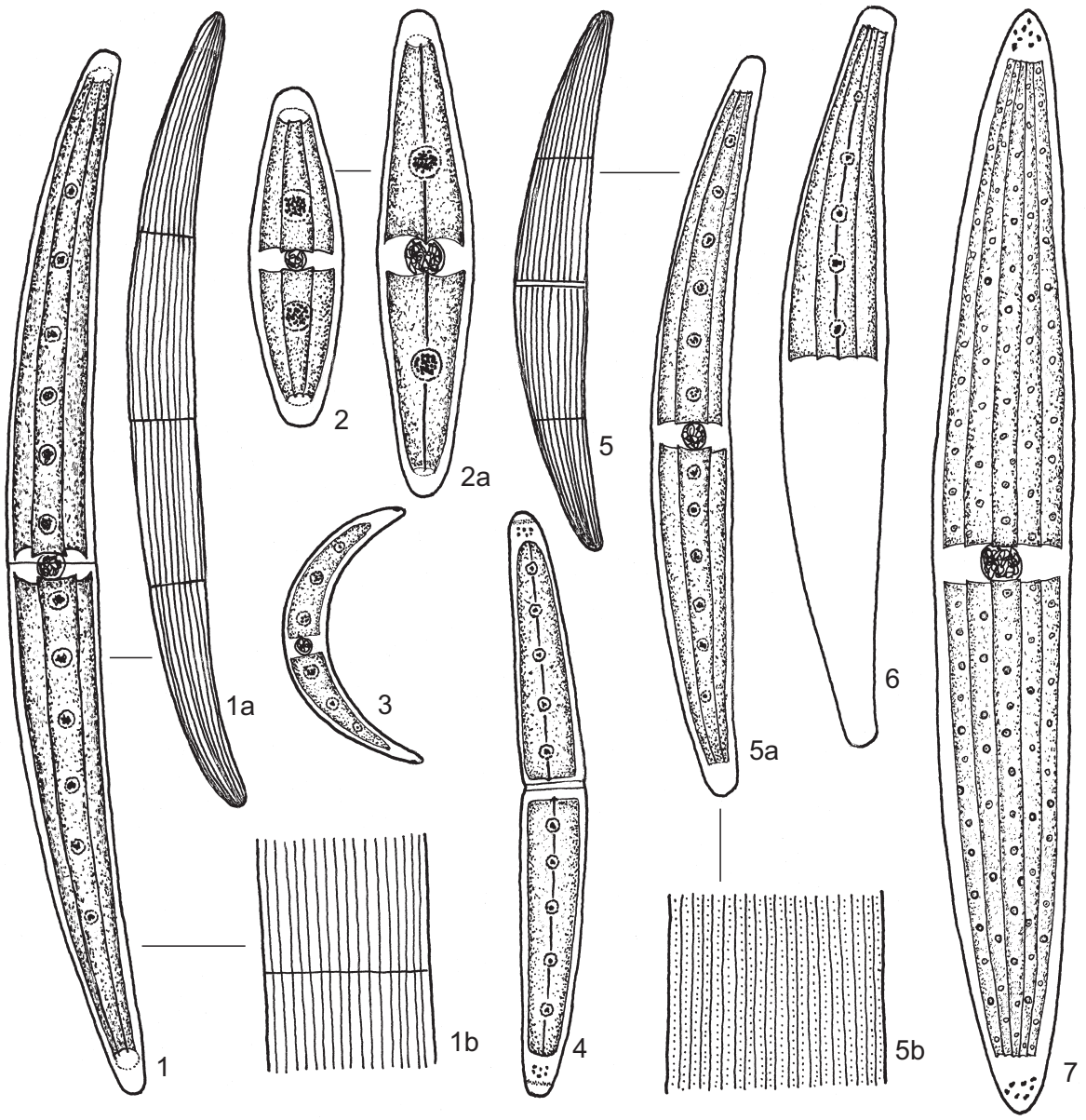

Figure 5. *Closterium.* 1, 1a–b – *Closterium intermedium*; 2, 2a – *C. navicula*; 3 – *C. venus*; 4 – *C. baillyanum*; 5, 5a–b – *C. striolatum*; 6 – *C. costatum*; 7 – *C. lunula*. Drawings E. Nowotarska.

stream springs, pH range 5.1–7.7, altitude range 600–1270 m.

Number of localities in the Gorce Mts: 44 (0.108).
Turbacz range: 42 (0.127): **103**, **137**, **185**, **247**, **302**.
Lubań range: 2 (0.025): **21**.
Lower montane zone: 35 (0.109), Upper montane zone: 9 (0.231).

Closterium jenneri Ralfs [*Cl. cynthia* De Notaris var. *jenneri* (Ralfs) Krieger] (Figs 9: 9; 10: 9; Map 27)

Description. Cells strongly curved, gradually tapering to rounded apices without endopores. Chloroplasts contain central row of pyrenoids. False girdle bands present. Cell wall very finely striated. L: 100, W: 15, Ap: 2.5, L/W: 6.7.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Puddles on roads, pH range 6.7, altitude range 960 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **280**.
Lubań range: Not recorded.
Lower montane zone: 1 (0.003).

Closterium juncidum Ralfs (Figs 3: 9, 9a; 4: 9; Map 28)

Description. Cells nearly straight, cylindrical in mid-region, gradually tapering to slightly curved, conical apices without endopores. Chloroplasts contain central row of pyrenoids. Girdle bands present. Cell wall very finely striated, sometimes smooth. L: 80–275, W: 10–15, Ap: 5, L/W: 6.2–18.

Notes. **M**ostly var. *brevius* (Nordstedt) Krieger, which is smaller, was recorded in the material.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles and moist soil on roads and paths, wet mosses of *Bryidae* class, puddles and old wells in marshes, pH range 5.7–7.9, altitude range 620–1230 m.

Number of localities in the Gorce Mts: 49 (0.12).
Turbacz range: 48 (0.145): **115**, **143**, **176**, **219**, **351**, **382**.
Lubań range: 1 (0.013): **62**.
Lower montane zone: 43 (0.134), Upper montane zone: 6 (0.154).

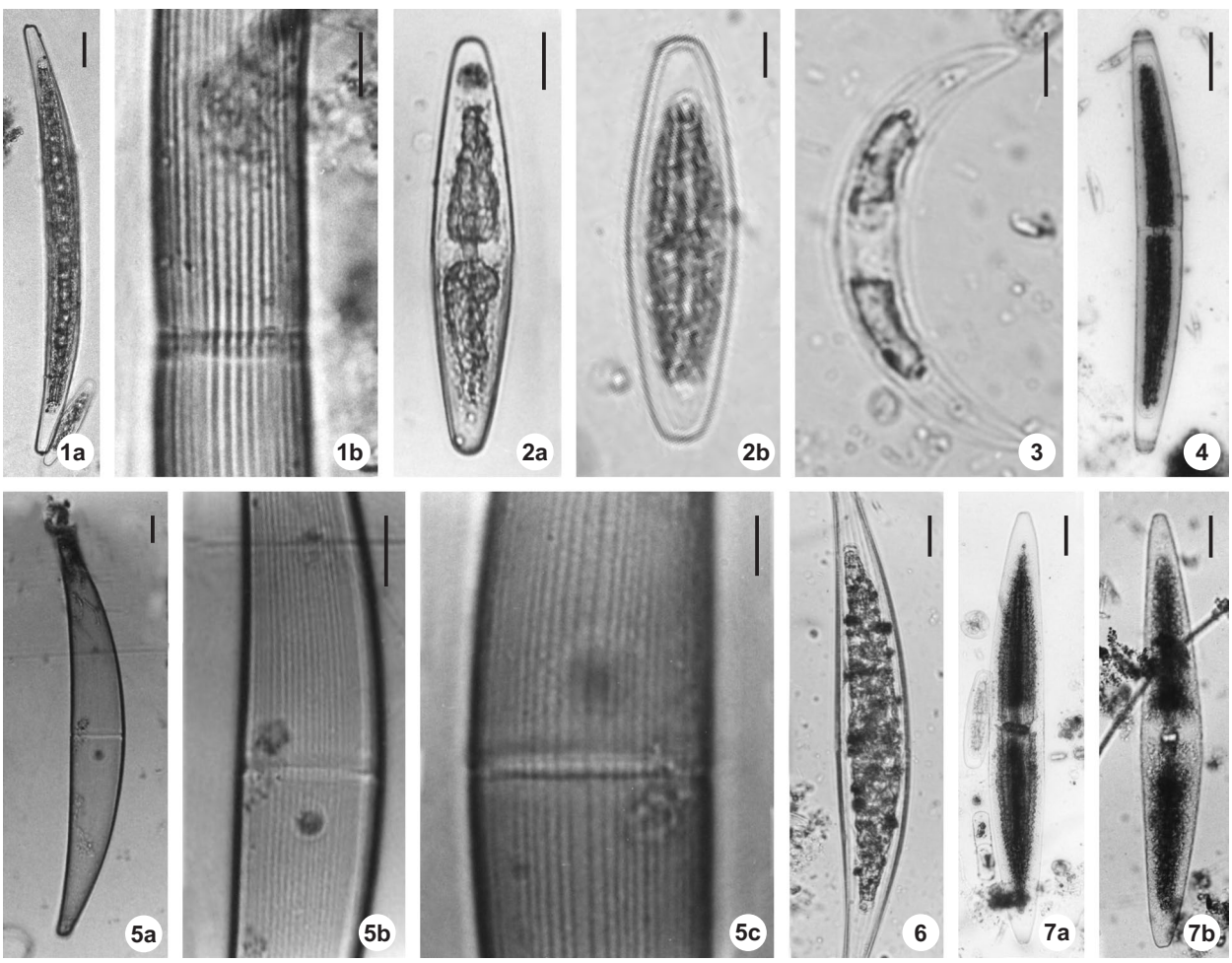

Figure 6. *Closterium*. 1a–b – *Closterium intermedium*; 2a–b – *C. navicula*; 3 – *C. venus*; 4 – *C. baillyanum*; 5a–c – *C. striolatum*; 6 – *C. costatum*; 7a–b – *C. lunula*. Scales: 1a, 5a–b, 6 = 20 µm; 1b, 2a, 3, 5c = 10 µm; 2b = 5 µm; 4, 7a–b = 50 µm. LM by M. Wayda.

Closterium kuetzingii Brébisson
(Figs 3: 8, 8a; 4: 8; Map 29)

Description. Cells nearly straight, fusiform in mid-region, tapering to colorless, slightly curved apices without endopores. Chloroplasts contain central row of pyrenoids. Girdle bands absent. Cell wall very finely striated. L: 340–550, W: 20–30, Ap: 2.5–5, L/W: 11–21.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic waterbodies, puddles on roads, puddles and old wells in marshes, oxbow lakes, pH range 6.1–7.7, altitude range 600–1230 m.

Number of localities in the Gorce Mts: 23 (0.056).
Turbacz range: 22 (0.067): **103**, **155**, **240**, **345**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 18 (0.056), Upper montane zone: 5 (0.128).

Closterium lineatum Ehrenberg ex Ralfs
(Figs 7: 1; 8: 1; Map 30)

Description. Cells nearly straight, cylindrical in mid-region, gradually tapering to slightly curved, conical apices without endopores. Chloroplasts contain central row of pyrenoids. False girdle bands present. Cell wall very finely striated L: 650, W: 35, Ap: 7.5, L/W: 16.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Old wells in marshes, pH range 6.7–7.4, altitude range 1060 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **291**.
Lubań range: Not recorded.
Lower montane zone: 1 (0.003).

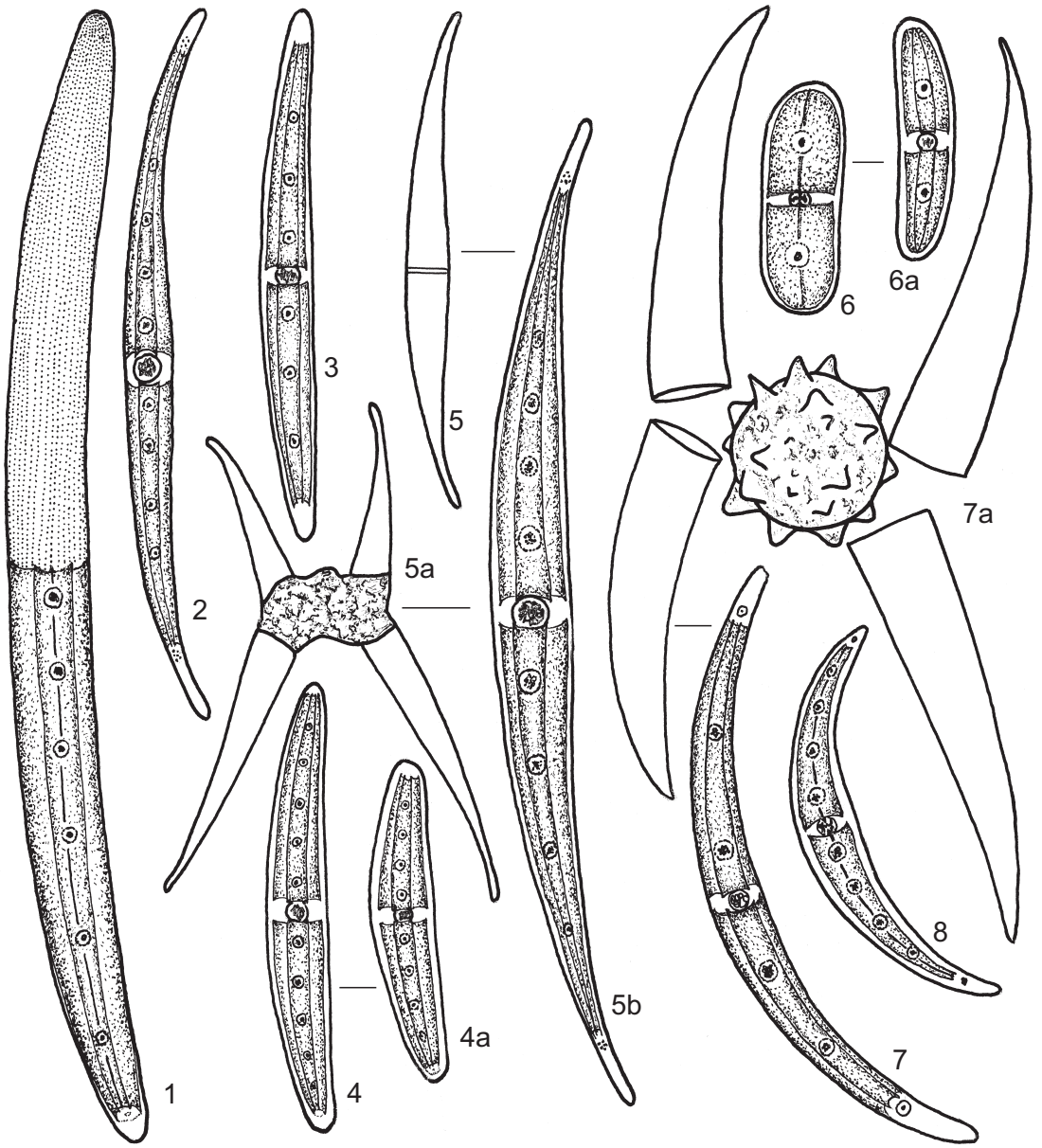

Figure 7. *Closterium*. 1 – *Closterium lineatum*; 2 – *Cl. strigosum*; 3 – *Cl. cornu*; 4, 4a – *Cl. tumidum*; 5, 5a–b – *Cl. rostratum*; 6, 6a – *Cl. pusillum*; 7, 7a – *Cl. calosporum*; 8 – *Cl. tumidulum*. Drawings E. Nowotarska.

Closterium littorale F. Gay (Figs 3: 6; 4: 6; Map 31)

Description. Cells slightly curved, ventral side of mid-region slightly inflated, gradually tapering to rounded apices. Chloroplasts contain central row of pyrenoids. Girdle bands absent. Cell wall smooth. L: 130–250, W: 15–30, Ap: 2.5–5, L/W: 6.5–10.

Distribution in Poland. Carpathian Mts (Mrozińska 1989), Oświęcim Basin (Kyselewa 1973), Mazovian Lowland (Ligowski 1986).

Habitat. *Sphagnum* puddles, puddles and moist soil on roads, wet mosses of *Bryidae* class, puddles and old wells in marshes, oxbow lakes, pH range 4.9–8.1, altitude range 430–1230 m.

Number of localities in the Gorce Mts: 30 (0.073).
Turbacz range: 26 (0.079): **22**, **81**, **115**, **187**, **236**, **239**, **359**.
Lubań range: 4 (0.051): **79**.
Foothill zone: 6 (0.125), Lower montane zone: 22 (0.068), Upper montane zone: 2 (0.051).

Closterium lunula Ehrenberg et Hemprich ex Ralfs [*Cl. coloratum* (Klebs) Gutwiński, *Cl. praegrande* Rabenhorst] (Figs 5: 7; 6: 7a–b; Map 32)

Description. Cells straight or very slightly curved, sometimes fusiform; ventral side straight, tapering to conical from mid-region, slightly rounded apices without endopores. Chloroplasts contain many small and dispersed pyrenoids. Girdle bands absent. Cell wall smooth. L: 325–620, W: 40–100, Ap: 20–30, L/W: 4–11.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads and paths, moist soil on roads, puddles and old wells in marshes, pH range 4.9–7.6, altitude range 750–1200 m.

Number of localities in the Gorce Mts: 18 (0.044).
Turbacz range: 17 (0.052): **109**, **226**, **295**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 16 (0.05), Upper montane zone: 2 (0.051).

Closterium macilentum Brébisson (Figs 9: 5; 10: 5; Map 33)

Description. Cells nearly straight, in mid-region cylindrical, gradually tapering to slightly curved conical apices without endopores. Chloroplasts contain central row of pyrenoids. Girdle bands present. Cell wall smooth. L: 370, W: 15, Ap: 5, L/W: 24.7.

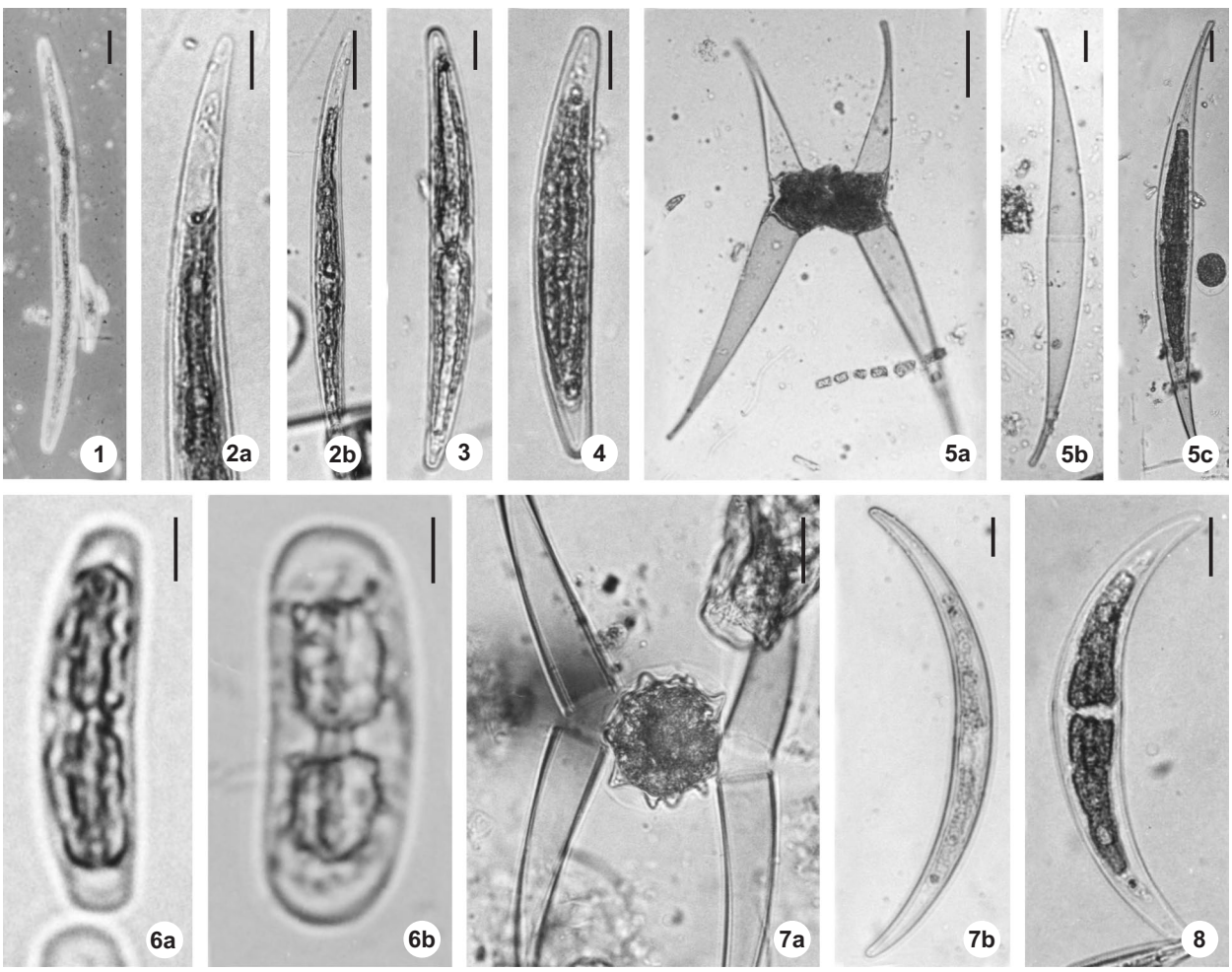

Figure 8. *Closterium*. 1 – *Closterium lineatum*; 2a–b – *Cl. strigosum*; 3 – *Cl. cornu*; 4 – *Cl. tumidum*; 5a–c – *Cl. rostratum*; 6a–b – *Cl. pusillum*; 7a–b – *Cl. calosporum*; 8 – *Cl. tumidulum*. Scales: 1, 5a = 50 μm; 7a = 40 μm; 2a, 3–4, 7b, 8 = 10 μm; 2b, 5b–c = 20 μm; 6a–b = 5 μm. LM by M. Wayda.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Puddle on road, pH range 5.7, altitude range 850 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **323**.
Lubań range: Not recorded.
Lower montane zone: 1 (0.003).

Closterium moniliferum Ehrenberg ex Ralfs [*Cl. malincernianiforme* Grönblad, *Cl. galiciense* Gutwiński, *Cl. moniliforme* (Bory) Ehrenberg]

(Figs 9: 1; 10: 1; Map 34)

Description. Cells strongly curved, gradually tapering to rounded apices without endopores. Ventral side in mid-region often has small bulge. Chloroplasts contain central row of pyrenoids. Girdle bands absent. Cell wall smooth sometimes finely striated. L: 175–400, W: 40–55, Ap: 10–15, L/W: 4–7.5.

Distribution in Poland. Species very often recorded; probably very common in the whole country

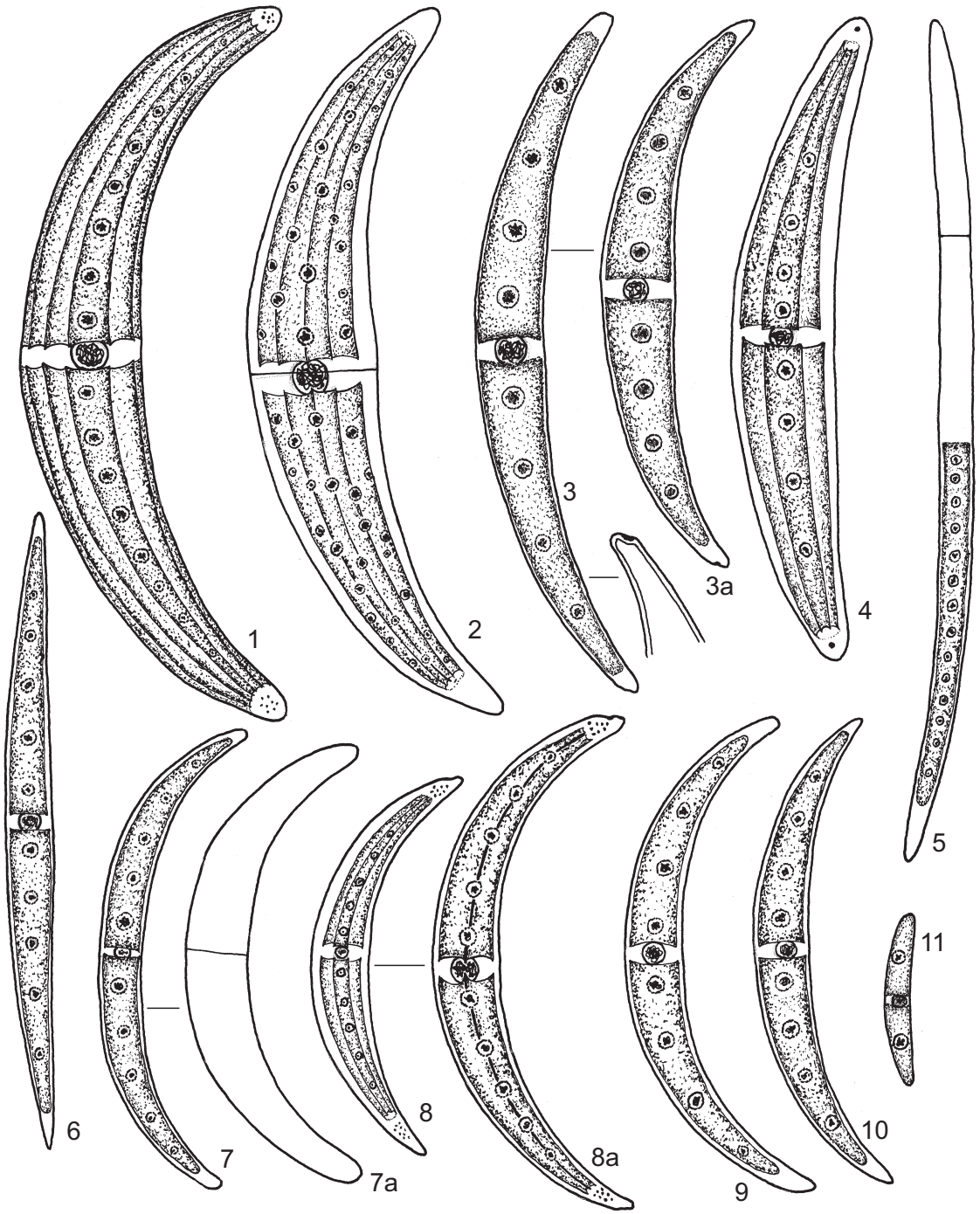

Figure 9. *Closterium*. 1 – *Closterium moniliferum*; 2 – *Cl. ehrenbergii*; 3, 3a – *Cl. dianae*; 4 – *Cl. pseudolunula*; 5 – *Cl. macilentum*; 6 – *Cl. idiosporum*; 7, 7a – *Cl. cynthia*; 8, 8a – *Cl. parvulum*; 9 – *Cl. jenneri*; 10 – *Cl. exile*; 11 – *Cl. pygmaeum*. Drawings E. Nowotarska.

Habitat. Polyhumic waterbodies, puddles on roads and paths, moist soil on roads, wet mosses of *Bryidae* class, puddles and old wells in marshes, oxbow lakes, stream springs, temporary waterbodies, fish ponds, pH range 6.7–8.8, altitude range 390–1230 m.

Number of localities in the Gorce Mts: 132 (0.323).
Turbacz range: 114 (0.345): **80**, **84**, **92**, **162**, **181**, **255**, **407**.
Lubań range: 18 (0.228): **5**, **21**, **52**, **70**, **76**.
Foothill zone: 13 (0.271), Lower montane zone: 111 (0.345), Upper montane zone: 8 (0.206).

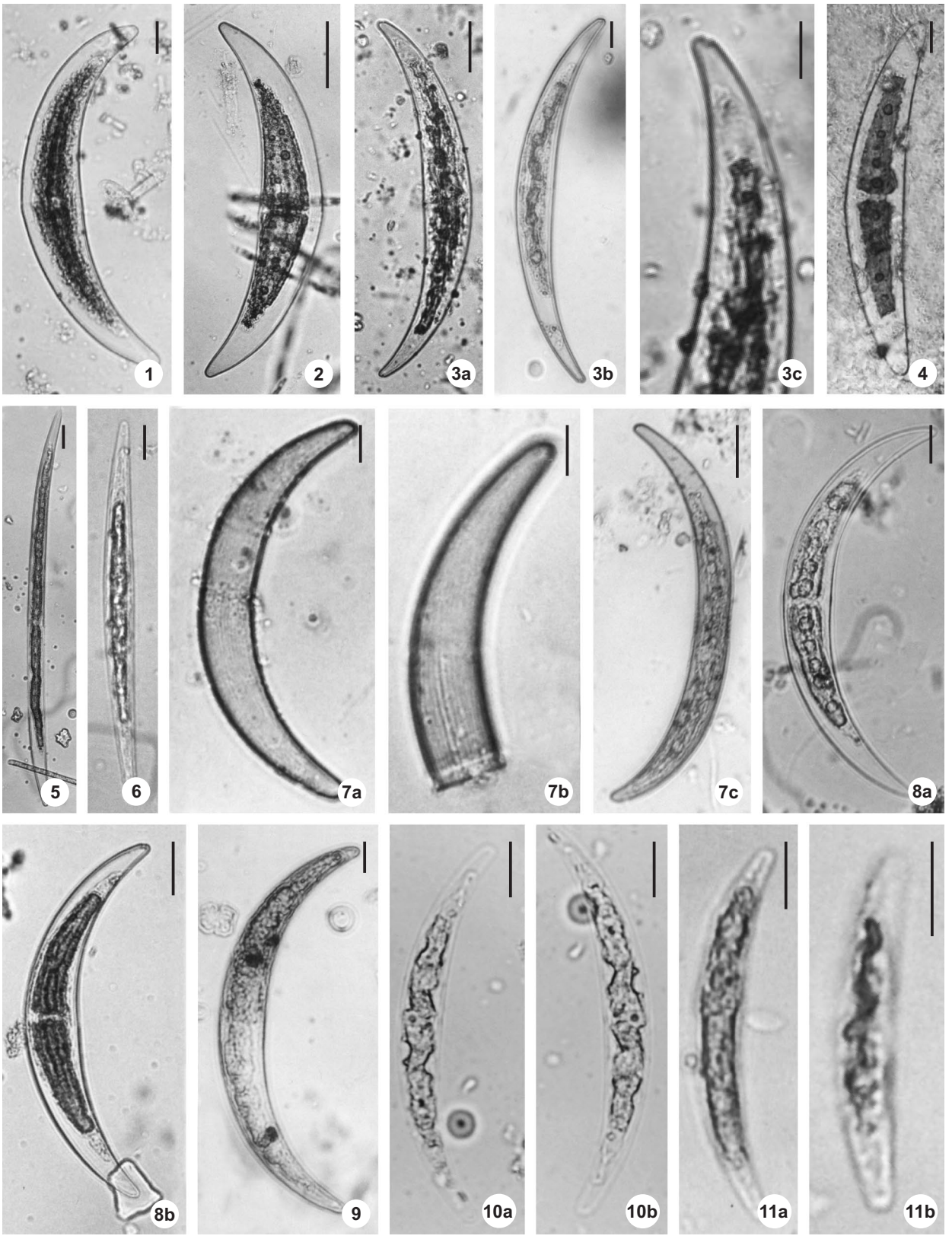

Figure 10. *Closterium*. 1 – *Closterium moniliferum*; 2 – *Cl. ehrenbergii*; 3a–c – *Cl. dianae*; 4 – *Cl. pseudolunula*; 5 – *Cl. macilentum*; 6 – *Cl. idiosporum*; 7a–c – *Cl. cynthia*; 8a–b – *Cl. parvulum*; 9 – *Cl. jenneri*; 10a–b – *Cl. exile*; 11a–b – *Cl. pygmaeum*. Scales: 1, 3a, 4–5, 7c, 8b = 20 µm; 2 = 50 µm; 3b–c, 6, 7a–b, 8a, 9–11b = 10 µm. LM by M. Wayda.

Closterium navicula (Brébisson) Lütkemüller [*P. navicula* Brébisson] (Figs 5: 2, 2a; 6: 2a–b; Map 35)

Description. Cells fusiform to elliptic, with rounded apices without endopores. Chloroplasts with prominent longitudinal ridges contain one or two pyrenoids in axial row. Girdle bands absent. Cell wall smooth. L: 42.5–80, W: 12.5–15, Ap: 10, L/W: 3–6.4.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads and paths, wet mosses of *Bryidae* class, puddles and old wells in marshes, stream springs, pH range 5.0–8.4, altitude range 580–1270 m.

Number of localities in the Gorce Mts: 61 (0.149).
Turbacz range: 56 (0.17): **115**, **160**, **185**, **213**.
Lubań range: 5 (0.064): **3**, **21**, **66**.
Foothill zone: 1 (0.021), Lower montane zone: 50 (0.155), Upper montane zone: 10 (0.256).

Closterium parvulum Nägeli (Figs 9: 8, 8a; 10: 8a–b; Map 36)

Description. Cells strongly curved, gradually tapering to narrowly rounded apices with endopores. Chloroplasts contain central row of pyrenoids. Girdle bands absent. Cell wall smooth. L: 90–188.5, W: 10–25, Ap: 2.5–5, L/W: 6–11.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads and paths, wet mosses of *Bryidae* class, puddles and old wells in marshes, oxbow lakes, stream springs, temporary waterbodies, fish ponds, pH range 6.1–7.3, altitude range 390–1240 m.

Number of localities in the Gorce Mts: 134 (0.328).
Turbacz range: 121 (0.367): **120**, **160**, **166**, **259**, **407**, **408**.
Lubań range: 13 (0.165): **3**, **21**, **52**, **70**.
Foothill zone: 6 (0.125), Lower montane zone: 115 (0.357), Upper montane zone: 13 (0.333).

Closterium praelongum Brébisson (Figs 3: 3, 3a, 4, 4a–b; 4: 3a–b, 4a–c; Map 37)

Description. Cells straight, in mid-region cylindrical, tapering towards ends to conical, slightly curved apices without endopores. Chloroplasts contain central row of pyrenoids. Girdle bands present. Cell wall punctate or smooth. Zygospores globular, with smooth cell wall; ~45 µm in diameter. L: 550–700, W: 22–30, Ap: 10, L/W: 18.3–34.

Notes. Mostly var. *brevius*, which is smaller, has a smooth cell wall and is slightly inflated on ventral side in the mid-region, was recorded in the material. L: 175–450, W: 15–30, Ap: 5, L/W: 8–18.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads and paths, moist soil on roads, wet mosses of *Bryidae* class, puddles and old wells in marshes, oxbow lakes, stream springs, pH range 6.1–7.9, altitude range 430–1270 m.

Number of localities in the Gorce Mts: 67 (0.164).
Turbacz range: 58 (0.176): **87**, **117**, **152**, **181**, **259**, **406**.
Lubań range: 9 (0.113): **1**, **17**, **71**.
Foothill zone: 6 (0.125), Lower montane zone: 48 (0.149), Upper montane zone: 13 (0.333).

Closterium pritchardianum W. Archer (Figs 11: 1, 1a; 12: 1a–d; Map 38)

Description. Cells slightly curved or straight, gradually tapering to conical, slightly recurved apices without endopores. Chloroplasts contain central row of pyrenoids. Girdle bands absent. Cell wall punctate, sometimes with irregular longitudinal striae. L: 350–660, W: 30–45, Ap: 10–15, L/W: 10–17.3.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. Moist soil on roads, wet mosses of *Bryidae* class, puddles and old wells in marshes, pH range 6.7–7.9, altitude range 610–1240 m.

Number of localities in the Gorce Mts: 12 (0.029).
Turbacz range: 12 (0.036): **119**, **133**, **163**, **253**, **366**.
Lubań range: Not recorded.
Lower montane zone: 11 (0.034), Upper montane zone: 1 (0.026).

Closterium pronum Brébisson (Figs 11: 4, 4a; 12: 4; Map 39)

Description. Cells very slightly curved, gradually tapering to elongate, narrowly rounded apices without endopores. Chloroplasts contain central row of pyrenoids. Girdle bands absent. Cell wall smooth. L: 300, W: 10, Ap: 2.5, L/W: 31.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic pond, pH range 7.2, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Closterium pseudolunula O.Borge [*Cl. spetsbergense* Borge] (Figs 9: 4; 10: 4; Map 40)

Description. Cells very slightly curved (ventral side straight), tapering towards ends to broadly rounded apices without endopores. Chloroplasts contain central row of pyrenoids. Girdle bands absent. Cell wall smooth. L: 160–360, W: 35–45, Ap: 15, L/W: 4–9.

Distribution in Poland. Sudety Mts (Grönblad 1926).

Habitat. Puddles and moist soil on roads, wet mosses of *Bryidae* class, puddles and old wells in marshes, oxbow lakes, fish ponds, pH range 6.7–8.5, altitude range 340–1210 m.

Number of localities in the Gorce Mts: 38 (0.093).

Turbacz range: 33 (0.1): **80**, **117**, **143**, **182**, **259**, **328**.
Lubań range: 5 (0.063): **33**, **47**, **55**, **78**.
Foothill zone: 9 (0.188), Lower montane zone: 27 (0.084), Upper montane zone: 2 (0.051).

Closterium pusillum Hantzsch
(Figs 7: 6, 6a; 8: 6a–b; Map 41)

Description. Cells very slightly curved, tapering toward ends to broadly rounded apices without endopores. Chloroplasts with single pyrenoid. Girdle bands absent. Cell wall smooth. L: 32–37, W: 7.5–11, Ap: 5, L/W: 3–4.

Notes. Only var. *monolithum* Wittrock was recorded in the material.

Distribution in Poland. Carpathian Mts (Gutwiński 1909), Lublin Upland (Eichler 1896), Mazovian Lowland (Kadłubowska 1960), Wielkopolska Lowland (Kotlińska 1976).

Habitat. *Sphagnum* puddles, puddles in marshes, pH range 5.7–6.5, altitude range 920–1250 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 2 (0.006): **297**, **359**.
Lubań range: Not recorded.
Lower montane zone: 1 (0.003), Upper montane zone: 1 (0.026).

Closterium pygmaeum Gutwiński
(Figs 9: 11; 10: 11a–b; Map 42)

Description. Cells slightly curved, gradually tapering to rounded apices without endopores. Chloroplasts with two axial pyrenoids. Girdle bands absent. Cell wall smooth. L: 35–45, W: 5, Ap: 2, L/W: 7–9.

Distribution in Poland. Not recorded.

Habitat. Puddles on roads, wet mosses of *Bryidae* class and puddles in marshes, pH range 6.1–7.4, altitude range 720–1240 m.

Number of localities in the Gorce Mts: 3 (0.007).
Turbacz range: 3 (0.009): **176**, **185**, **230**.
Lubań range: Not recorded.
Lower montane zone: 3 (0.009).

Closterium rostratum Ehrenberg ex Ralfs
(Figs 7: 5, 5a–b; 8: 5a–c; Map 43)

Description. Cells slightly curved, fusiform in mid-region, tapering toward the ends to elongate, colorless, slightly curved apices without endopores. Chloroplasts contain central row of pyrenoids. Girdle bands absent. Cell wall very finely striated. Zygospores rectangular, with concave sides and truncate-concave angles extending into the parental cells; breadth ~75 μm. L: 225–450, W: 25–35, Ap: 2.5–5, L/W: 9–16.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, puddles on roads and paths, moist soil on roads, wet mosses of *Bryidae* class, puddles and old wells in marshes, stream springs, temporary waterbodies, pH range 5.1–8.3, altitude range 720–1240 m.

Number of localities in the Gorce Mts: 32 (0.078).
Turbacz range: 32 (0.097): **115**, **158**, **240**, **350**.
Lubań range: Not recorded.
Lower montane zone: 28 (0.087), Upper montane zone: 4 (0.103).

Closterium strigosum Brébisson [*Cl. peracerosum* Gay] (Figs 7: 2; 8: 2a–b; Map 44)

Description. Cells slightly curved, gradually tapering to truncate apices without endopores. Chloroplasts con- tain central row of pyrenoids. Girdle bands absent. Cell wall smooth. L: 125–170, W: 12.5–15, Ap: 5, L/W: 10–11.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, puddles and moist soil on roads, wet mosses of *Bryidae* class in marshes, fish ponds, pH range 5.5–8.5, altitude range 690–1230 m.

Number of localities in the Gorce Mts: 5 (0.012).
Turbacz range: 2 (0.007): **330**, **367**.
Lubań range: 3 (0.038): **21**, **66**, **71**.
Lower montane zone: 4 (0.012), Upper montane zone: 1 (0.026).

Closterium striolatum Ehrenberg ex Ralfs
(Figs 5: 5, 5a–b; 6: 5a–c; Map 45)

Description. Cells very slightly curved, cylindrical in mid-region, tapering to truncately rounded apices without endopores. Chloroplasts contain central row of pyrenoids. Girdle bands present. Cell wall distinctly striate and punctate between striae. L: 155–350, W: 20–40, Ap: 10, L/W: 7–11.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads, paths, marshes, in old wells, stream springs, pH range 5.1–7.0, altitude range 520–1270 m.

Number of localities in the Gorce Mts: 31 (0.076).
Turbacz range: 28 (0.085): **103**, **135**, **167**, **206**, **297**.
Lubań range: 3 (0.038): **21**, **62**.
Foothill zone: 2 (0.042), Lower montane zone: 20 (0.062), Upper montane zone: 9 (0.231).

Closterium sublaterale Růžička
(Figs 11: 2, 2a; 12: 2a–b; Map 46)

Description. Cells slightly curved, gradually tapering to truncate apices without endospores; mid-region often with small bulge on ventral side. Chloroplasts contain central row of pyrenoids. Girdle bands absent. Cell wall very finely striated. L: 215–345, W: 30–40, Ap: 10–15, L/W: 6–9.

Distribution in Poland. Not recorded.

Habitat. Puddles on roads, wet mosses of *Bryidae* class, puddles and old wells in marshes, pH range 6.5–8.6, altitude range 390–1230 m.

Number of localities in the Gorce Mts: 21 (0.051).
Turbacz range: 18 (0.055): **106**, **143**, **255**, **328**, **407**.
Lubań range: 3 (0.038): **26**, **52**, **66**.
Foothill zone: 2 (0.042), Lower montane zone: 16 (0.05), Upper montane zone: 3 (0.077).

Closterium tumidulum F. Gay
(Figs 7: 8; 8: 8; Map 47)

Description. Cells very strongly curved, gradually tapering to rounded apices without endospores; mid-region often with prominent bulge on ventral side. Chloroplasts contain central row of pyrenoids. Girdle bands absent. Cell wall smooth. L: 80–125, W: 12.5–15, Ap: 2.5, L/W: 6–8.3.

Distribution in Poland. Southern Wielkopolska Lowland (Lesiak 1984), Pomeranian Lakeland (Oleksowicz 1986).

Habitat. *Sphagnum* puddles, moist soil on roads, wet mosses of *Bryidae* class in marshes, pH range 5.0–7.4, altitude range 690–1220 m.

Number of localities in the Gorce Mts: 13 (0.032).
Turbacz range: 12 (0.036): **171**, **255**, **279**, **382**.
Lubań range: 1 (0.013): **53**.
Lower montane zone: 12 (0.037), Upper montane zone: 1 (0.026).

Closterium tumidum L. N. Johnson
(Figs 7: 4, 4a; 8: 4; Map 48)

Description. Cells slightly curved, gradually tapering to truncate apices without endospores, mid-region with prominent bulge on ventral side. Chloroplasts contain central row of pyrenoids. Girdle bands absent. Cell wall smooth. L: 117.5–180, W: 15–25, Ap: 5–10, L/W: 6–8.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. *Sphagnum* puddles, puddles on roads and paths, moist soil on roads, puddles and old wells in marshes, springs and oxbow lakes, pH range 6.0–7.9, altitude range 640–1230 m.

Number of localities in the Gorce Mts: 12 (0.029).
Turbacz range: 12 (0.036): **99**, **219**, **357**.
Lubań range: Not recorded.
Lower montane zone: 10 (0.031), Upper montane zone: 2 (0.051).

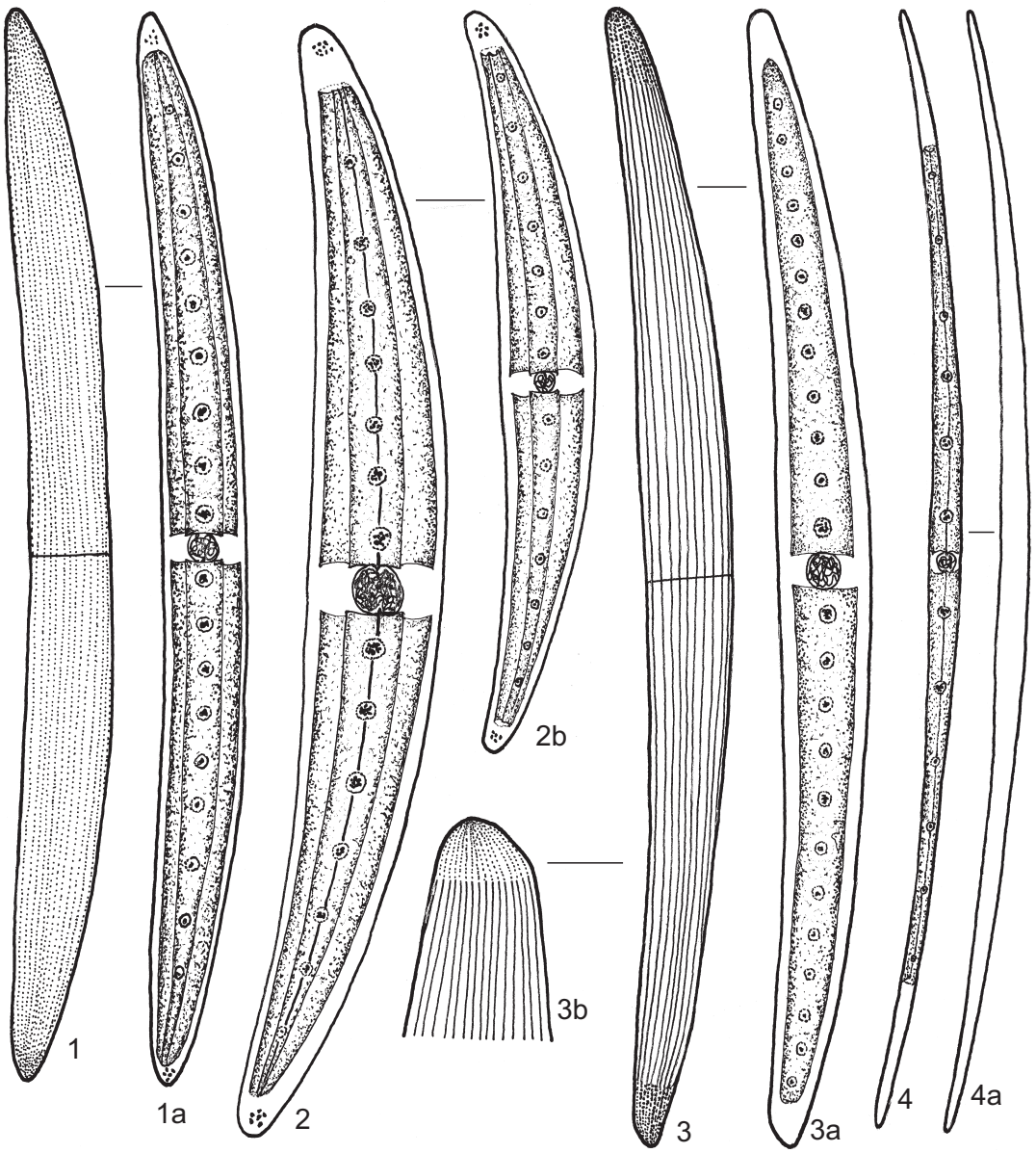

Figure 11. *Closterium.* 1, 1a – *Closterium pritchardianum*; 2, 2a – *C. sublaterale*; 3, 3a–b – *C. turgidum*; 4, 4a – *C. pronum*. Drawings E. Nowotarska.

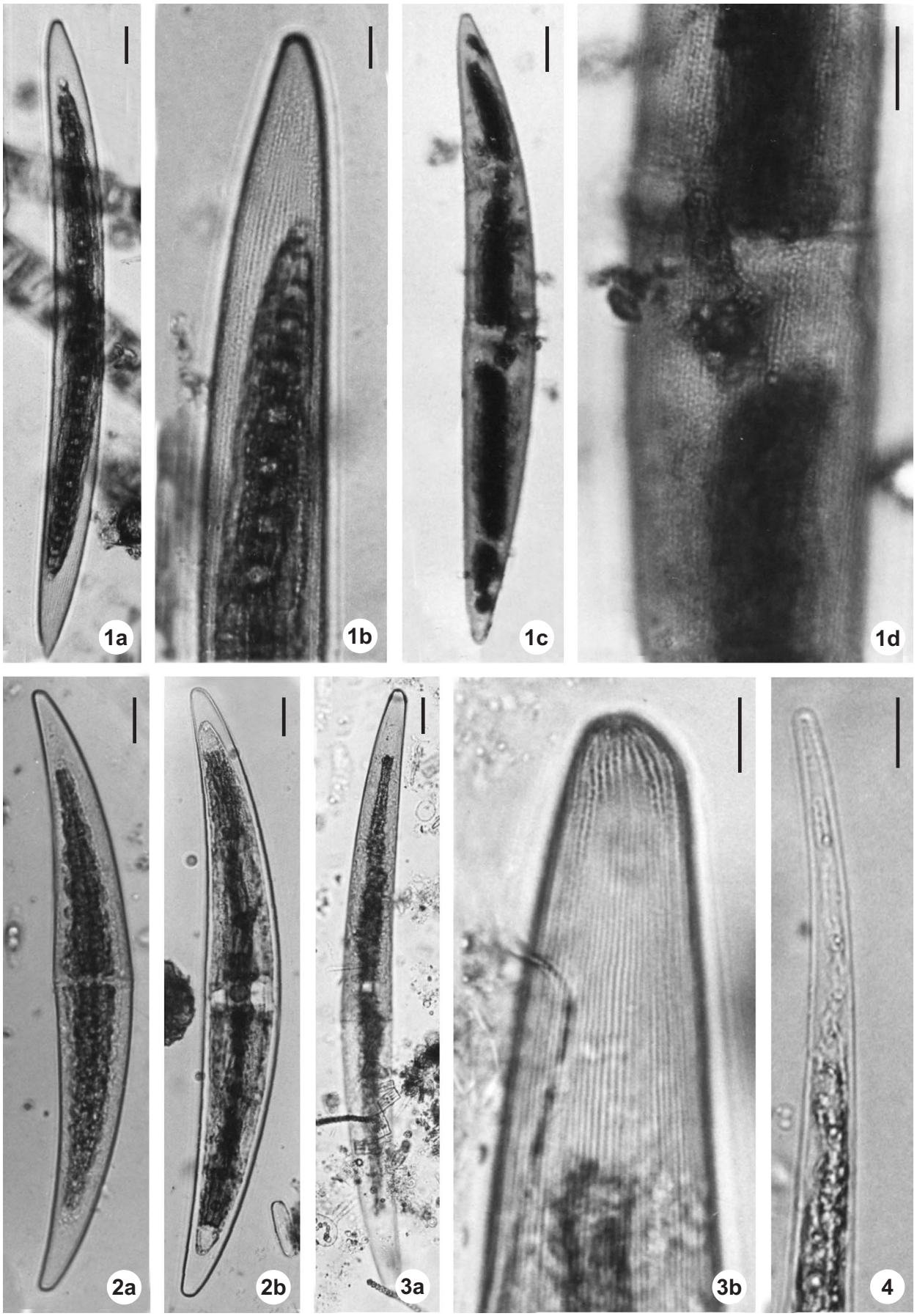

Figure 12. *Closterium*. 1a–d – *Closterium pritchardianum*; 2a–b – *C. sublaterale*; 3a–b – *C. turgidum*; 4 – *C. pronum*. Scales: 1a, 1c, 2a–b, 3a = 20 µm; 1b, 1d, 3b, 4 = 10 µm. LM by M. Wayda.

Closterium turgidum Ehrenberg ex Ralfs
(Figs 11: 3, 3a–b; 12: 3a–b; Map 49)

Description. Cells slightly curved, cylindrical in mid-region, tapering toward ends to truncately rounded apices without endopores. Chloroplasts contain central row of pyrenoids. False girdle bands present. Cell wall finely striate, near ends punctate. L: 660, W: 60, Ap: 10, L/W: 11.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. Polyhumic pond, pH range 7.1, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Closterium venus Kützing ex Ralfs
(Figs 5: 3; 6: 3; Map 50)

Description. Cells very strongly curved, gradually tapering to narrowly rounded apices with prominent endopores. Chloroplasts contain central row of pyrenoids. Girdle bands absent. Cell wall smooth. L: 50–90, W: 10, Ap: 2,5, L/W: 5–10.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, temporary waterbodies, pH range 6.1–7.3, altitude range 730–1270 m.

Number of localities in the Gorce Mts: 5 (0.012).
Turbacz range: 4 (0.012): **278**, **293**, **297**, **360**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 4 (0.012), Upper montane zone: 1 (0.026).

Cosmarium Corda ex Ralfs

Cosmarium alpestre J. Roy et Bisset
(Figs 13: 1; 14: 1; Map 51)

Description. Cells broadly elliptical, with very shallow constriction. Sinus widely open. Semicells semicircular, with strongly convex margins and flattened apices. Top view broadly elliptical. Chloroplasts with two prominent pyrenoids. Cell wall with very distinct pores. L: 87.5, W: 72.5, I: 70, L/W: 1.2.

Distribution in Poland. Not recorded.

Habitat. *Sphagnum* puddle, pH range 6.0, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Cosmarium anceps P. Lundell [*Dy. anceps* P. Lundell, *Dy. parvulum* Brébisson]
(Figs 13: 5, 5a; 14: 5a–d; Map 52)

Description. Cells hexagonal, moderately constricted. Sinus open. Semicells trapezoidal, with concave apices and margins, lower and upper angles rounded. Top view elliptical. Chloroplasts plate-shaped, with single pyrenoid. Cell wall smooth. L: 25–37.5, W: 12.5–20, I: 10, L/W: 2.0–2.8.

Distribution in Poland. Species often recorded, but mostly from southern regions of Poland.

Habitat. *Sphagnum* puddles, puddles on roads and paths, moist soil on roads, wet mosses of *Bryidae* class, old wells in marshes, stream springs, temporary waterbodies, pH range 5.9–8.4, altitude range 480–1270 m.

Number of localities in the Gorce Mts: 101 (0.247).
Turbacz range: 87 (0.264): **80**, **88**, **95**, **144**, **181**, **259**.
Lubań range: 14 (0.177): **3**, **28**, **52**, **65**.
Foothill zone: 7 (0.146), Lower montane zone: 83 (0.258), Upper montane zone: 11 (0.282).

Cosmarium angulosum Brébisson [*Co. meneghinii* Brébisson in Ralfs var. *angulosum* (Brébisson) Rabenhorst, *Co. meneghinii* Brébisson in Ralfs var. *concinum* (Rabenhorst) W. West et G. S. West] (Figs 13: 7; 14: 7; Map 53)

Description. Cells rectangular, deeply constricted. Sinus narrow, with parallel margins, broadening in outer part. Semicells square, with flat apices and parallel margins; lower angles straight, upper angles rounded. Top view elliptical. Chloroplasts plate-shaped, with single pyrenoid. Cell wall smooth. L: 20, W: 15, I: 5, L/W: 1.3.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. Polyhumic pond, old well, pH range 7.1–7.2, altitude range 870–1080 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 1 (0.003): **360**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 2 (0.006).

Cosmarium annulatum (Nägeli) de Bary [*Ca. annulatus* Nägeli, *Dy. annulatum* Nägeli]
(Figs 23: 20; 24: 20; Map 54)

Description. Cells rectangular, with very shallow constriction. Sinus narrow. Semicells rectangular, with flat apices and parallel margins with six swellings, lower and upper angles rounded. Top view circular. Chloroplasts plate-shaped, with single pyrenoid. Cell wall ornamented with six rows of longitudinal distinct granules. L: 52.5, W: 20, I: 10, L/W: 2.6.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. Wet mosses of *Bryidae* class in marsh, pH range 7.4, altitude range 1220 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **301**. Lubań range: Not recorded.
Upper montane zone: 1 (0.026).

Cosmarium arctoum Nordstedt
(Figs 13: 2, 2a; 14: 2a–b; Map 55)

Description. Cells rectangular, with very shallow constriction. Sinus wide and open. Semicells reversed-trapezoidal,

with flat apices and convex margins, lower and upper angles rounded. Top view elliptical. Chloroplasts plate-shaped, with single pyrenoid. Cell wall smooth. L: 15, W: 12.5, I: 10, L/W: 1.2.

Distribution in Poland. Carpathian Mts (Gutwiński 1909), Lublin Upland (Eichler 1890).

Habitat. Puddles on road, pH range 6.7, altitude range 1090 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **202**.
Lubań range: Not recorded.
Lower montane zone: 1 (0.003).

Cosmarium asphaerosporum Wittrock (Figs 13: 6, 6a; 14: 6a–b; Map 56)

Description. Cells square, moderately constricted. Sinus wide, open, nearly rectangular. Semicells reversed-trapezoidal, with broadly truncate apices and convex margins, lower and upper angles rounded. Top view elliptical. Chloroplasts plate-shaped, with single pyrenoid. Cell wall smooth. L: 12, W: 10, I: 5, L/W: 1.2.

Notes. Only specimens belonging to var. *strigosum* Nordstedt were recorded in the material.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, pH range 4.6–4.9, altitude range 1210 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **34**.
Upper montane zone: 1 (0.026).

Cosmarium bioculatum Brébisson ex Ralfs [*Co. phasoleus* Brébisson var. *bioculatum* (Brébisson ex Ralfs) Klebs] (Figs 13: 3; 14: 3; Map 57)

Description. Cells square, deeply constricted. Sinus linear, broadening in outer part. Semicells elliptical, with flat apices and convex margins, lower and upper angles rounded. Top view elliptical. Chloroplasts plate-shaped, with single pyrenoid. Cell wall smooth. L: 17.5, W: 17.5, I: 7.5, L/W: 1.0.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Temporary pond, pH range 7.5, altitude range 660 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **10**.
Lower montane zone: 1 (0.003).

Cosmarium biretum Brébisson ex Ralfs [*Co. quadrangulatum* Hantzsch] (Figs 13: 10; 14: 10; Map 58)

Description. Cells square to hexagonal, deeply constricted. Sinus closed in apical part, open in outer part. Semicells reversed-trapezoidal, with convex apices and straight margins; angles rounded, upper angles sometimes slightly protracted. Top view elliptical. Chloroplasts plate-shaped, containing pair of pyrenoids. Cell wall ornamented with rows of small granules. L: 40–75, W: 45–65, I: 15–20, L/W: 1.0–1.4.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. Puddles on roads, wet mosses of *Bryidae* class on meadows, temporary pond, pH range 7.3–7.7, altitude range 520–960 m.

Number of localities in the Gorce Mts: 7 (0.017).
Turbacz range: 6 (0.018): **89**, **108**, **134**, **135**, **143**, **283**.
Lubań range: 1 (0.013): **9**.
Foothill zone: 2 (0.042), Lower montane zone: 5 (0.016).

Cosmarium blyttii Wille (Figs 13: 4; 14: 4; Map 59)

Description. Cells rectangular, deeply constricted. Sinus linear, open. Semicells trapezoidal, with flat apices with four swellings, and convex margins with four swellings; lower angles acute, upper rounded. Top view elliptical, with lateral inflations. Chloroplasts plate-shaped, with single pyrenoid. Ornamentation consists of two rows of small granules near margins and few larger ones on inflation in central part of semicell. L: 20–55, W: 20, I: 5, L/W: 1.0–1.3.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. Polyhumic pond, puddles on meadow, pH range 5.5–7.4, altitude range 960–1060 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 2 (0.006): **292**, **360**.
Lubań range: Not recorded.
Lower montane zone: 2 (0.006).

Cosmarium boeckii Wille (Figs 13: 9, 9a; 14: 9a–c; Map 60)

Description. Cells hexagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, apices and margins with five swellings; lower and upper angles rounded. Top view elliptical, with two lateral inflations. Chloroplasts plate-shaped, with single pyrenoid. Ornamentation consists of two rows of small granules near margins and large central granule surrounded by few smaller ones in central part of each semicell. L: 30–32.5, W: 30–32.5, I: 10, L/W: 1.0.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, pH range 5.7–7.2, altitude range 870–960 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 1 (0.003): **360**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 2 (0.006).

Cosmarium botrytis Meneghini ex Ralfs [*Co. geminiferum* Brébisson] (Figs 25: 2, 2a; 26: 2a–b; Map 61)

Description. Cells hexagonal, slightly elliptical, deeply constricted. Sinus linear, broadening in outer part.

Semicells trapezoidal, with straight or sometimes concave apices and strongly convex margins; lower and apical angles rounded. Top view elliptical, with two lateral inflations. Chloroplasts plate-shaped, with pair of pyrenoids. Cell wall furnished with small granules arranged in various ways, sometimes larger granules occupy central part of semicell. L: 50–82.5, W: 45–62.5, I: 15–20, L/W: 1.1–1.4.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, puddles and moist soil on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes, oxbow lakes, pH range 5.5–8.9, altitude range 470–1230 m.

Number of localities in the Gorce Mts: 99 (0.242).
Turbacz range: 87 (0.264): **80**, **85**, **115**, **160**, **181**, **258**.
Lubań range: 12 (0.152): **8**, **21**, **52**, **71**.
Foothill zone: 7 (0.146), Lower montane zone: 82 (0.255), Upper montane zone: 10 (0.256).

Cosmarium caelatum Ralfs
(Figs 13: 12; 14: 12a–b; Map 62)

Description. Cells elliptico-hexagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with flat apices with four swellings and convex margins with four swellings; swellings furnished with granules. Top view elliptical. Chloroplasts plate-shaped, with pair of pyrenoids. Ornamentation consists of three concentric rows of small granules near margins and some longitudinal rows of larger granules below isthmus. L: 45–50, W: 35–40, I: 15, L/W: 1.1–1.2.

Distribution in Poland. Species often recorded, but mostly from southern Poland.

Habitat. Polyhumic waterbodies, *Sphagnum* puddles, puddles on roads and paths, moist soil on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes, pH range 5.0–7.9, altitude range 580–1270 m.

Number of localities in the Gorce Mts: 53 (0.13).
Turbacz range: 51 (0.154): **111**, **158**, **176**, **258**, **345**.

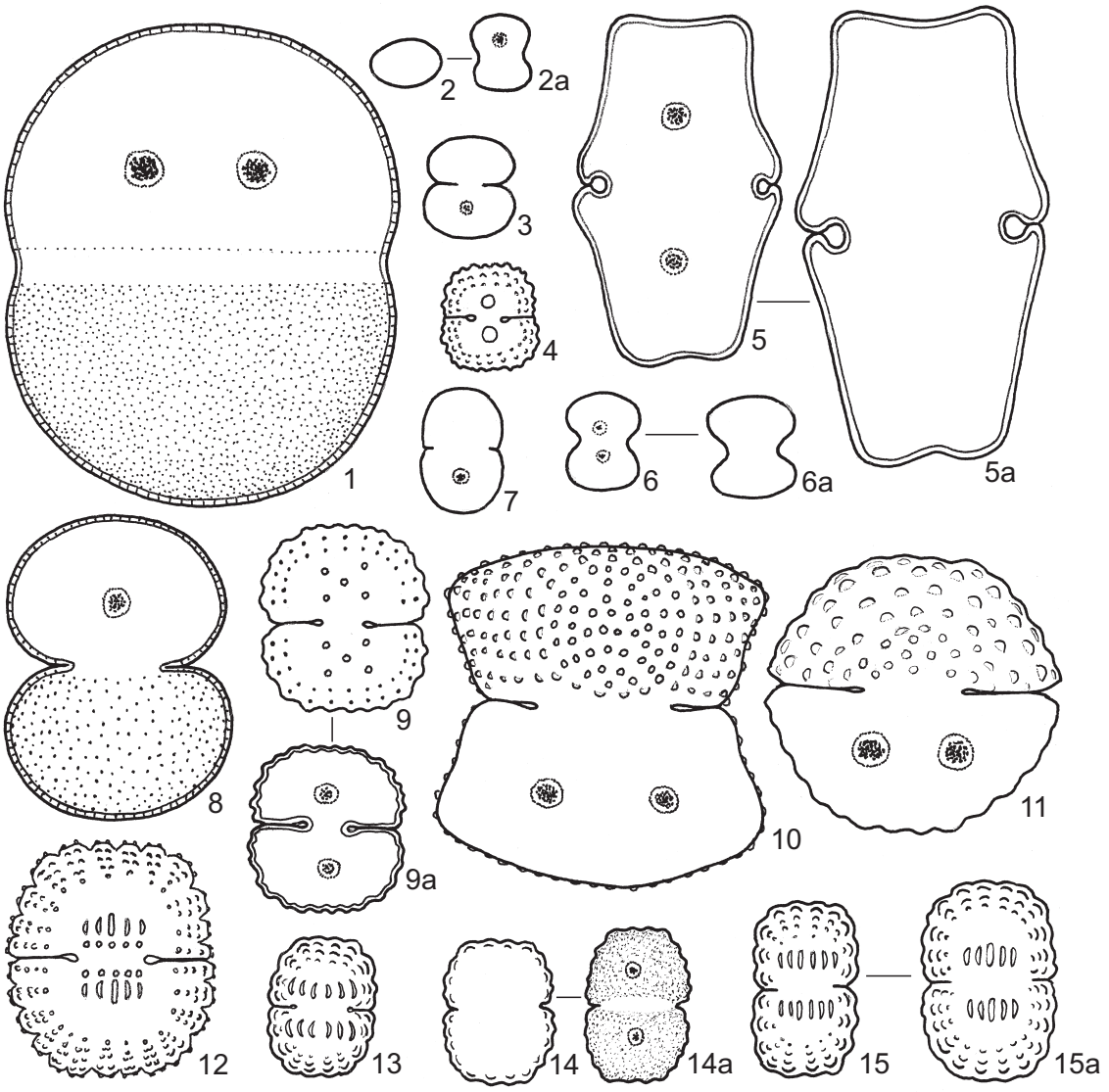

Figure 13. *Cosmarium.* 1 – *Cosmarium alpestre*; 2, 2a – *Co. arctoum*; 3 – *Co. bioculatum*; 4 – *Co. blyttii*; 5, 5a – *Co. anceps*; 6, 6a – *Co. asphaerosporum*; 7 – *Co. angulosum*; 8 – *Co. contractum*; 9, 9a – *Co. boeckii*; 10 – *Co. biretum*; 11 – *Co. cyclicum*; 12 – *Co. caelatum*; 13 – *Co. saxicola*; 14, 14a – *Co. notabile*; 15, 15a – *Co. crenatum*. Drawings E. Nowotarska.

Lubań range: 2 (0.026): **21**, **61**.
Foothill zone: 1 (0.021), Lower montane zone: 43 (0.133), Upper montane zone: 9 (0.231).

Cosmarium connatum Brébisson ex Ralfs [*Ca. connatus* Kirchner, *Dy. connatum* (Brébisson ex Ralfs) Kirchner] (Figs 15: 1; 16: 1a–b; Map 63)

Description. Cells elliptical shape, moderately constricted. Sinus broadly open, with rounded apex. Semicells elliptical, with convex apices and strongly convex margins, lower and upper angles rounded. Top view circular, with two distinct pyrenoids. Cell wall with distinct poles. L: 75–85, W: 45–65, I: 40–50, L/W: 1.3–1.8.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic pond, pH range 5.9–7.2, altitude range 870 m.
Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Cosmarium conspersum Ralfs (Figs 25: 9; 26: 9a–b; Map 64)

Description. Cells nearly rectangular, deeply constricted. Sinus linear, broadening in outer part. Semicells nearly rectangular, with convex apices and straight margins, broadest in apical part, lower and apical angles rounded. Top view elliptical. Chloroplasts plate-shaped, with pair of pyrenoids. Ornamentation consists of rows of distinct granules. L: 80–85, W: 70, I: 20, L/W: 1.1–1.2.

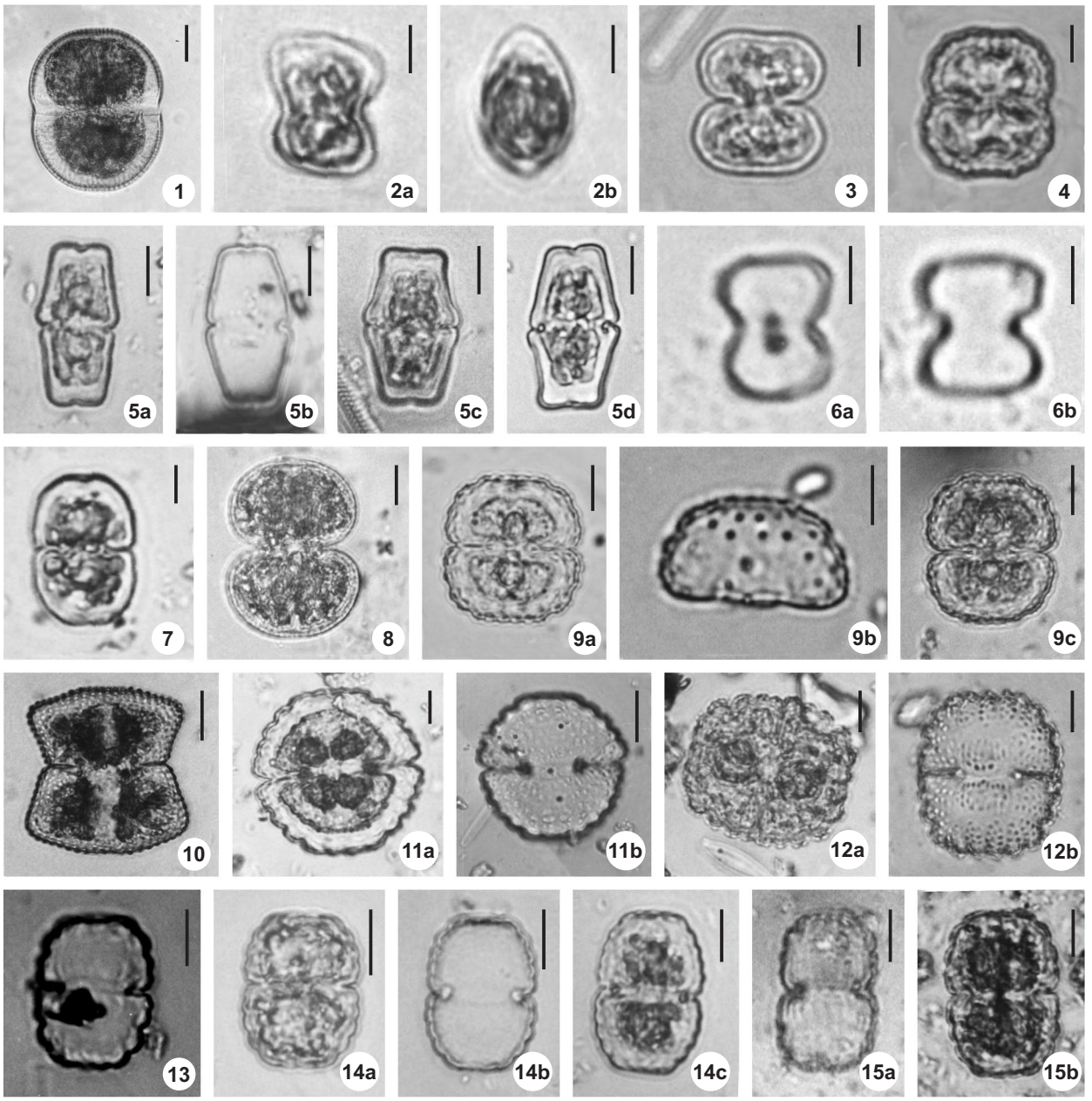

Figure 14. *Cosmarium*. 1 – *Cosmarium alpestre*; 2a–b – *Co. arctoum*; 3 – *Co. bioculatum*; 4 – *Co. blyttii*; 5a–d – *Co. anceps*; 6a–b – *Co. asphaerosporum*; 7 – *Co. angulosum*; 8 – *Co. contractum*; 9a–c – *Co. boeckii*; 10 – *Co. biretum*; 11a–b – *Co. cyclicum*; 12a–b – *Co. caelatum*; 13 – *Co. saxicolum*; 14a–c – *Co. notabile*; 15a–b – *Co. crenatum*. Scales: 1, 11b = 20 µm; 2a–b, 3–4, 6a–b, 7 = 5 µm; 5a–d, 8–11a, 12a–15b = 10 µm. LM by M. Wayda.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. Polyhumic pond, puddles in marshes, pH range 7.2–7.5, altitude range 390–870 m.

Number of localities in the Gorce Mts: 3 (0.007).
Turbacz range: 2 (0.006): **101**, **407**.
Lubań range: 1 (0.013): **21**.
Foothill zone: 1 (0.021), Lower montane zone: 2 (0.006).

Cosmarium contractum O. Kirchner [*Co. elipsoideum* Elfving, *Co. indentatum* Grönblad, *Co. jacobsenii* R. Roy et Bisset, *Co. minutum* Delponte]
(Figs 13: 8; 14: 8; Map 65)

Description. Cells elliptical, deeply constricted. Sinus linear, strongly broadening in outer part. Semicells elliptical, with strongly convex margins and slightly convex apices, lower and upper angles rounded. Chloroplasts plate-shaped, with single pyrenoid. Cell wall punctate. L: 45–55, W: 30–45, I: 15, L/W: 1.2–1.8.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, puddles on roads, old wells, pH range 5.7–7.4, altitude range 870–1080 m.

Number of localities in the Gorce Mts: 3 (0.007).
Turbacz range: 2 (0.006): **294**, **346**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 3 (0.009).

Cosmarium costatum Nordstedt
(Figs 23: 17; 24: 17a–b; Map 66)

Description. Cells hexagonal, broadly rounded, moderately constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with flat apices with four swellings and convex margins with four swellings; lower angles straight, apical rounded. Top view elliptical, with lateral inflations. Chloroplasts plate-shaped, with single pyrenoid. Three rows of small granules near margins, six longitudinal ridges below isthmus on each semicell. L: 30–42.5, W: 25–30, I: 10, L/W: 1.0–1.4.

Distribution in Poland. Sudety Mts (Grönblad 1926), Carpathian Mts (Gutwiński 1909), Mazovian Lowland (Wysocka 1934).

Habitat. Puddles and moist soil on roads, puddles, wet mosses of *Bryidae* class on meadows, pH range 6.1–8.3, altitude range 570–1240 m.

Number of localities in the Gorce Mts: 18 (0.044).
Turbacz range: 18 (0.044): **85**, **96**, **162**, **185**, **241**, **302**, **385**.
Lubań range: Not recorded.
Foothill zone: 3 (0.062), Lower montane zone: 11 (0.034), Upper montane zone: 4 (0.103).

Cosmarium crenatum Ralfs ex Ralfs [*Co. tricrenatum* Gutwiński, *Co. boldtianum* Gutwiński, *Eu. sinuosum* Kützing] (Figs 13: 15, 15a; 14: 15a–b; Map 67)

Description. Cells rectangular, moderately constricted. Sinus linear, broadening in outer part. Semicells square, with flat apices with four swellings and straight margins with two or three swellings; lower angles straight, apical rounded. Top view elliptical, with lateral ridges. Chloroplasts plate-shaped, with single pyrenoid. Two rows of small granules near margins, six thick longitudinal ridges below isthmus on each semicell. L: 30–35, W: 20–25, I: 10, L/W: 1.4–1.5.

Notes. Specimens belonging to var. *bicrenatum* Nodstedt were recorded in the material; they have margins with two swellings.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Puddles and moist soil on roads, wet mosses of *Bryidae* class on meadows, oxbow lakes, temporary waterbodies, fish ponds, pH range 7.1–8.5, altitude range 480–1230 m.

Number of localities in the Gorce Mts: 22 (0.054).
Turbacz range: 21 (0.063): **88**, **94**, **125**, **182**, **227**, **328**.
Lubań range: 1 (0.013): **9**.
Foothill zone: 3 (0.062), Lower montane zone: 18 (0.056), Upper montane zone: 1 (0.026).

Cosmarium cyclicum P. Lundell
(Figs 13: 11; 14: 11a–b; Map 68)

Description. Cells hexagonal or elliptical, deeply constricted. Sinus closed in apical part, sometimes linear, broadening in outer part. Semicells trapezoidal or semicircular, with flat apices with four swellings and convex margins with four swellings, lower angles acute, apical rounded. Top view elliptical, with acute poles. Chloroplasts contain pair of pyrenoids. Two or three series of intramarginal undulations near margins. L: 40–55, W: 45–55, I: 15, L/W: 0.9–1.0.

Distribution in Poland. Carpathian Mts (Wasylik 1971), Lublin Upland (Eichler 1896), Mazovian Lowland (Tomaszewicz 1970).

Habitat. *Sphagnum* puddles, puddles on roads and paths, moist soil on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes, temporary waterbodies, pH range 5.4–7.4, altitude range 590–1230 m.

Number of localities in the Gorce Mts: 29 (0.071).
Turbacz range: 25 (0.076): **85**, **115**, **158**, **163**, **244**, **366**.
Lubań range: 4 (0.051): **9**, **53**, **69**.
Foothill zone: 2 (0.042), Lower montane zone: 23 (0.071), Upper montane zone: 4 (0.103).

Cosmarium cymatopleurum Nordstedt [*Co. archeri* R. Roy et Bisset] (Figs 17: 14; 18: 14; Map 69)

Description. Cells hexagonal, deeply constricted. Sinus closed in apical part, broadening in outer part. Semicells trapezoidal, with flat apices and convex margins with five or six swellings; lower and apical angles rounded. Top view elliptical. Chloroplasts contain pair of pyrenoids. Cell wall smooth. L: 85–95, W: 55–65, I: 20–25, L/W: 1.4–1.6.

Notes. Only specimens belonging to var. *archeri* (R. Roy et Bisset.) W. West et G. S. West were recorded in the material.

Distribution in Poland. Sudety Mts (Grönblad 1926), Carpathian Mts (Wasylik 1971).

Habitat. Moist soil on roads, old wells, pH range 7.4–7.9, altitude range 700–1080 m.

Number of localities in the Gorce Mts: 4 (0.01).
Turbacz range: 4 (0.012): **130**, **214**, **221**, **370**.
Lubań range: Not recorded.
Lower montane zone: 4 (0.012).

Cosmarium davidsonii R. Roy et Bisset [*Co. tetragonum* (Nägeli) W.Archer in Pritchard var. *davidsonii* (R. Roy et Bisset) W. West et G. S. West]
(Figs 15: 5, 5a; 16: 5a–b; Map 70)

Description. Cells hexagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with flat apices with four swellings and slightly convex margins with four swellings; lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Two or three rows of small granules near margins. L: 30–40, W: 20–25, I: 10, L/W: 1.4–1.6.

Distribution in Poland. Sudety Mts (Grönblad 1926), Carpathian Mts (Wasylik 1971).

Habitat. Puddles on roads and paths, moist soil on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes, stream springs, pH range 5.3–7.7, altitude range 760–1270 m.

Number of localities in the Gorce Mts: 46 (0.112).
Turbacz range: 43 (0.13): **95**, **134**, **182**, **258**, **376**.
Lubań range: 3 (0.048): **8**, **50**, **60**.
Foothill zone: 1 (0.021), Lower montane zone: 38 (0.118), Upper montane zone: 7 (0.179).

Cosmarium debaryi W. Archer [*Pls. debaryi* W. Archer]
(Figs 17: 1, 1a; 18: 1a–b; Map 71)

Description. Cells rectangular, moderately constricted. Sinus widely open, with acute apex. Semicells rectangular, with strongly rounded apices and straight margins; lower and apical angles rounded. Top view circular. Chloroplasts contain numerous pyrenoids. Cell wall punctate. L: 110, W: 50, I: 35, L/W: 2.2.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. Polyhumic pond, *Sphagnum* puddles, pH range 5.7–6.9, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**. Lower montane zone: 1 (0.003).

Cosmarium decedens (Reinsch) Raciborski
(Figs 17: 7; 18: 7; Map 72)

Description. Cells rectangular, moderately constricted. Sinus prominently open. Semicells rectangular, with strongly concave apices; lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall punctate. L: 40, W: 15–20, I: 10, L/W: 2.0–2.7.

Notes. Specimens belonging to var. *minutum* (Gutwiński) Krieger et Gerloff were recorded in the material; they are smaller (L: 15, W: 7.5, I: 5, L/W: 2.0).

Distribution in Poland. Sudety Mts (Schröder 1896), Carpathian Mts (Kawecka 1965), Lublin Upland (Eichler 1895).

Habitat. Puddles on roads, moist soil on roads, old wells in marshes, pH range 6.7–7.4, altitude range 680–1240 m.

Number of localities in the Gorce Mts: 6 (0.013).
Turbacz range: 5 (0.015): **85**, **156**, **204**, **219**, **296**.
Lubań range: 1 (0.013): **60**.
Lower montane zone: 5 (0.016), Upper montane zone: 1 (0.026).

Cosmarium dentiferum Corda ex Nordstedt
(Figs 17: 8; 18: 8a–b; Map 73)

Description. Cells rectangular, deeply constricted. Sinus closed in apical part, open in outer part. Semicells reniform, with flat or slightly concave apices and strongly convex margins; lower and apical angles rounded. Top view elliptical. Chloroplasts contain pair of pyrenoids. Cell wall furnished with rows of distinct granules. L: 55–75, W: 45–50, I: 20, L/W: 1.2–1.4.

Notes. Only specimens belonging to var. *alpinum* Messikomer fo. *minor* Huber-Pestalozzii were recorded in the material.

Distribution in Poland. Carpathian Mts (Gutwiński 1909), Masurian Lakeland (Sosnowska-Półtoracka 1974).

Habitat. *Sphagnum* puddles, puddles on roads and paths, moist soil on roads, puddles and old wells in marshes, pH range 5.3–7.7, altitude range 760–1270 m.

Number of localities in the Gorce Mts: 14 (0.034).
Turbacz range: 14 (0.042): **153**, **176**, **251**, **357**.
Lubań range: Not recorded.
Lower montane zone: 8 (0.023), Upper montane zone: 6 (0.154).

Cosmarium didymochondrum Nordstedt
(Figs 17: 15; 18: 15a–c; Map 74)

Description. Cells elliptical, deeply constricted. Sinus closed in apical part, open in outer part. Semicells trapezoidal, with flat apices with four swellings and convex margins with five of six swellings; lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Rows of small granules near margins, two larger granules below isthmus on each semicell. L: 40–45, W: 30–40, I: 10–12.5, L/W: 1.1–1.3.

Notes. Only specimens belonging to var. *tatricum* Gutwiński were recorded in the material.

Distribution in Poland. Carpathian Mts (Mrozińska 1990), Sudety Mts (Schröder 1896), Pomeranian Lakeland (Torka 1908).

Habitat. Moist soil on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes, oxbow lakes, fish ponds, pH range 6.7–8.5, altitude range 510–1220 m.

Number of localities in the Gorce Mts: 66 (0.161).
Turbacz range: 53 (0.161): **117**, **140**, **172**, **258**, **408**.
Lubań range: 13 (0.165): **4**, **17**, **48**.
Foothill zone: 8 (0.167), Lower montane zone: 52 (0.161), Upper montane zone: 6 (0.154).

Cosmarium difficile Lütkemüller [*Co. granatum* Brébisson in Ralfs.var. *hexagonum* Klebs, *Co. meneghinii* Brébisson var. *difficile* (Lütkemüller) Gutwiński]

(Figs 17: 10; 18: 10; Map 75)

Description. Cells rectangular, deeply constricted. Sinus linear, broadening in outer part. Semicells nearly square, with flat apices and concave margins; lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 30, W: 20, I: 10, L/W: 1.5.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. *Sphagnum* puddles, puddles in marshes, pH range 5.7–7.0, altitude range 870–1270 m.

Number of localities in the Gorce Mts: 4 (0.01).
Turbacz range: 3 (0.01): **226**, **297**, **333**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 3 (0.01), Upper montane zone: 1 (0.026).

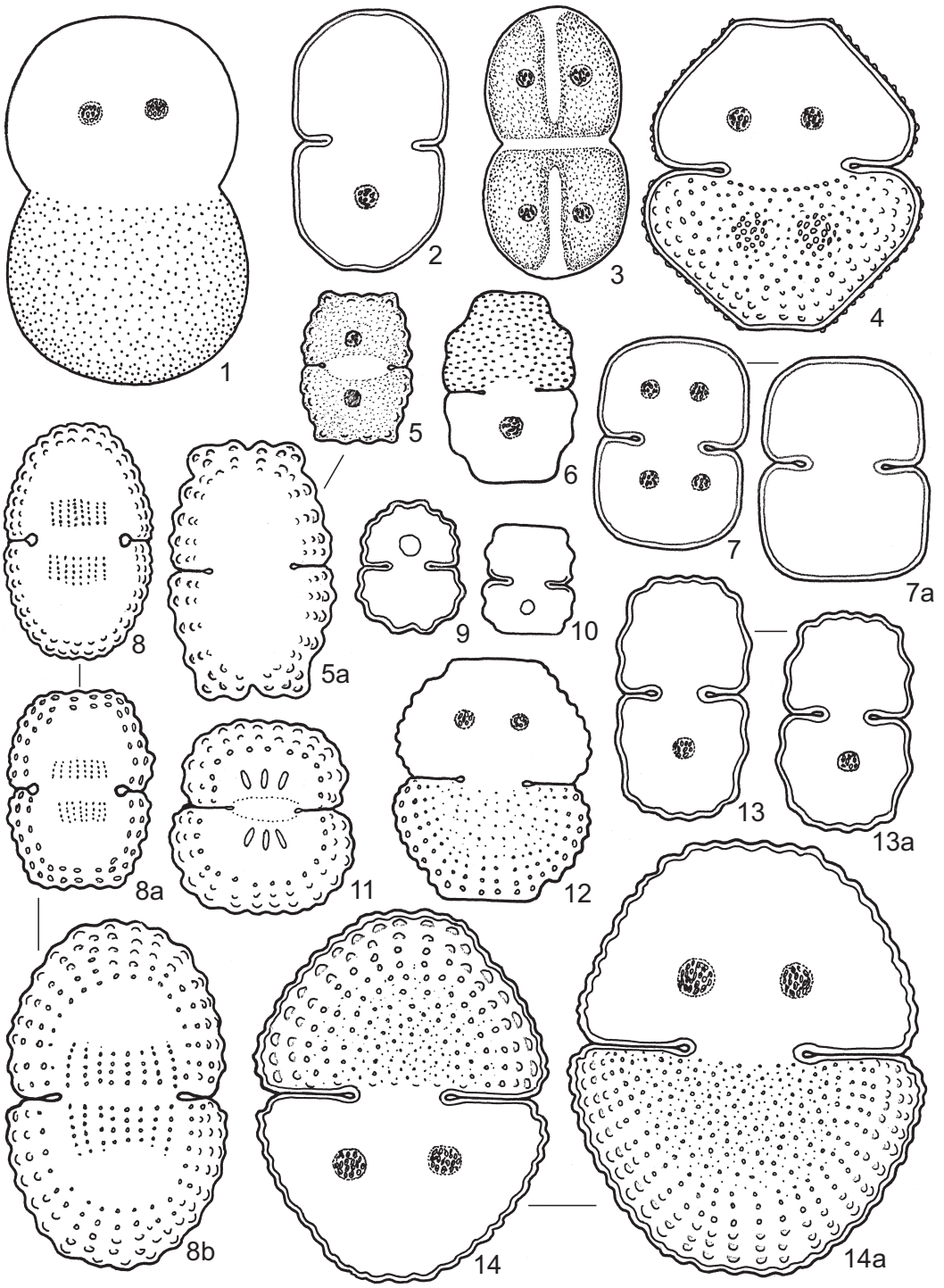

Figure 15. *Cosmarium*. 1 – *Cosmarium connatum*; 2 – *Co. subquadratum*; 3 – *Co. thwaitesii*; 4 – *Co. turpinii*; 5, 5a – *Co. davidsonii*; 6 – *Co. venustum*; 7, 7a – *Co. subbroomei*; 8, 8a–b – *Co. speciosum*; 9 – *Co. impressulum* var. *crenulatum*; 10 – *Co. regnellii*; 11 – *Co. sexnotatum*; 12 – *Co. vexatum*; 13, 13a – *Co. tetragonum*; 14, 14a – *Co. hornavanense.* Drawings E. Nowotarska.

Cosmarium dispersum L. N. Johnson
(Figs 17: 4; 18: 4a–b; Map 76)

Description. Cells elliptico-hexagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with flat apices with four swellings and convex margins with six swellings; lower and apical angles rounded. Top view elliptical. Chloroplasts contain pair of pyrenoids. Cell wall smooth. L: 40, W: 40, I: 10, L/W: 1.0.

Distribution in Poland. Not recorded.

Habitat. *Sphagnum* puddles, pH range 6.2, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Cosmarium elegantissimum P. Lundell
(Figs 17: 5, 5a; 18: 5a–b; Map 77)

Description. Cells elliptico-rectangular, with shallow constriction. Sinus open. Semicells semi-elliptical, with convex apices and straight margins; lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall furnished with parallel longitudinal rows of large granules L: 42.5–55, W: 20–25, I: 15–22.5, L/W: 1,7–2.2.

Notes. Only specimens belonging to variety fo. minor W. West were recorded in the material.

Distribution in Poland. Sudety Mts (Grönblad 1926), Southern Wielkopolska Lowland (Lesiak 1990), Mazovian Lowland (Tomaszewicz 1988), Masurian Lakeland (Szymańska 1984).

Habitat. *Sphagnum* puddles, puddles on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes, pH range 6.0–7.9, altitude range 610–1100 m.

Number of localities in the Gorce Mts: 9 (0.022).
Turbacz range: 8 (0.024): **137**, **198**, **240**, **244**, **260**, **333**, **370**, **385**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 9 (0.028).

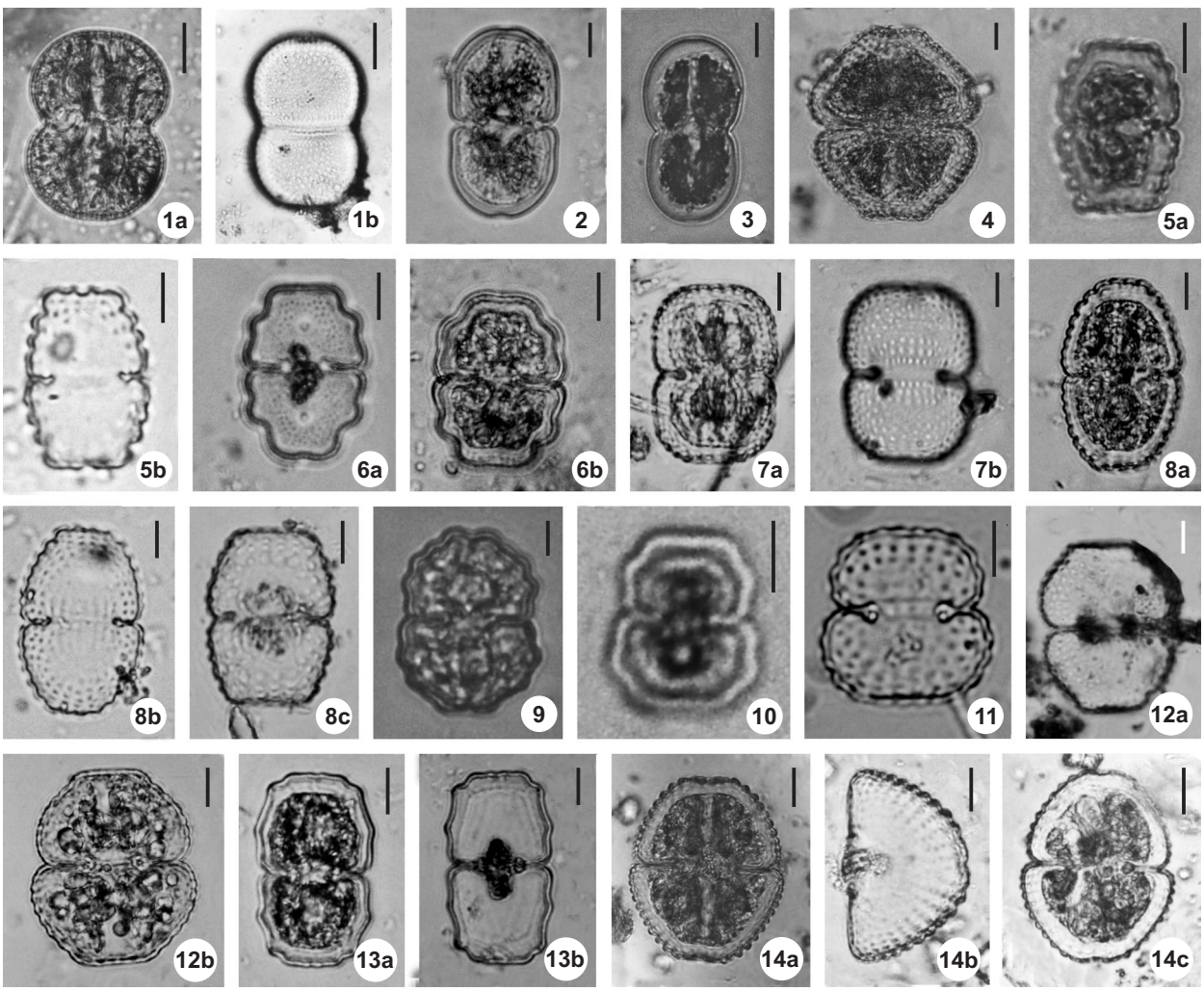

Figure 16. *Cosmarium*. 1a–b – *Cosmarium connatum*; 2 – *Co. subquadratum*; 3 – *Co. thwaitesii*; 4 – *Co. turpinii*; 5a–b – *Co. davidsonii*; 6a–b – *Co. venustum*; 7a–b – *Co. subbroomei*; 8a–c – *Co. speciosum*; 9 – *Co. impressulum* var. *crenulatum*; 10a–b – *Co. regnellii*; 11 – *Co. sexnotatum*; 12a–b – *Co. vexatum*; 13a–b – *Co. tetragonum*; 14a–c – *Co. hornavanense.* Scales: 1a–b, 14a–c = 20 µm; 2–8c, 11–13b = 10 µm; 9, 10a–b = 5 µm. LM by M. Wayda.

Cosmarium exiguum W. Archer
(Figs 17: 2, 2a; 18: 2a–b; Map 78)

Description. Cells rectangular, deeply constricted. Sinus distinctly open. Semicells nearly square, with flat apices and straight margins; lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 15, W: 7.5, I: 2.5, L/W: 2.0.

Distribution in Poland. Lublin Upland (Eichler 1895), Southern Wielkopolska Lowland (Lesiak 1990), Mazovian Lowland (Tomaszewicz 1988).

Habitat. Wet mosses of *Bryidae* class in marshes, pH range 7.4, altitude range 920 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **169**.
Lubań range: Not recorded.
Lower montane zone: 1 (0.003).

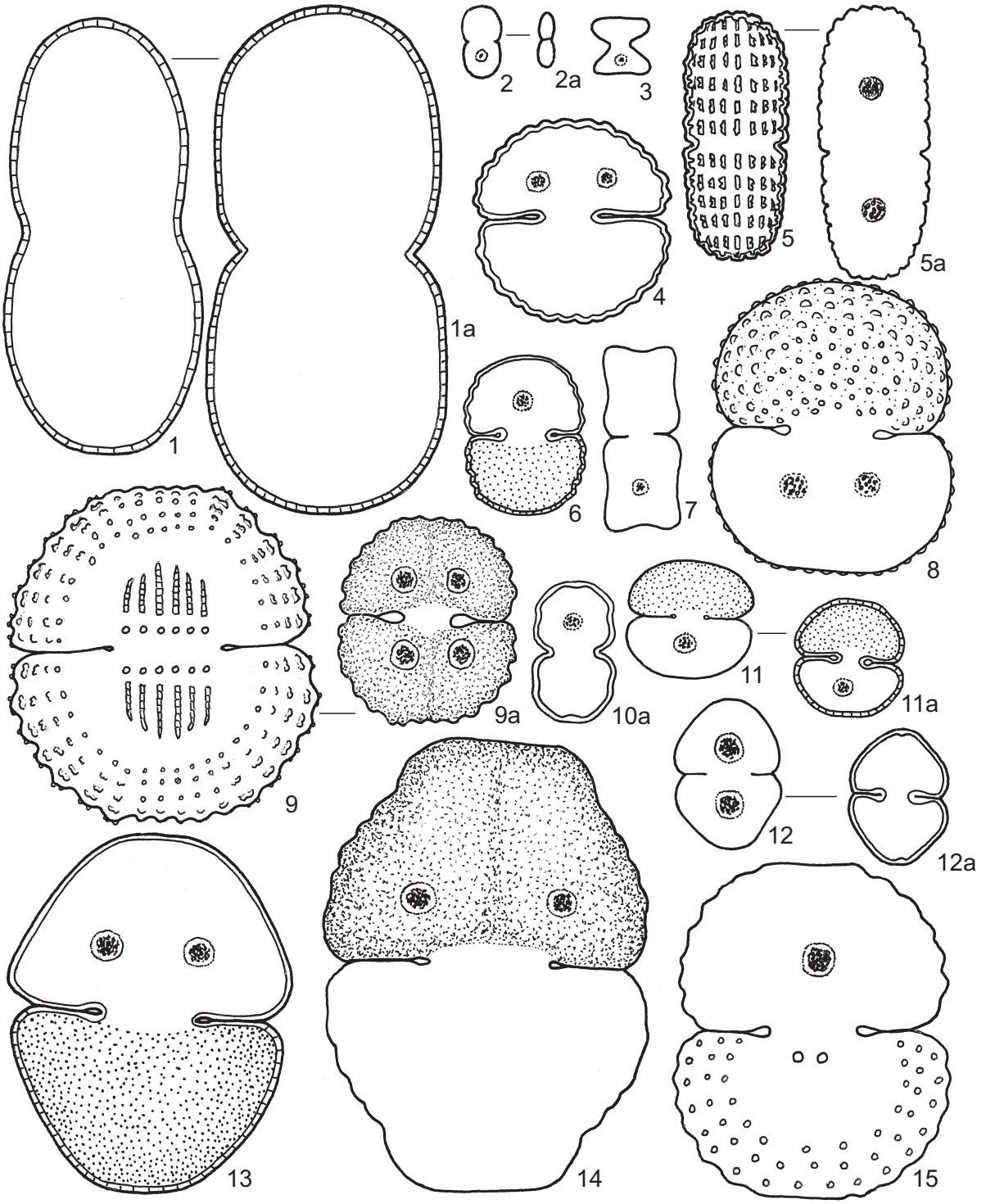

Figure 17. *Cosmarium.* 1, 1a – *Cosmarium debaryi*; 2, 2a – *Co. exiguum*; 3 – *Co. majae*; 4 – *Co. dispersum*; 5, 5a – *Co. elegantissimum*; 6 – *Co. garrolense*; 7 – *Co. decedens*; 8 – *Co. dentiferum*; 9, 9a – *Co. formosulum*; 10 – *Co. difficile*; 11, 11a – *Co. neodepressum*; 12, 12a – *Co. granatum*; 13 – *Co. galeritum*; 14 – *Co. cymatopleurum*; 15 – *Co. didymochondrum*. Drawings E. Nowotarska.

Cosmarium formosulum Hoff [*Co. nathorstii* Boldt] (Figs 17: 9, 9a; 18: 9a–b; Map 79)

Description. Cells hexagonal, rounded, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with flat, crenate apices and convex crenate margins (sometimes swellings furnished with pair of granules); lower and apical angles rounded. Top view elliptical. Chloroplasts contain pair of pyrenoids. Concentric rows of small granules near margins; row of thick longitudinal ridges below isthmus on each semicell. L: 40–50, W: 30–50, I: 12.5–15, L/W: 1.0–1.3.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads and paths, moist soil on roads, wet

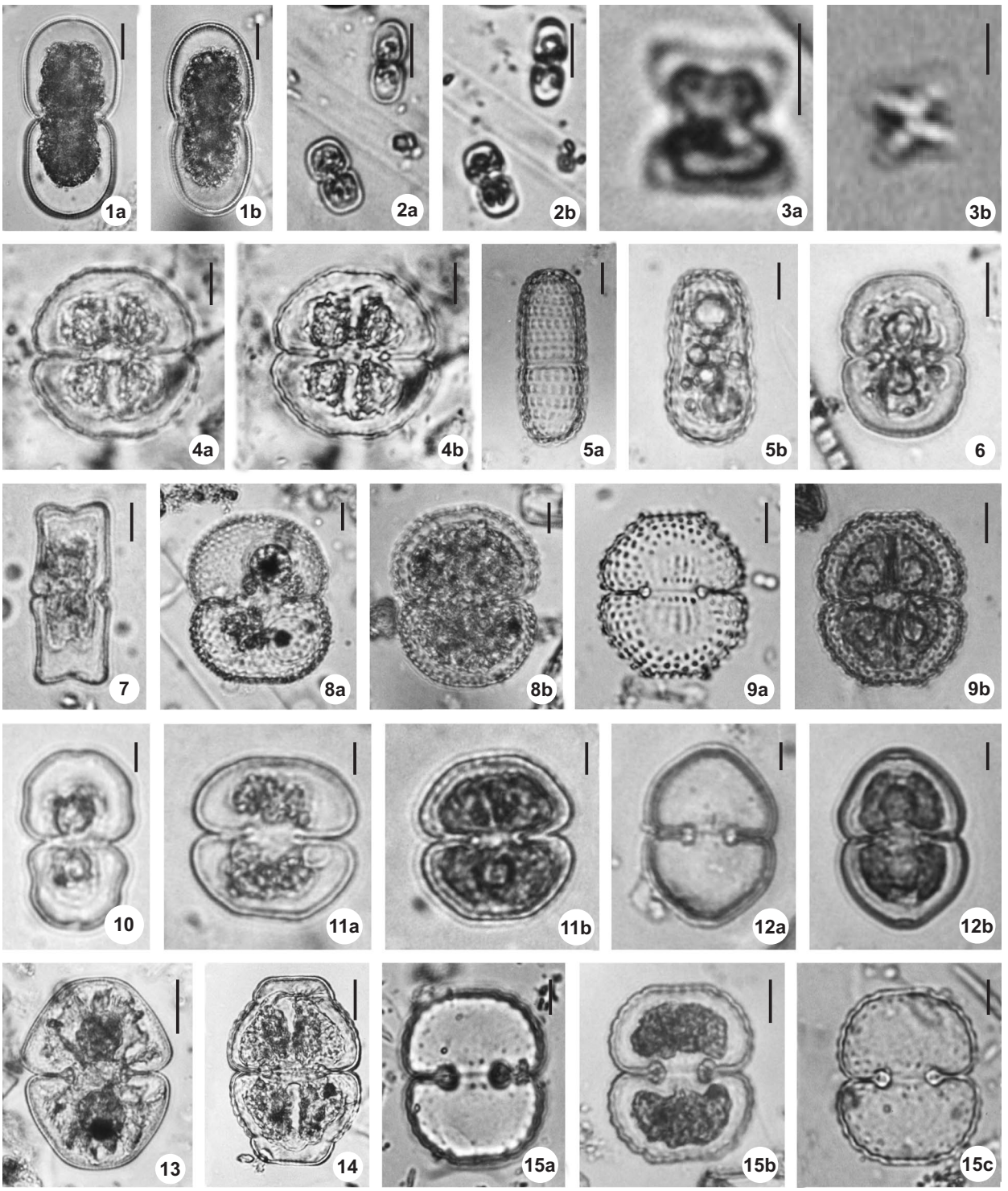

Figure 18. *Cosmarium*. 1a–b – *Cosmarium debaryi*; 2a–b – *Co. exiguum*; 3a–b – *Co. majae*; 4a–b – *Co. dispersum*; 5a–b – *Co. elegantissimum*; 6 – *Co. garrolense*; 7 – *Co. decedens*; 8a–b – *Co. dentiferum*; 9a–b – *Co. formosulum*; 10 – *Co. difficile*; 11a–b – *Co. neodepressum*; 12a–b – *Co. granatum*; 13 – *Co. galeritum*; 14 – *Co. cymatopleurum*; 15a–c – *Co. didymochondrum*. Scales: 1a–b, 13–14 = 20 μm; 2a–b, 4a–9b, 15a–c = 10 μm; 3a–b, 10–12b = 5 μm. LM by M. Wayda.

mosses of *Bryidae* class, puddles, old wells in marshes, oxbow lakes, temporary waterbodies, pH range 5.3–8.2, altitude range 520–1270 m.

Number of localities in the Gorce Mts: 39 (0.095):
Turbacz range: 38 (0.115): **115**, **133**, **174**, **297**, **384**.
Lubań range: 1 (0.013): **10**.
Foothill zone: 1 (0.021), Lower montane zone: 33 (0.102), Upper montane zone: 5 (0.128).

Cosmarium galeritum Nordstedt
(Figs 17: 13; 18: 13; Map 80)

Description. Cells hexagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with flat apices and slightly convex margins. Top view elliptical. Chloroplasts contain pair of pyrenoids. Cell wall punctate. L: 55–75, W: 45–60, I: 15–20, L/W: 1.0–1.4.

Distribution in Poland. Silesian Lowland (Kirchner 1878), Carpathian Mts (Wasylik 1971).

Habitat. *Sphagnum* puddles, puddles on roads, moist soil on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes, oxbow lakes, pH range 5.1–8.6, altitude range 690–1270 m.

Number of localities in the Gorce Mts: 53 (0.130).
Turbacz range: 48 (0.145): **109**, **125**, **175**, **240**.
Lubań range: 5 (0.063): **8**, **21**, **74**.
Lower montane zone: 37 (0.115), Upper montane zone: 16 (0.41).

Cosmarium garrolense J. Roy et Bisset
(Figs 17: 6; 18: 6; Map 81)

Description. Cells broadly elliptical, deeply constricted. Sinus closed in apical part, broadening in outer part. Semicells nearly rectangular, with slightly convex apices and convex margins with four or five swellings; lower and upper angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 30, W: 20–25, I: 10, L/W: 1.2–1.5.

Distribution in Poland. Carpathian Mts (Gutwiński 1909), Oświęcim Basin (Kyselowa 1977).

Habitat. Puddles on roads and paths, moist soil on roads, wet mosses of *Bryidae* class in mountain meadows, pH range 6.7–7.4, altitude range 810–1240 m.

Number of localities in the Gorce Mts: 7 (0.017).
Turbacz range: 6 (0.018): **155**, **208**, **222**, **229**, **276**, **301**.
Lubań range: 1 (0.013): **73**.
Lower montane zone: 5 (0.016), Upper montane zone: 2 (0.051).

Cosmarium gonioides West et G. S. West
(Figs 23: 6; 24: 6; Map 82)

Description. Cells rectangular, with shallow constriction. Sinus open, very shallow. Semicells nearly square, with slightly concave apices and straight margin; lower angles rounded, apical straight. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 20, W: 10, I: 7.5, L/W: 2.0.

Distribution in Poland. Sudety Mts (Grönblad 1926).

Habitat. Polyhumic pond, pH range 7.1, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Cosmarium granatum Brébisson ex Ralfs
(Figs 17: 12, 12a; 18: 12a–b; Map 83)

Description. Cells hexagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with slightly protracted and convex, sometimes flat apices and convex margins; lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 30–35, W: 20–25, I: 5–10, L/W: 1.4–1.5.

Notes. Specimens belonging to var. *elongatum* Nordstedt were recorded in the material; they have more elongated cells (L: 50–55, W: 25–30, I: 10–15, L/W: 1.8–2.0).

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Puddles on roads, moist soil on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes, oxbow lakes, pH range 6.4–8.3, altitude range 510–1220 m.

Number of localities in the Gorce Mts: 40 (0.098).
Turbacz range: 34 (0.103): **117**, **140**, **169**, **211**.
Lubań range: 6 (0.076): **5**, **48**, **61**, **74**.
Foothill zone: 4 (0.083), Lower montane zone: 32 (0.099), Upper montane zone: 4 (0.102).

Cosmarium hammeri Reinsch [*Co. homalodermum* Nordstedt, *Co. lidanum* Raciborski]
(Figs 19: 6; 20: 6; Map 84)

Description. Cells hexagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with slightly concave apices and concave margins, lower angles straight, apical rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall punctate. L: 55–65, W: 45–60, I: 15, L/W: 1.1–1.3.

Notes. Only specimens belonging to var. *homalodermum* (Nordstedt) W. et G. S. West were recorded in the material.

Distribution in Poland. Carpathian Mts (Gutwiński 1914), Lublin Upland (Eichler 1890).

Habitat. Puddles on paths, moist soil on roads, wet mosses of *Bryidae* class on meadows, pH range 7.4, altitude range 820–1220 m.

Number of localities in the Gorce Mts: 4 (0.01).
Turbacz range: 3 (0.009): **171**, **217**, **296**.
Lubań range: 1 (0.013): **45**.
Lower montane zone: 3 (0.009), Upper montane zone: 1 (0.026).

Cosmarium holmiense P. Lundell [*Co. incisum* (Jacobsen) Raciborski, *Co. plicatum* Reinsch var. *hibernicum* W. West] (Figs 19: 1, 1a–b; 20: 1a–c; Map 85)

Description. Cells hexagonal, deeply constricted. Sinus closed in apical part, open in outer part. Semicells trapezoidal, with flat apices with four swellings and slightly convex margins; lower angles straight, apical angles rounded. Top view elliptical. Chloroplasts contain single

pyrenoid. Cell wall smooth. L: 45, W: 25–30, I: 15, L/W: 1.5–1.8.

Notes. The typical variety is very rare (seven localities in the Gorce Mts). Most specimens belong to the variety that has a linear sinus in the apical part, margins without swellings, and rounded lower angles.

Distribution in Poland. Species very often recorded, but mostly from southern Poland.

Habitat. Puddles on roads, moist soil on roads and paths, wet mosses of *Bryidae* class, puddles, old wells in marshes, oxbow lakes, temporary waterbodies, fish ponds, pH range 5.8–8.6, altitude range 390–1230 m.

Number of localities in the Gorce Mts: 105 (0.257).
Turbacz range: 85 (0.258): **88**, **95**, **160**, **182**, **240**.
Lubań range: 20 (0.253): **3**, **10**, **53**, **60**, **73**.
Foothill zone: 14 (0.292), Lower montane zone: 83 (0.258), Upper montane zone: 8 (0.205).

Cosmarium hornavanense Gutwiński [*Co. tetraophthalmum* Brébisson var. *pyramidatum* Strøm]
(Figs 15: 14, 14a; 16: 14a–c; Map 86)

Description. Cells hexagonal to elliptico-hexagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with flat apices with four swellings and convex undulated margins; lower and apical angles rounded. Top view elliptical. Chloroplasts contain pair of pyrenoids. Four or five concentric rows of granules near margins (granules smaller towards center of cell), few longitudinal rows of granules below isthmus (sometimes forming ridges). L: 87.5–95, W: 55–85, I: 20–25, L/W: 1.1–1.5.

Notes. Specimens belonging to var. *minor* Roubal, which are smaller (L: 75–85, W: 55–75, I: 20, L/W: 1.0–1.3), and var. *mesoleion* (Nordstedt) Růžička, with more elliptical cells (L: 75–90, W: 55–60, I: 20–25, L/W: 1.4–1.5), were recorded in the material.

Distribution in Poland. Sudety Mts (Grönblad 1926), Carpathian Mts (Wasylik 1971).

Habitat. Puddles on roads, moist soil on roads and paths, wet mosses of *Bryidae* class, puddles, old wells in marshes, temporary waterbodies, pH range 5.8–8.6, altitude range 390–1230 m.

Number of localities in the Gorce Mts: 100 (0.244).
Turbacz range: 87 (0.264): **80**, **84**, **99**, **158**, **185**, **255**, **407**.
Lubań range: 13 (0.165): **3**, **10**, **53**, **61**.
Foothill zone: 8 (0.167), Lower montane zone: 87 (0.271), Upper montane zone: 5 (0.128).

Cosmarium humile Nordstedt ex De Toni [*Co. danicum* Bëgeson, *Co. striatum* Boldt]
(Figs 23: 3; 24: 3; Map 87)

Description. Cells octagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with flat apices with six swellings and slightly convex margins with three swellings; lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Some dispersed granules near margins, sometimes cell wall smooth. L: 15, W: 15, I: 10, L/W: 1.0.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic pond, *Sphagnum* puddles, pH range 6.2–7.1, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Cosmarium impressulum Elfving [*Co. suborthogonum* Raciborski] (Figs 23: 21, 21a–d; 24: 21a–c; Map 88)

Description. Cells elliptical, deeply constricted. Sinus linear, broadening in outer part. Semicells semicircular, with eight swellings (sometimes as faint undulations), with strongly concave apices. Margins straight in lower part, convex in apical part; lower angles straight, upper angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 20–30, W: 15–25, I: 5, L/W: 1.2–1.5.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic waterbodies, puddles on roads and paths, moist soil on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes, oxbow lakes, temporary waterbodies, fish ponds, pH range 6.1–9.2, altitude range 390–1230 m.

Number of localities in the Gorce Mts: 95 (0.232).
Turbacz range: 78 (0.236): **82**, **84**, **99**, **160**, **182**, **258**, **409**.
Lubań range: 17 (0.215): **1**, **21**, **51**, **67**, **76**.
Foothill zone: 18 (0.375), Lower montane zone: 71 (0.22), Upper montane zone: 6 (0.167).

Cosmarium impressulum var. *crenulatum* (Nägeli) Willi Krieger & Gerloff [*Co. crenulatum* (Nägeli); *Co. undulatum* Corda var. *crenulatum* (Nägeli) Wittrock]
(Figs 15: 9; 16: 9; Map 89)

Description. Cells elliptico-rectangular, deeply constricted. Sinus linear, broadening in outer part. Semicells semicircular, with convex apices with two swellings and strongly convex margins with three swellings, lower angles straight, upper rounded. Top view elliptical. Chloroplasts plate-shaped, with single pyrenoid. Cell wall smooth. L: 27.5, W: 20, I: 5, L/W: 1.4.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Puddle in gravel near stream bank, pH range 7.4, altitude range 580 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **409**.
Lubań range: Not recorded.
Foothill zone: 1 (0.021).

Cosmarium jenisejense Boldt
(Figs 19: 13, 13a; 20: 13a–c; Map 90)

Description. Cells square, deeply constricted. Sinus linear, broadening in outer part. Semicells rectangular, with flat apices and convex margins, lower and apical angles

rounded. Top view elliptical, with three large granules on each lateral side. Chloroplasts contain single pyrenoid. Two concentric rows of granules near margins, three longitudinal ridges below isthmus on each semicell. L: 30, W: 25, I: 10, L/W: 1.2.

Notes. Only specimens belonging to var. *notatum* (Grönblad) Förster were recorded in the material.

Distribution in Poland. Carpathian Mts (Gutwiński 1897).

Habitat. Polyhumic waterbodies, *Sphagnum* puddles, pH range 5.9–6.0, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Cosmarium laeve Rabenhorst [*Co. lejodermum* (Gay) Hansgirg, *Co. meneghinii* Brébisson var. *octangulare* (Wille) W. West et G. S. West]

(Figs 23: 12, 12a; 24: 12a–b; Map 91)

Description. Cells elliptical or elliptico-hexagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells semicircular, with five angles, or trapezoidal with distinctly concave apices. Margins in lower part straight, in apical part convex, sometimes with small undulations; lower angles straight, upper angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 15–35, W: 12.5–25, I: 5, L/W: 1.2–1.8.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic waterbodies, *Sphagnum* puddles, puddles on roads and paths, moist soil on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes,

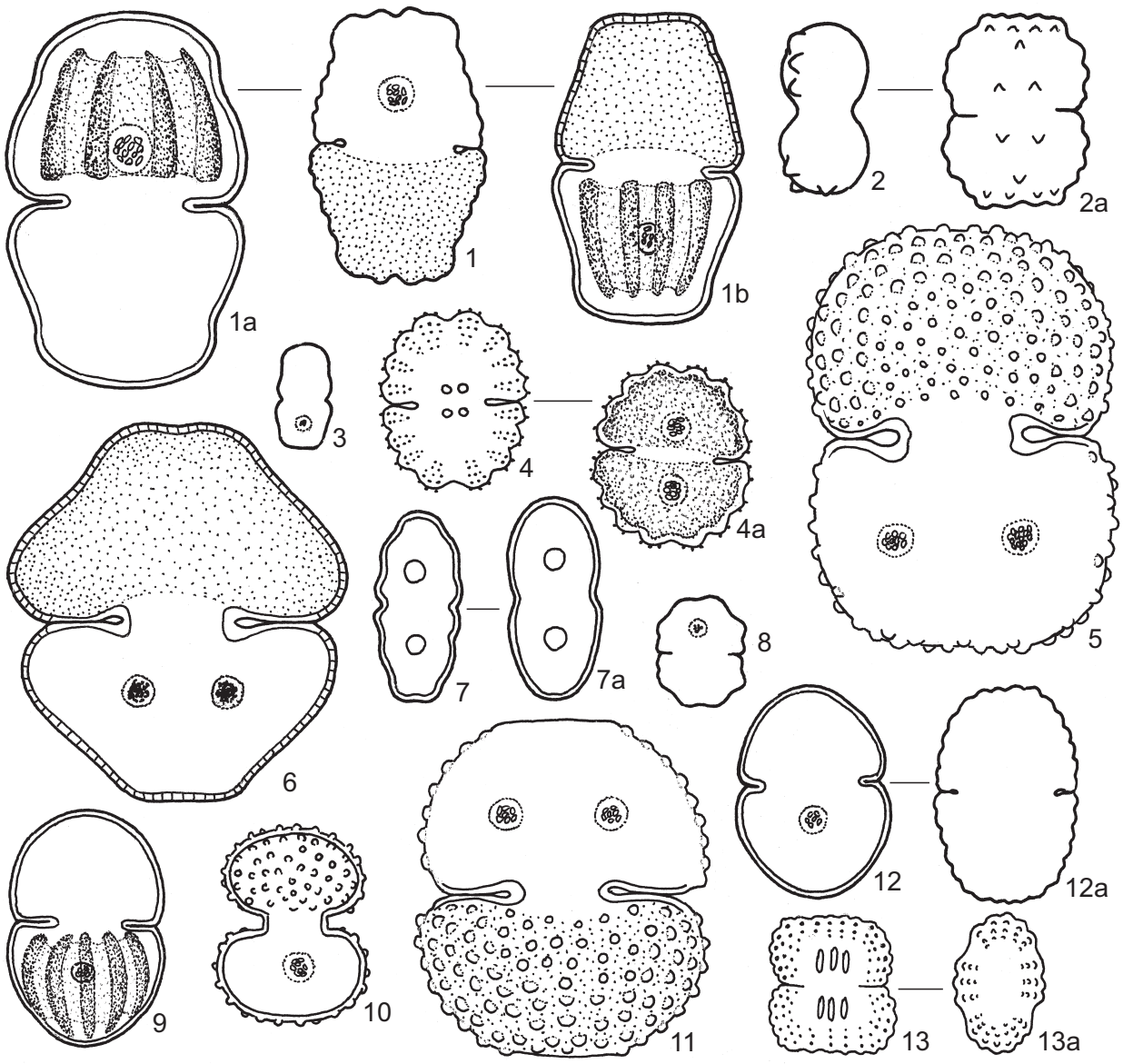

Figure 19. *Cosmarium*. 1, 1a–b – *Cosmarium holmiense*; 2, 2a – *Co. limnophilum*; 3 – *Co. pseudoexiguum*; 4, 4a – *Co. nasutum*; 5 – *Co. margaritatum;* 6 – *Co. hammeri*; 7, 7a – *Co. parvulum*; 8 – *Co. meneghinii*; 9 – *Co. pseudopyramidatum*; 10 – *Co. porteanum*; 11 – *Co. margaritiferum*; 12, 12a – *Co. microsphinctum*; 13, 13a – *Co. jenisejense*. Drawings E. Nowotarska.

oxbow lakes, temporary, waterbodies, fish ponds, pH range 5.1–9.2, altitude range 440–1270 m.

Number of localities in the Gorce Mts: 156 (0.381).
Turbacz range: 128 (0.388): **80**, **115**, **134**, **185**, **255**.
Lubań range: 28 (0.354): **3**, **21**, **53**, **61**, **75**.
Foothill zone: 9 (0.188), Lower montane zone: 131 (0.407), Upper montane zone: 16 (0.41).

Cosmarium limnophilum Schmidle
(Figs 19: 2, 2a; 20: 2a–c; Map 92)

Description. Cells elliptico-rectangular, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with flat apices furnished with five large granules and slightly convex margins with four granules on each side; lower angles straight, upper angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Small, dispersed tubercules near margins. L: 30, W: 25, I: 10, L/W: 1.2.

Distribution in Poland. Sudety Mts (Grönblad 1926).

Habitat. Polyhumic pond, *Sphagnum* puddles, pH range 6.9–7.1, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Cosmarium majae Strøm
(Figs 17: 3; 18: 3a–b; Map 93)

Description. Cells hexagonal, deeply constricted. Sinus open, with acute apex. Semicells semi-elliptical, with flat apices and convex margins; lower angles rounded, apical angles acute. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 8, W: 7, I: 5, L/W: 1.1.

Distribution in Poland. Sudety Mts (Matuła 1995).

Habitat. Polyhumic pond, pH range 6.9–7.1, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

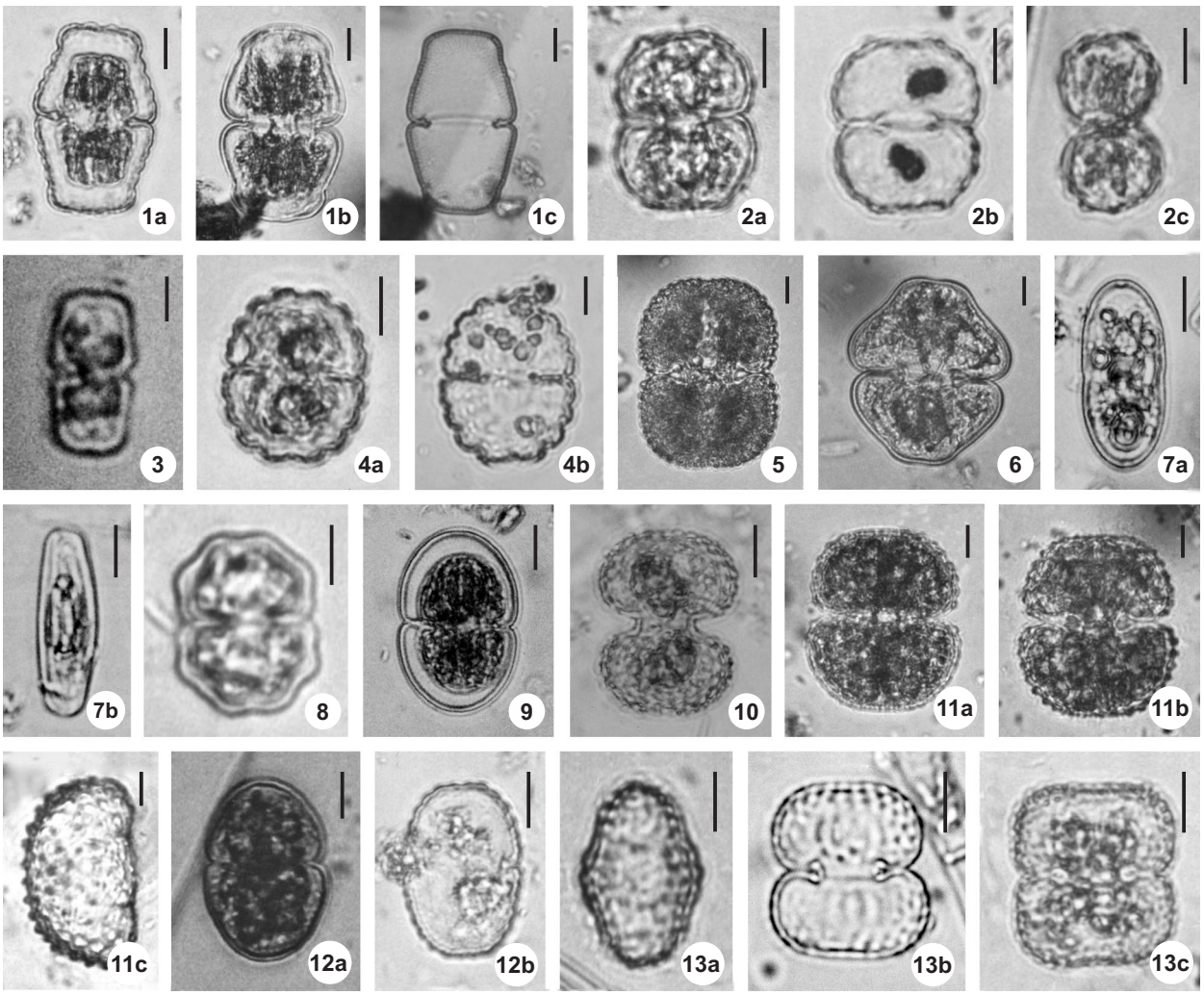

Figure 20. *Cosmarium*. 1a – *Cosmarium holmiense* var. *holmiense*; 1b–c – *Co. holmiense* var. *integrum*; 2a–c – *Co. limnophilum*; 3 – *Co. pseudoexiguum*; 4a–b – *Co. nasutum*; 5 – *Co. margaritatum*; 6 – *Co. hammeri*; 7a–b – *Co. parvulum*; 8 – *Co. meneghinii*; 9 – *Co. pseudopyramidatum*; 10 – *Co. porteanum*; 11a–c – *Co. margaritiferum*; 12a–b – *Co. microsphinctum*; 13a–c – *Co. jenisejense*. Scales: 1a–2c, 4a–7b, 9–13d = 10 µm; 3, 8 = 5 µm. LM by M. Wayda.

Cosmarium margaritatum (P. Lundell) J. Roy et Bisset (Figs 19: 5; 20: 5; Map 94)

Description. Cells rectangular, deeply constricted. Sinus closed in apical part, open in outer part. Semicells rectangular, with slightly convex apices and margins; lower and apical angles rounded. Top view elliptical. Chloroplasts contain pair of pyrenoids. Cells furnished with rows of large granules and punctate between rows. L: 70, W: 55, I: 15, L/W: 1.3.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. Polyhumic waterbodies, *Sphagnum* puddles, puddles on roads and paths, moist soil on roads, old wells in marshes, pH range 5.4–7.1, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Cosmarium margaritiferum Meneghini ex Ralfs (Figs 19: 11; 20: 11a–c; Map 95)

Description. Cells hexagonal, rounded, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with flat apices and convex margins, lower and apical angles rounded. Top view elliptical. Chloroplasts contain pair of pyrenoids. Cell wall furnished with conical granules of different sizes. L: 40–60, W: 35–50, I: 15, L/W: 1.1–1.2.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic waterbodies, *Sphagnum* puddles, puddles on roads and paths, moist soil on roads, old wells in marshes, pH range 5.1–7.7, altitude range 730–1250 m.

Number of localities in the Gorce Mts: 16 (0.039).
Turbacz range: 12 (0.036): **109**, **206**.
Lubań range: 4 (0.051): **3**, **21**.
Lower montane zone: 14 (0.043), Upper montane zone: 2 (0.051).

Cosmarium meneghinii Brébisson ex Ralfs (Figs 19: 8; 20: 8; Map 96)

Description. Cells octagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells hexagonal, with concave apices and straight or concave margins; lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 15–30, W: 12.5–20, I: 5, L/W: 1.2–1.5.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, fish ponds, pH range 6.0–8.5, altitude range 630–870 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 1 (0.003): **367**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 2 (0.006).

Cosmarium microsphinctum Nordstedt (Figs 19: 12, 12a; 20: 12a–b; Map 97)

Description. Cells elliptical, with shallow constriction. Sinus linear, broadening in outer part. Semicells semicircular, with convex apices and margins; lower angles straight, apical angles rounded. Top view elliptical. Chloroplasts contain pair of pyrenoids. Cell wall smooth. L: 30–37.5, W: 25, I: 15–20, L/W: 1.2–1.5.

Notes. Specimens belonging to var. *crispulum* Nordstedt were recorded in the material; they have undulated cell margins.

Distribution in Poland. Sudety Mts (Schröder 1896), Carpathian Mts (Wasylik 1971).

Habitat. Moist soil on roads, pH range 7.5, altitude range 580–840 m.

Number of localities in the Gorce Mts: 3 (0.007).
Turbacz range: 3 (0.009): **94**, **96**, **237**.
Lubań range: Not recorded.
Foothill zone: 2 (0.042), Lower montane zone: 1 (0.003).

Cosmarium nasutum Nordstedt [*Co. subnasutum* Raciborski, *Co. tirolense* Gutwiński, *Eu. scitum* W.West] (Figs 19: 4, 4a; 20: 4a–b; Map 98)

Description. Cells elliptical, deeply constricted. Sinus linear, broadening in outer part. Semicells semicircular or trapezoidal, with apices with two swellings and convex margins with four swellings (sometimes swellings furnished with pair of granules); lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Few concentric rows of granules near margins, two large granules and row of thin longitudinal ridges below isthmus on each semicell. L: 30–45, W: 25–30, I: 10, L/W: 1.2–1.8.

Distribution in Poland. Sudety Mts (Schröder 1898), Carpathian Mts (Gutwiński 1909), Lublin Upland (Eichler 1895).

Habitat. Polyhumic pond, *Sphagnum* puddles, puddles on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes, pH range 6.1–7.7, altitude range 580–1270 m.

Number of localities in the Gorce Mts: 15 (0.037).
Turbacz range: 15 (0.045): **176**, **229**, **297**, **382**.
Lubań range: Not recorded.
Foothill zone: 1 (0.021), Lower montane zone: 11 (0.034), Upper montane zone: 3 (0.077).

Cosmarium neodepressum G.J.P.Ramos & C.W.N.Moura [*Co. secedens* Delponte; *Co. phasoleus* Brébisson var. *achondrum* Boldt; *Co. depressum* (Nägeli) P. Lundell] (Figs 17: 11, 11a; 18: 11a–b; Map 99)

Description. Cells elliptical, deeply constricted. Sinus linear, broadening in outer part. Semicells elliptical, with flat apices and concave margins; lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall punctate. L: 25, W: 25, I: 5, L/W: 1.0.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic pond, pH range 7.1–7.2, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Cosmarium nitidulum De Notaris
(Figs 21: 9; 22: 9; Map 100)

Description. Cells elliptical, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with flat apices and convex margins; lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 27.5–32.5, W: 17.5–22.5, I: 10, L/W: 1.3–1.5.

Distribution in Poland. Sudety Mts (Schröder 1898), Carpathian Mts (Gutwiński 1897), Wielkopolska Lowland (Gabański et al. 1937).

Habitat. Moist soil on roads, puddles on roads and marshes, pH range 6.1–8.0, altitude range 580–610 m.

Number of localities in the Gorce Mts: 4 (0.01).
Turbacz range: 4 (0.012): **94**, **96**, **101**, **137**.
Lubań range: Not recorded.
Foothill zone: 3 (0.063), Lower montane zone: 1 (0.003).

Cosmarium notabile Brébisson [*Dy. notabile* (de Bary) Hansgirg] (Figs 13: 14, 14a; 14: 14a–c; Map 101)

Description. Cells rectangular or hexagonal, moderately constricted. Sinus linear, broadening in outer part. Semicells rectangular to trapezoidal, with flat apices with four swellings and straight or slightly convex margins with four or five swellings; lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 25–30, W: 15–20, I: 10–12.5, L/W: 1.4–2.0.

Distribution in Poland. Sudety Mts (Schröder 1883), Carpathian Mts (Wasylik 1971), Silesian Lowland (Gleisberg 1920), Wielkopolska Lowland (Danowska-Krawiecowa 1934).

Habitat. *Sphagnum* puddles, puddles on roads and paths, moist soil on roads and paths, wet mosses of *Bryidae* class, puddles, old wells in marshes, oxbow lakes, temporary waterbodies, pH range 5.0–8.9, altitude range 580–1240 m.

Number of localities in the Gorce Mts: 68 (0.166).
Turbacz range: 60 (0.181): **84**, **115**, **162**, **213**, **185**.
Lubań range: 8 (0.101): **3**, **9**, **53**, **65**.
Foothill zone: 3 (0.063), Lower montane zone: 57 (0.177), Upper montane zone: 8 (0.205).

Cosmarium novae-semliae Wille
(Figs 21: 10; 22: 10; Map 102)

Description. Cells rectangular, with shallow constriction. Sinus large and open, with rounded apex. Semicells rectangular, with flat apices and slightly convex margins; lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Some conical granules near apical angles. L: 15–17.5, W: 10–12.5, I: 7.5–10, L/W: 1.4–1.5.

Distribution in Poland. Sudety Mts (Grönblad 1926), Carpathian Mts (Gutwiński 1897).

Habitat. Puddles on roads, paths and marshes, pH range 6.1–7.3, altitude range 850–1150 m.

Number of localities in the Gorce Mts: 4 (0.012).
Turbacz range: 4 (0.012): **276**, **292**, **314**, **323**.
Lubań range: Not recorded.
Lower montane zone: 3 (0.009), Upper montane zone: 1 (0.026).

Cosmarium obliquum Nordstedt [*Nothocosmarium obliquum* (Nordstedt) Raciborski]
(Figs 21: 1, 1a; 22: 1a–b; Map 103)

Description. Cells square or rectangular, with shallow constriction. Sinus very shallow and open. Semicells rectangular, with flat apices and concave margin; lower angles rounded, apical angles straight. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 12.5–15, W: 10–15, I: 5–10, L/W: 1.0–1.5.

Distribution in Poland. Sudety Mts (Grönblad 1926), Carpathian Mts (Gutwiński 1909), Wielkopolska Lowland (Danowska-Krawiecowa 1934), Mazovian Lowland (Wysocka 1934).

Habitat. Moist soil on roads, wet mosses of *Bryidae* class and puddles in marshes, pH range 6.7–7.5, altitude range 720–1230 m.

Number of localities in the Gorce Mts: 5 (0.012).
Turbacz range: 5 (0.015): **158**, **283**, **302**, **330**, **370**.
Lubań range: Not recorded.
Lower montane zone: 3 (0.009), Upper montane zone: 2 (0.051).

Cosmarium obtusatum (Schmidle) Schmidle
(Figs 25: 3; 26: 3a–b; Map 104)

Description. Cells elliptical or circular, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with flat or slightly concave apices and convex, undulated margins; lower and apical angles rounded. Top view elliptical. Chloroplasts contain pair of pyrenoids. Two or three series of intramarginal undulations near margins, sometimes cell wall punctate. L: 40–70, W: 40–62.5, I: 10–20, L/W: 1.0–1.4.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. Polyhumic waterbodies, *Sphagnum* puddles, puddles on roads and paths, moist soil on roads and paths, wet mosses of *Bryidae* class, puddles, old wells in marshes, oxbow lakes, temporary waterbodies, pH range 5.1–8.9, altitude range 390–1230 m.

Number of localities in the Gorce Mts: 82 (0.2).
Turbacz range: 72 (0.218): **115**, **140**, **182**, **258**, **407**. Lubań range: 10 (0.127): **8**, **21**, **52**, **71**.
Foothill zone: 8 (0.167), Lower montane zone: 66 (0.203), Upper montane zone: 8 (0.205).

Cosmarium ochthodes Nordstedt
(Figs 25: 6, 6a; 26: 6a–b; Map 105)

Description. Cells elliptical or hexagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells semicircular, semi-elliptical or trapezoidal, with flattened or convex apices and convex margins, furnished with flat undulations; lower and apical angles rounded. Top view elliptical. Chloroplasts contain pair of pyrenoids. Two or three series of flattened intramarginal undulations near margins, gradually reducing towards semicell center, central part of semicells punctate. L: 65–110, W: 50–80, I: 20–25, L/W: 1.1–1.4.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic waterbodies, *Sphagnum* puddles, puddles on roads and paths, moist soil on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes, oxbow lakes, temporary waterbodies, pH range 5.9–8.4, altitude range 920–1240 m.

Number of localities in the Gorce Mts: 116 (0.284).
Turbacz range: 101 (0.306): **85**, **115**, **145**, **181**, **258**.
Lubań range: 15 (0.19): **7**, **21**, **46**, **52**, **72**, **74**.
Foothill zone: 6 (0.125), Lower montane zone: 98 (0.304), Upper montane zone: 12 (0.308).

Cosmarium ornatum Ralfs ex Ralfs
(Figs 23: 13; 24: 13; Map 106)

Description. Cells elliptical, deeply constricted. Sinus linear, broadening in outer part. Semicells semi-elliptical, with flattened apices and convex margins, lower and apical angles rounded. Top view elliptical, with two lateral inflations. Chloroplasts contain pair of pyrenoids. Cell wall furnished with rows of granules. L: 32.5, W: 37.5, I: 15, L/W: 0.9.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic pond, pH range 5.5–7.0, altitude range 970 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **360**.
Lubań range: Not recorded.
Lower montane zone: 1 (0.03).

Cosmarium pachydermum P. Lundell
(Figs 21: 3; 22: 3; Map 107)

Description. Cells broadly elliptical, deeply constricted. Sinus closed in apical part, open in outer part. Semicells semicircular, with convex apices and margins, lower and apical angles rounded. Top view elliptical. Chloroplasts contain pair of pyrenoids. Cell wall punctate. L: 85–110, W: 65–85, I: 20–30, L/W: 1.3–1.5.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, moist soil on roads, wet mosses of *Bryidae* class, old wells in marshes, pH range 5.4–7.7, altitude range 580–1210 m.

Number of localities in the Gorce Mts: 9 (0.022).
Turbacz range: 8 (0.025): **101**, **118**, **226**, **238**, **247**, **261**, **330**, **370**.
Lubań range: 1 (0.013): **21**.
Foothill zone: 1 (0.021), Lower montane zone: 7 (0.021), Upper montane zone: 1 (0.026).

Cosmarium paragranatoides Skuja
(Figs 21: 4, 4a–b; 22: 4a–b; Map 108)

Description. Cells hexagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with slightly concave apices and convex margins, with distinct indentation on each side of semicell; lower and apical angles rounded. Distinct tubercule on each semicell below isthmus. Top view elliptical, with two lateral inflations. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 30, W: 15–17.5, I: 5, L/W: 1.7–2.0.

Distribution in Poland. Not recorded.

Habitat. *Sphagnum* puddles, polyhumic pond, pH range 5.7–7.1, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Cosmarium parvulum Brébisson
(Figs 19: 7, 7a; 20: 7a–b; Map 109)

Description. Cells elliptical, with shallow constriction. Sinus shallow and open. Semicells trapezoidal, strongly elongated, with concave apices and slightly undulated margins. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 30–35, W: 15, I: 10, L/W: 2.0–2.3.

Distribution in Poland. Carpathian Mts (Gutwiński 1896), Masurian Lakeland (Michalski et al. 1939).

Habitat. Oxbow lakes, pH range 7.6–8.6, altitude range 530–910 m.

Number of localities in the Gorce Mts: 3 (0.007).
Turbacz range: 3 (0.009): **224**, **289**, **399**.
Lubań range: Not recorded.
Foothill zone: 1 (0.021), Lower montane zone: 2 (0.006).

Cosmarium pericymatium Nordstedt
(Figs 21: 8; 22: 8; Map 110)

Description. Cells elliptical, moderately constricted. Sinus broadly open. Semicells semicircular, with convex apices and margins. Apices and margins slightly undulated. Top view circular. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 45–50, W: 25–30, I: 20–25, L/W: 1.5–2.0.

Distribution in Poland. Carpathian Mts (Kawecka 1965).

Habitat. Moist soil on roads, oxbow lakes, fish ponds, pH range 7.6–9.1, altitude range 440–700 m.

Number of localities in the Gorce Mts: 7 (0.017).
Turbacz range: 7 (0.021): **83**, **114**, **367**, **395**, **399**, **400**, **401**.
Lubań range: Not recorded.
Foothill zone: 5 (0.104), Lower montane zone: 2 (0.006).

Cosmarium pokornyanum (Grunow) West et G. S. West [*Eu. binale* Ralfs var. *angustatum* (Wittrock) Lagerheim, *Eu. angustatum* Wittrock, *Eu. polare* Nordstedt, *Eu. pokornyanum* Grunow]
(Figs 21: 11, 11a–c; 22: 11a–b; Map 111)

Description. Cells octagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells hexagonal, with slightly concave apices, margins in lower part of semicell parallel or divergent, sometimes concave, in apical part convergent; lower angles straight, apical rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 25–35, W: 15–20, I: 5, L/W: 1.7–2.0.

Distribution in Poland. Sudety Mts (Zacharias 1895), Carpathian Mts (Mrozińska 1989), Lublin Upland (Eichler 1895).

Habitat. Moist soil and puddles on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes, oxbow lakes, pH range 7.0–8.6, altitude range 520–1220 m.

Number of localities in the Gorce Mts: 32 (0.078).
Turbacz range: 29 (0.088): **80**, **144**, **181**, **240**.
Lubań range: 3 (0.038): **1**, **16**.
Foothill zone: 3 (0.063), Lower montane zone: 26 (0.081), Upper montane zone: 3 (0.077).

Cosmarium porteanum W. Archer
(Figs 19: 10; 20: 10; Map 112)

Description. Cells rectangular, deeply constricted. Sinus open, very broad. Semicells reniform, with slightly convex apices and strongly convex margins; lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall furnished with rows of granules. L: 35, W: 30–32.5, I: 15, L/W: 1.1–1.2.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, temporary waterbodies, pH range 6.0–7.5, altitude range 660–870 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: Not recorded.
Lubań range: 2 (0.025): **9**, **21**.
Lower montane zone: 2 (0.006).

Cosmarium praemorsum Brébisson
(Figs 21: 2; 22: 2; Map 113)

Description. Cells broadly elliptical, deeply constricted. Sinus linear, broadening in outer part. Semicells semicircular, with slightly convex apices and strongly convex margins; lower and apical angles rounded. Top view elliptical. Chloroplasts contain pair of pyrenoids. Cell wall furnished with granules of different sizes, chaotically arranged. L: 42.5–60, W: 42.5–50, I: 15, L/W: 1.0–1.2.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. *Sphagnum* puddles, puddles on roads and paths, temporary waterbodies, pH range 6.1–8.1, altitude range 660–1050 m.

Number of localities in the Gorce Mts: 6 (0.015).
Turbacz range: 4 (0.012): **24**, **203**, **313**, **246**.
Lubań range: 2 (0.025): **10**, **21**.
Lower montane zone: 6 (0.018).

Cosmarium pseudoexiguum Raciborski [*Pls. pseudoexiguum* (Raciborski) Lagerheim]
(Figs 19: 3; 20: 3; Map 114)

Description. Cells rectangular, deeply constricted. Sinus linear, broadening in outer part. Semicells rectangular, with straight apices and margins, lower angles straight, apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 17.5, W: 10, I: 5, L/W: 1.8.

Distribution in Poland. Sudety Mts (Grönblad 1926), Carpathian Mts (Wasylik 1961), Kotlina Sandomierska (Wasylik 1957).

Habitat. Moist soil on road, pH range 7.5, altitude range 900 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **319**.
Lubań range: Not recorded.
Lower montane zone: 1 (0.003).

Cosmarium pseudopyramidatum P. Lundell
(Figs 19: 9; 20: 9; Map 115)

Description. Cells elliptical, deeply constricted. Sinus linear, broadening in outer part. Semicells semicircular, with convex apices and margins; lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 35–55, W: 25–30, I: 10–15, L/W: 1.4–1.8.

Notes. Specimens belonging to var. *rotundata* (Krieg.) Messikommer, having semicells more circular than the typical variety, were recorded in the material.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, puddles on roads and paths, moist soil on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes, oxbow lakes, pH range 6.1–7.6, altitude range 570–1230 m.

Number of localities in the Gorce Mts: 30 (0.073).
Turbacz range: 29 (0.088): **96**, **144**, **185**, **251**, **382**.
Lubań range: 1 (0.013): **1**.
Foothill zone: 2 (0.042), Lower montane zone: 25 (0.078), Upper montane zone: 3 (0.077).

Cosmarium pulcherrimum Nordstedt
(Figs 21: 5; 22: 5; Map 116)

Description. Semicells elliptical, deeply constricted. Sinus linear, broadening in outer part. Semicells semicircular, with convex apices and margins furnished with fourteen undulations on each semicell (a pair of granules on each undulation); lower angles straight, apical angles rounded. Top view elliptical. Four concentric rows of granules near margins, ten longitudinal ridges below isthmus on each semicell. L: 50, W: 35, I: 15, L/W: 1.4.

Notes. Only a single specimen in one sample was found.

Distribution in Poland. Carpathian Mts (Gutwiński 1897).

Habitat. Old well in marsh, pH range 6.1, altitude range 1200 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **338**.
Lubań range: Not recorded.
Upper montane zone: 1 (0.026).

Cosmarium pyramidatum Brébisson ex Ralfs
(Figs 21: 6; 22: 6; Map 117)

Description. Cells hexagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with flat or slightly rounded apices and convex margins; lower angles straight, apical angles rounded. Top view elliptical. Chloroplasts contain pair of pyrenoids. Cell wall smooth. L: 70–85, W: 40–50, I: 20–30, L/W: 1.7–1.8.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

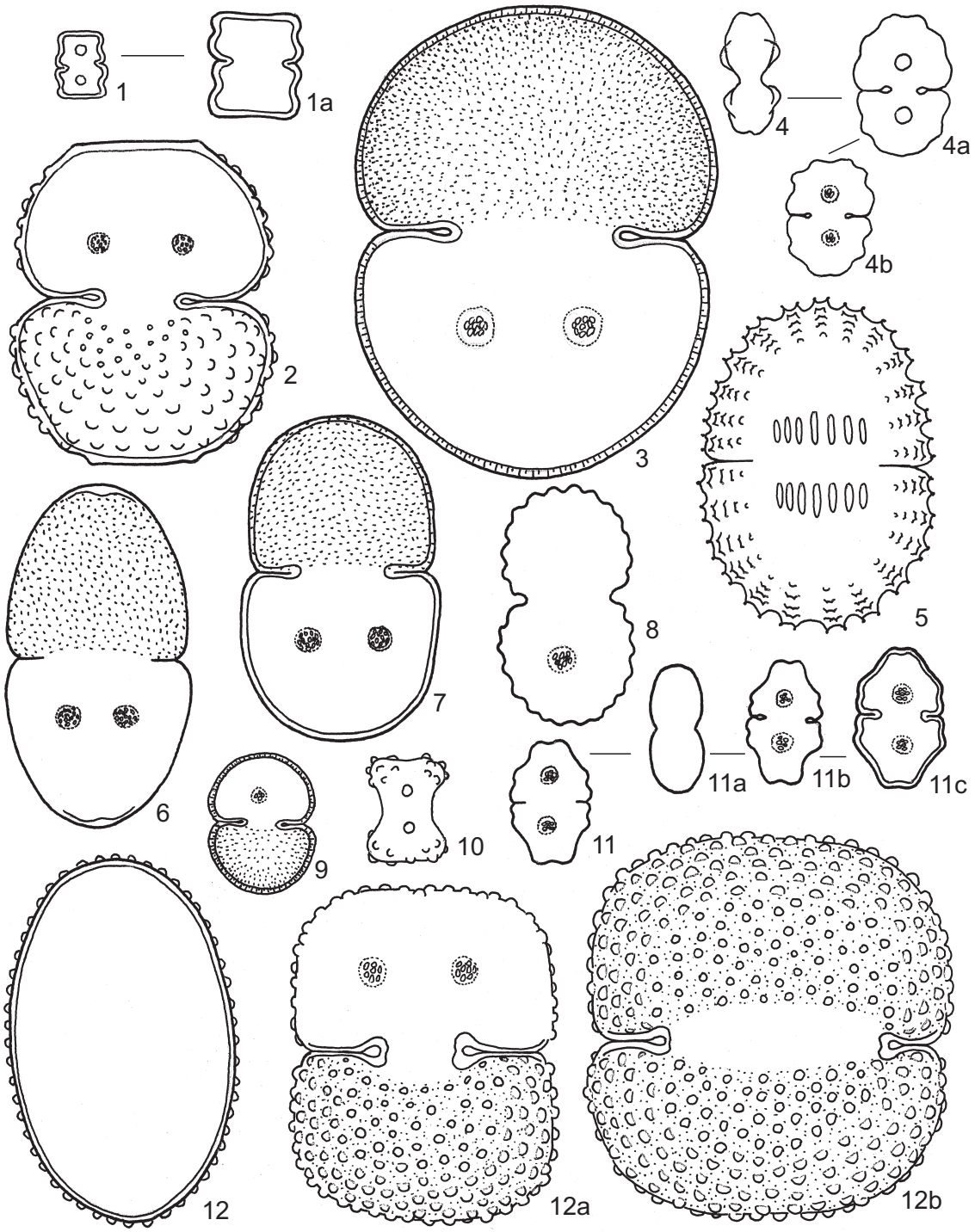

Figure 21. *Cosmarium.* 1, 1a – *Cosmarium obliquum*; 2 – *Co. praemorsum*; 3 – *Co. pachydermum*; 4, 4a–b – *Co. paragranatoides*; 5 – *Co. pulcherrimum*; 6 – *Co. pyramidatum*; 7 – *Co. quadratum*; 8 – *Co. pericymatium*; 9 – *Co. nitidulum*; 10 – *Co. novae-semiliae*; 11, 11a–c – *Co. pokornyanum*; 12, 12a–b – *Co. quadrum*. Drawings E. Nowotarska.

Habitat. *Sphagnum* puddles, pH range 5.9, altitude range 870–1270 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 1 (0.003): **297**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003), Upper montane zone: 1 (0.026).

Cosmarium quadratulum (F. Gay) De Toni
(Figs 23: 10; 24: 10; Map 118)

Description. Cells rectangular, deeply constricted. Sinus linear, broadening in outer part. Semicells rectangular, with concave apices and margins; lower and apical angles straight. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 10, W: 15, I: 5, L/W: 0.7.

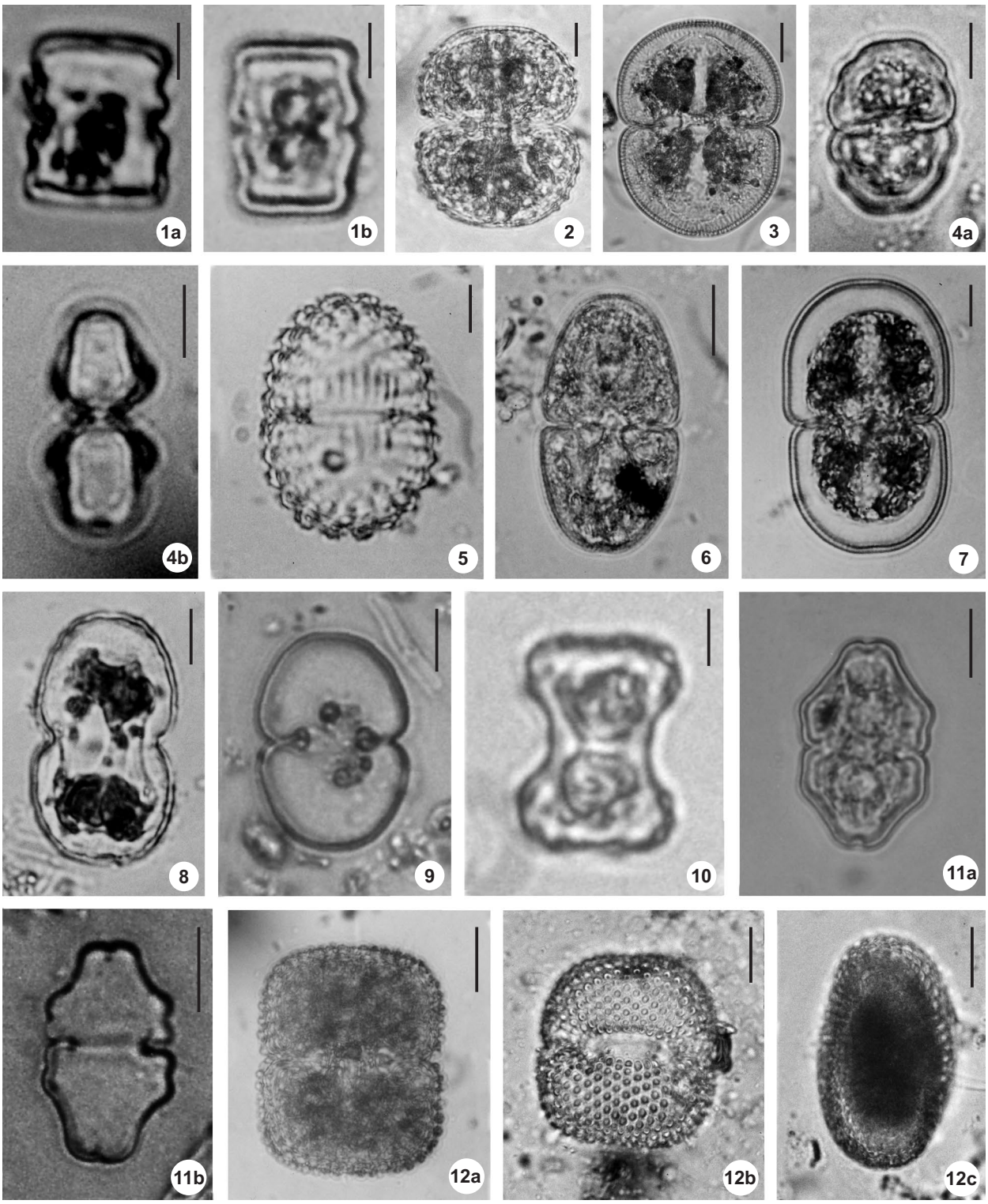

Figure 22. *Cosmarium*. 1a–b – *Cosmarium obliquum*; 2 – *Co. praemorsum*; 3 – *Co. pachydermum*; 4a–b – *Co. paragranatoides*; 5 – *Co. pulcherrimum*; 6 – *Co. pyramidatum*; 7 – *Co. quadratum*; 8 – *Co. pericymatium*; 9 – *Co. nitidulum*; 10 – *Co. novae-semliae*; 11a–b – *Co. pokornyanum*; 12a–c – *Co. quadrum*. Scales: 1a–b, 10 = 5 µm; 2, 4a–b, 5, 7–9, 11a–b = 10 µm; 3, 6, 12a–c = 20 µm. LM by M. Wayda.

Notes. Only a single specimen in one sample was found.

Distribution in Poland. Sudety Mts (Grönblad 1926), Carpathian Mts (Gutwiński 1895), Southern Wielkopolska Lowland (Lesiak 1990), Mazovian Lowland (Tomaszewicz 1988).

Habitat. Wet mosses of *Bryidae* class in meadow, pH range 7.5, altitude range 1220 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **301**.
Lubań range: Not recorded. Upper montane zone: 1 (0.026).

Cosmarium quadratum Ralfs ex Ralfs [*Dy. quadratum* (Ralfs) Hansgirg] (Figs 21: 7; 22: 7; Map 119)

Description. Cells rectangular, deeply constricted. Sinus linear, broadening in outer part. Semicells square or rectangular, with convex apices and straight, sometimes concave, margins near base, lower angles straight, apical angles rounded. Top view elliptical. Chloroplasts contain pair of pyrenoids. Cell wall smooth. L: 50–82.5, W: 30–45, I: 12.5–20, L/W: 1,7–2.2.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic waterbodies, *Sphagnum* puddles, puddles on roads and paths, moist soil on roads and paths, wet mosses of *Bryidae* class, puddles, old wells in marshes, oxbow lakes, pH range 5.1–8.9, altitude range 390–1270 m.

Number of localities in the Gorce Mts: 198 (0.484).
Turbacz range: 176 (0.533): **80**, **85**, **99**, **162**, **185**, **255**, **407**.
Lubań range: 22 (0.278): **7**, **21**, **52**, **65**, **73**.
Foothill zone: 13 (0.271), Lower montane zone: 164 (0.509), Upper montane zone: 21 (0.538).

Cosmarium quadrum P. Lundell (Figs 21: 12, 12a–b; 22: 12a–c; Map 120)

Description. Cells rectangular, deeply constricted. Sinus linear, broadening in outer part. Semicells rectangular, with slightly concave apices and margins; lower and apical margins rounded. Top view elliptical. Chloroplasts contain pair of pyrenoids. Cell wall furnished with rows of large granules. L: 70–75, W: 60–75, I: 20–25, L/W: 1.0–1.2.

Notes. Specimens belonging to var. *sublatum* (Nordstedt) W. West et G. S. West were recorded in the material; they have straight apices and margins.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic pond, *Sphagnum* puddles, pH range 6.0–7.2, altitude range 870–1270 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 1 (0.003): **297**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003), Upper montane zone: 1 (0.026).

Cosmarium rectangulare Grunow [*Co. gothlandicum* Wittrock var. *minus* Wille, *Co hexagonum* Elfving] (Figs 23: 5; 24: 5; Map 121)

Description. Cells octagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells hexagonal, with flat apices and straight margins; lower angles straight, apical angle rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 25–45, W: 20–35, I: 5–10, L/W: 1.3–1.5.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic pond, *Sphagnum* puddles, puddles on roads, pH range 5.9–7.2, altitude range 700–870 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 1 (0.003): **109**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 2 (0.006).

Cosmarium regnellii Wille [*Co. pseudoprotuberans* Kirchner var. *retusiforme* Fritsch et Rich] (Figs 15: 10; 16: 10a–b; Map 122)

Description. Cells octagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells hexagonal, with flat apices and straight or slightly concave margins, lower and apical angle rounded, middle ones slightly protracted. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 12.5–15, W: 10–15, I: 5–20, L/W: 1.0–1.3.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic pond, *Sphagnum* puddles, puddles on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes, pH range 7.2–7.9, altitude range 650–1080 m.

Number of localities in the Gorce Mts: 20 (0.049).
Turbacz range: 18 (0.055): **158**, **169**, **244**.
Lubań range: 2 (0.026): **8**, **21**.
Lower montane zone: 19 (0.059), 1 (0.026).

Cosmarium reniforme (Ralfs) W. Archer (Figs 23: 22; 24: 22a–b; Map 123)

Description. Cells rectangular, deeply constricted. Sinus closed in apical part, open in outer part. Semicells reniform, with slightly convex apices and strongly convex margins; lower and apical angles rounded. Top view elliptical. Chloroplasts contain pair of pyrenoids. Cell wall furnished with rows of granules. L: 45–50, W: 42.5–55, I: 10–20, L/W: 0.9–1.1.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic pond, puddles on roads, wet mosses of *Bryidae* class, old wells in marshes, temporary waterbodies pH range 7.2–7.9, altitude range 650–1080 m.

Number of localities in the Gorce Mts: 7 (0.017).
Turbacz range: 5 (0.012): **148**, **152**, **280**, **283**, **370**.
Lubań range: 2 (0.026): **9**, **21**.
Lower montane zone: 7 (0.021).

Cosmarium saxicola Kaiser
(Figs 13: 13; 14: 13; Map 124)

Description. Cells rectangular, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with flat apices with four swellings and convex margins with three swellings, the two lowest undulations smaller than apical ones; lower angle straight, upper angle rounded. Two rows of large granules near margins, six longitudinal ridges below isthmus in each semicell. L: 25, W: 20, I: 10, L/W: 1.3.

Notes. Only a single specimen in one sample was found.

Distribution in Poland. Carpathian Mts (Růžička 1964).

Habitat. puddles on road, pH range 6.9, altitude range 660 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **115**.
Lubań range: Not recorded.
Lower montane zone: 1 (0.003).

Cosmarium sexangulare P. Lundell
(Figs 23: 9; 24: 9; Map 125)

Description. Cells decagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells hexagonal, with flat or slightly convex apices and slightly concave margins in apical part; lower angle straight, middle and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 20, W: 15, I: 5, L/W: 1.5.

Notes. Only specimens belonging to var. *minus* R. Roy et Bisset were recorded in the material; they are smaller.

Distribution in Poland. Carpathian Mts (Gutwiński 1897), Lublin Upland (Eichler 1896), Southern Wielkopolska Lowland (Lesiak 1990), Wielkopolska Lowland (Wawrzyniak 1923), Mazovian Lowland (Tomaszewicz 1970).

Habitat. Fish ponds, pH range 8.5, altitude range 630 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **367**.
Lubań range: Not recorded.
Lower montane zone: 1 (0.003).

Cosmarium sexnotatum Gutwiński
(Figs 15: 11; 16: 11; Map 126)

Description. Cells hexagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells elliptical, with flat apices with six swellings and convex margins with three swellings; lower and apical angles rounded. Top view elliptical, with inflations on each lateral side. Chloroplasts contain single pyrenoid. Two rows of granules near margins, three ridges below isthmus on each semicell. L: 30, W: 20–30, I: 10, L/W: 1.0–1.5.

Distribution in Poland. Southern Wielkopolska Lowland (Lesiak 1990).

Habitat. Puddles on roads, wet mosses of *Bryidae* class in marshes, pH range 6.0–7.0, altitude range 960–1230 m.

Number of localities in the Gorce Mts: 4 (0.01).
Turbacz range: 4 (0.012): **282**, **302**, **314**, **324**.
Lubań range: Not recorded.
Lower montane zone: 2 (0.006), Upper montane zone: 2 (0.051).

Cosmarium speciosum P. Lundell [*Co. rostafińskii* Gutwiński, *Dy. speciosum* (Lundell) Hansgirg]
(Figs 15: 8, 8a–b; 16: 8a–c; Map 127)

Description. Cells rectangular, elliptical or hexagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells rectangular, semicircular or trapezoidal, with flat apices and convex margins. Apices and margins undulated, lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Some concentric rows of granules near margins; row of longitudinal ridges below isthmus in each semicell. L: 37.5–65, W: 20–45, I: 10–15, L/W: 1.4–2.0.

Notes. Specimens belonging to var. *rostafinskii* (Gutwiński) W. et G. S. West were recorded in the material; they have trapezoidal semicells.

Distribution in Poland. Species often recorded, but mostly from southern Poland.

Habitat. *Sphagnum* puddles, puddles on roads and paths, moist soil on roads, wet mosses of *Bryidae* class, puddles and old wells in marshes, oxbow lakes, temporary waterbodies, fish ponds, pH range 5.4–8.4, altitude range 460–1270 m.

Number of localities in the Gorce Mts: 127 (0.311).
Turbacz range: 110 (0.333): **80**, **84**, **99**, **144**, **183**, **252**, **408**.
Lubań range: 17 (0.215): **8**, **9**, **48**, **52**, **65**, **74**.
Foothill zone: 19 (0.396), Lower montane zone: 90 (0.28), Upper montane zone: 18 (0.462).

Cosmarium sphagnicola West et G. S. West
(Figs 23: 8; 24: 8a–b; Map 128)

Description. Cells square, moderately constricted. Sinus open, with acute apex. Semicells hexagonal or trapezoidal, with slightly convex apices and straight or slightly convex margins; lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 10–12.5, W: 10–12.5, I: 5, L/W: 1.0.

Distribution in Poland. Sudety Mts (Schröder 1919).

Habitat. Polyhumic waterbody, pH range 5.9, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Cosmarium sphalerostichum Nordstedt
(Figs 23: 1; 24: 1a–b; Map 129)

Description. Cells square, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with flat apices and slightly convex margins with four or five acute granules; lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell

wall furnished with rows of acute granules. L: 20–22.5, W: 15–17.5, I: 5, L/W: 1.3.

Distribution in Poland. Sudety Mts (Schröder 1896).

Habitat. *Sphagnum* puddles, puddles on roads, moist soil on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes, pH range 5.1–7.9, altitude range 580–1270 m.

Number of localities in the Gorce Mts: 16 (0.039).
Turbacz range: 15 (0.003): **94**, **137**, **176**, **241**, **296**, **375**.
Lubań range: 1 (0.013): **60**.
Foothill zone: 2 (0.042), Lower montane zone: 11 (0.034), Upper montane zone: 3 (0.077).

Cosmarium sportella Brébisson ex Kützing
(Figs 25: 4; 26: 4a–b; Map 130)

Description. Cells hexangular, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with flat apices and margins convex in basal part and straight in apical part, furnished with granules; lower and apical angles rounded. Top view elliptical. Chloroplasts contain pair of pyrenoids. Cell wall furnished with rows of granules. Granules become smaller towards center of cell. L: 50–55, W: 40–50, I: 15, L/W: 1.0–1.3.

Notes. All specimens in the material from the Gorce Mts belong to var. *subnudum* W. West et G. S. West.

Distribution in Poland. Sudety Mts (Grönblad 1926), Carpathian Mts (Wasylik 1972).

Habitat. *Sphagnum* puddles, puddles on roads and paths, moist soil on roads and paths, wet mosses of *Bryidae* class, puddles, old wells in marshes, oxbow lakes, temporary waterbodies, fish ponds, pH range 5.4–9.2, altitude range 430–1270 m.

Number of localities in the Gorce Mts: 115 (0.281).
Turbacz range: 94 (0.285): **84**, **95**, **160**, **182**, **255**, **408**.
Lubań range: 21 (0.266): **8**, **21**, **47**, **53**, **71**, **74**.
Foothill zone: 6 (0.125), Lower montane zone: 103 (0.32), Upper montane zone: 6 (0.154).

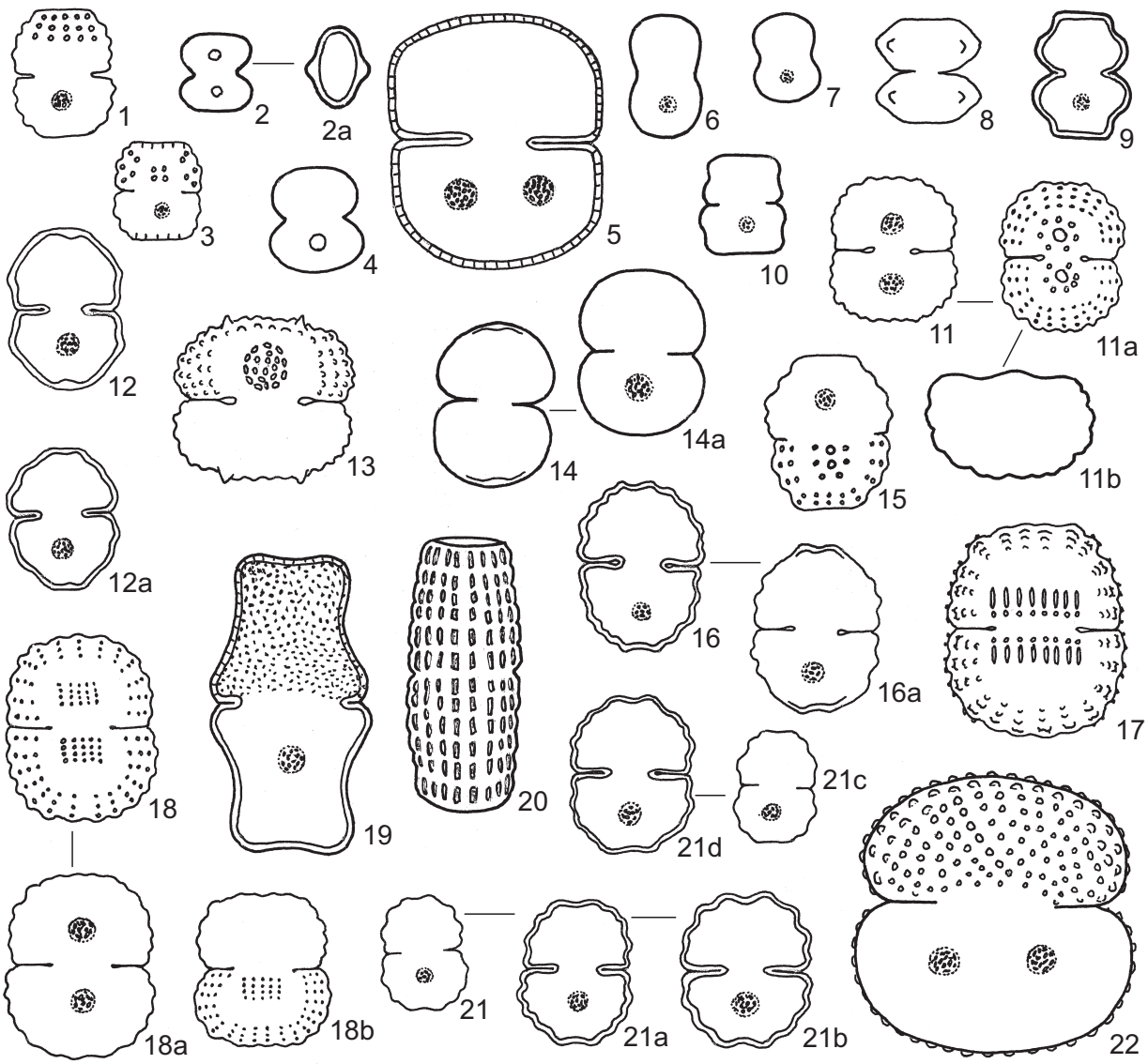

Figure 23. *Cosmarium*. 1 – *Cosmarium sphalerostichum*; 2, 2a – *Co. staurastroides*; 3 – *Co. humile*; 4 – *Co. subarctoum*; 5 – *Co. rectangulare*; 6 – *Co. gonioides*; 7 – *Co. tinctum*; 8 – *Co. sphagnicola*; 9 – *Co. sexangulare*; 10 – *Co. quadratulum*; 11, 11a–b – *Co. subcostatum*; 12, 12a – *Co. laeve*; 13 – *Co. ornatum*; 14, 14a – *Co. subtumidum*; 15 – *Co. subprotumidum*; 16, 16a – *Co. subgranatum*; 17 – *Co. costatum*; 18, 18a–b – *Co. subcrenatum*; 19 – *Co. tatricum*; 20 – *Co. annulatum*; 21, 21a–d – *Co. impressulum*; 22 – *Co. reniforme*. Drawings E. Nowotarska.

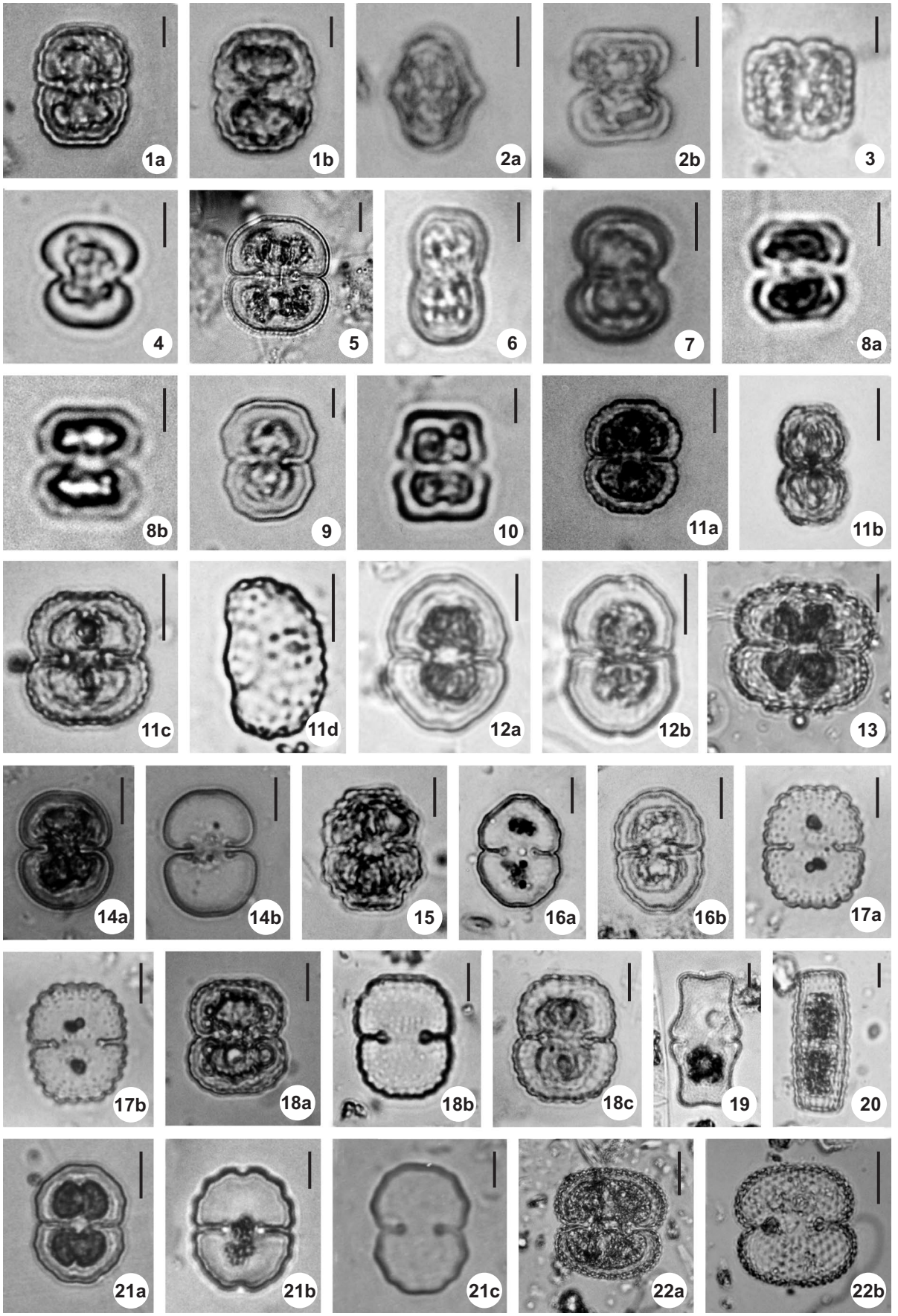

Figure 24. *Cosmarium*. 1a–b – *Cosmarium sphalerostichum*; 2a–b – *Co. staurastroides*. 3 – *Co. humile*; 4 – *Co. subarctoum*; 5 – *Co. rectangulare*; 6 – *Co. gonioides*; 7 – *Co. tinctum*; 8a–b – *Co. sphagnicola*; 9 – *Co. sexangulare*; 10 – *Co. quadratulum*; 11a–d – *Co. subcostatum*; 12a–b – *Co. laeve*; 13 – *Co. ornatum*; 14a–b – *Co. subtumidum*; 15 – *Co. subprotumidum*; 16a–b – *Co. subgranatum*; 17a–b – *Co. costatum*; 18a–c – *Co. subcrenatum*; 19 – *Co. tatricum*; 20 – *Co. annulatum*; 21a–c – *Co. impressulum*; 22a–b – *Co. reniforme*. Scales: 1a–4, 6–10, 21c = 5 µm; 5, 11a–21b = 10 µm; 22a–b = 20 µm. LM by M. Wayda.

Cosmarium staurastroides Eichler et Gutwiński
(Figs 23: 2, 2a; 24: 2a–b; Map 131)

Description. Cells rectangular, deeply constricted. Sinus open, with acute apex. Semicells rectangular, with abrupt, slightly convex apices and slightly convex margins; lower and apical angles rounded. Top view elliptical, with elongate inflation on each lateral side. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 12.5, W: 10, I: 5, L/W: 1.3.

Distribution in Poland. Lublin Upland (Eichler & Gutwiński 1894), Wielkopolska Lowland (Wawrzyniak 1924).

Habitat. *Sphagnum* puddles, pH range 5.9, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Cosmarium subarctoum (Lagerheim) Raciborski
(Figs 23: 4; 24: 4; Map 132)

Description. Cells hexangular, moderately constricted. Sinus open, with acute apex. Semicells elliptical, with flat apices and convex margins; lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 12.5, W: 10–12.5, I: 5–7.5, L/W: 1.0–1.3.

Distribution in Poland. Mazovian Lowland (Tomaszewicz 1988).

Habitat. *Sphagnum* puddles, puddles on foot paths and marshes, moist soil on roads, pH range 6.0–7.1, altitude range 600–1240 m.

Number of localities in the Gorce Mts: 5 (0.012).
Turbacz range: 4 (0.012): **103**, **222**, **266**, **276**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 4 (0.012), Upper montane zone: 1 (0.026).

Cosmarium subbroomei Schmidle
(Figs 15: 7, 7a; 16: 7a–b; Map 133)

Description. Cells rectangular, deeply constricted. Sinus linear, broadening in outer part. Semicells rectangular, with straight apices and margins; lower and apical angles rounded. Top view elliptical. Chloroplasts contain pair of pyrenoids. Cell wall furnished with chaotically dispersed granules, three or four longitudinal rows of granules below isthmus. Central part of semicells without granules. L: 40–55, W: 30–40, I: 12.5–15, L/W: 1.1–1.6.

Notes. Only specimens belonging to var. *taylori* Croasdale were recorded in the material.

Distribution in Poland. Silesian Lowland (Schröder 1897).

Habitat. *Sphagnum* puddles, puddles on roads, moist soil on roads, wet mosses of *Bryidae* class and puddles in marshes, pH range 6.1–8.6, altitude range 480–960 m.

Number of localities in the Gorce Mts: 38 (0.093).
Turbacz range: 34 (0.103): **84**, **99**, **160**, **182**, **232**, **382**.
Lubań range: 4 (0.051): **6**, **52**, **69**.
Foothill zone: 6 (0.125), Lower montane zone: 32 (0.099).

Cosmarium subcostatum Nordstedt
(Figs 23: 11, 11a–b; 24: 11a–d; Map 134)

Description. Cells rectangular or hexagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells rectangular or trapezoidal, with abrupt, undulated apices and strongly convex margins, lower and apical angles rounded. Top view elliptical, with inflation on each lateral margin. Chloroplasts contain single pyrenoid. Ornamentation consists of three or four concentric rows of small granules near margins and large central granule surrounded by few smaller ones in central part of each semicell. L: 20–35, W: 20–30, I: 5–10, L/W: 1.0–1.5.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. Puddles on roads and paths, moist soil on roads, wet mosses of *Bryidae* class, old wells in marshes, oxbow lakes, temporary waterbodies, fish ponds, pH range 5.9–9.2 altitude range 460–1240 m.

Number of localities in the Gorce Mts: 44 (0.108).
Turbacz range: 41 (0.124): **80**, **89**, **115**, **158**, **164**, **214**.
Lubań range: 3 (0.038): **3**, **33**, **53**.
Foothill zone: 3 (0.063), Lower montane zone: 34 (0.106), Upper montane zone: 7 (0.179).

Cosmarium subcrenatum Hantzsch
(Figs 23: 18, 18a–b; 24: 18a–c; Map 135)

Description. Cells rectangular, deeply constricted. Sinus linear, broadening in outer part. Semicells rectangular or trapezoidal, with abrupt apices with four swellings and convex margins with four to six swellings; lower angles straight, apical angles rounded. Top view elliptical, with inflation on each lateral margin. Chloroplasts contain single pyrenoid. Ornamentation consists of few concentric rows of small granules near margins and row of longitudinal thin ridges (sometimes only rows of granules) on each semicell. L: 25–35, W: 22.5–30, I: 10, L/W: 1.1–1.5.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Puddles on roads and paths, moist soil on roads and paths, wet mosses of *Bryidae* class, puddles and old wells in marshes, oxbow lakes, fish ponds, pH range 5.4–9.1 altitude range 480–1270 m.

Number of localities in the Gorce Mts: 210 (0.513).
Turbacz range: 167 (0.506): **82**, **87**, **117**, **160**, **181**, **255**.
Lubań range: 43 (0.544): **3**, **17**, **50**, **52**, **67**, **73**.
Foothill zone: 23 (0.479), Lower montane zone: 166 (0.516), Upper montane zone: 21 (0.538).

Cosmarium subcucumis Schmidle
(Figs 25: 7; 26: 7; Map 136)

Description. Cells elliptical, deeply constricted. Sinus linear, broadening in outer part. Semicells semicircular, with convex apices and strongly convex margins; lower and apical angles rounded. Top view elliptical.

Chloroplasts contain pair of pyrenoids. Cell wall smooth. L: 50–75, W: 30–55, I: 10–15, L/W: 1.2–1.7.

Distribution in Poland. Sudety Mts (Grönblad 1926), Carpathian Mts (Wasylik 1971), Wielkopolska Lowland (Hübler 1926), Pomeranian Lakeland (Oleksowicz 1978).

Habitat. Polyhumic waterbodies, *Sphagnum* puddles, puddles on roads and paths, moist soil on roads and paths, wet mosses of *Bryidae* class, puddles and old wells in marshes, oxbow lakes, temporary waterbodies, pH range 5.3–8.6 altitude range 480–1270 m.

Number of localities in the Gorce Mts: 177 (0.433).
Turbacz range: 146 (0.442): **80**, **99**, **162**, **181**, **255**.
Lubań range: 31 (0.392): **8**, **21**, **54**, **65**, **73**.
Foothill zone: 7 (0.146), Lower montane zone: 150 (0.466), Upper montane zone: 20 (0.513).

Cosmarium subgranatum (Nordstedt) Lütkemüller [*Co. granatum* Brébisson var. *subgranatum* Nordstedt, *Co. pseudospeciosum* Gutwiński var. *latior* Gutwiński] (Figs 23: 16, 16a; 24: 16a–b; Map 137)

Description. Cells hexagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells pentagonal, with convex apices and slightly undulated margins. Margins parallel in basal part of semicell, convergent in apical part; lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 25–30, W: 17.5–25, I: 5, L/W: 1.2–1.4.

Distribution in Poland. Carpathian Mts (Gutwiński 1909), Wielkopolska Lowland (Torka 1930), Pomeranian Lakeland (Oleksowicz 1986), Masurian Lakeland (Klebs 1880).

Habitat. Moist soil on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes, oxbow lakes, temporary waterbodies, pH range 6.5–7.8, altitude range 460–1140 m.

Number of localities in the Gorce Mts: 15 (0.037).
Turbacz range: 13 (0.039): **93**, **152**, **240**.
Lubań range: 2 (0.023): **4**, **42**.
Foothill zone: 1 (0.021), Lower montane zone: 14 (0.043).

Cosmarium subnotabile Wille (Figs 25: 5; 26: 5; Map 138)

Description. Cells rectangular, moderately constricted. Sinus linear, broadening in outer part. Semicells rectangular or trapezoidal, with abrupt apices with four swellings and straight or slightly convex margins with four swellings; lower and apical angles rounded. Top view elliptical, with inflation on each lateral side. Chloroplasts contain single pyrenoid. Two rows of granules near margins, one parallel row of granules below isthmus on each semicell. L: 30, W: 20, I: 10, L/W: 1.5.

Distribution in Poland. Carpathian Mts (Gutwiński 1898).

Habitat. *Sphagnum* puddles, puddles on roads, pH range 6.1, altitude range 1150–1270 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 2 (0.006): **297**, **314**.
Lubań range: Not recorded.
Upper montane zone: 2 (0.05).

Cosmarium subprotumidum Nordstedt (Figs 23: 15; 24: 15; Map 139)

Description. Cells octagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells hexagonal, with straight apices and margins having four undulations. Margins in basal part of semicell parallel, converging in apical part. Lower and apical angles straight. Top view elliptical, with inflation on each lateral side. Chloroplasts contain single pyrenoid. Three rows of granules near margins, some granules in central part of each semicell. L: 30, W: 20, I: 10, L/W: 1.5.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Oxbow lakes, pH range 7.5, altitude range 600 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **404**.
Lubań range: Not recorded.
Foothill zone: 1 (0.003).

Cosmarium subquadratum Nordstedt (Figs 15: 2; 16: 2; Map 140)

Description. Cells rectangular, deeply constricted. Sinus linear, broadening in outer part. Semicells rectangular, with slightly convex apices and slightly indented top and straight margins; lower angles straight and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall punctate. L: 50–55, W: 30, I: 15, L/W: 1.7–1.8.

Distribution in Poland. Sudety Mts (Grönblad 1926), Southern Wielkopolska Lowland (Lesiak 1984).

Habitat. Wet mosses of *Bryidae* class, pH range 6.5, altitude range 1230–1250 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 2 (0.006): **297**, **330**.
Lubań range: Not recorded.
Upper montane zone: 2 (0.005).

Cosmarium subspeciosum Nodstedt (Figs 25: 8, 8a; 26: 8a–c; Map 141)

Description. Cells elliptical to hexagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with abrupt apices with four swellings and convex margins with five or six swellings. Lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Two rows of granules near margins, few longitudinal rows of granules below isthmus on each semicell. L: 30–37,5, W: 20–30, I: 10, L/W: 1.0–1.4.

Distribution in Poland. Sudety Mts (Grönblad 1926), Carpathian Mts (Wasylik 1971), Wielkopolska Lowland (Wawrzyniak 1923).

Habitat. Puddles on roads and paths, moist soil on roads, wet mosses belonging to *Bryidae* class, puddles and old

wells in marshes oxbow lakes, pH range 4.9–9.2, altitude range 560–1220 m.

Number of localities in the Gorce Mts: 134 (0.328).
Turbacz range: 115 (0.348): **84**, **99**, **160**, **185**, **255**.
Lubań range: 19 (0.241): **8**, **11**, **50**, **53**, **72**.
Foothill zone: 8 (0.167), Lower montane zone: 116 (0.36), Upper montane zone: 10 (0.256).

Cosmarium subtumidum Nordstedt [*Co. klebsii* Gutwiński] (Figs 23: 14, 14a; 24: 14–b; Map 142)

Description. Cells elliptico-hexagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells semicircular, with slightly convex apices and strongly convex margins, lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall punctate. L: 25, W: 20, I: 5, L/W: 1.3.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

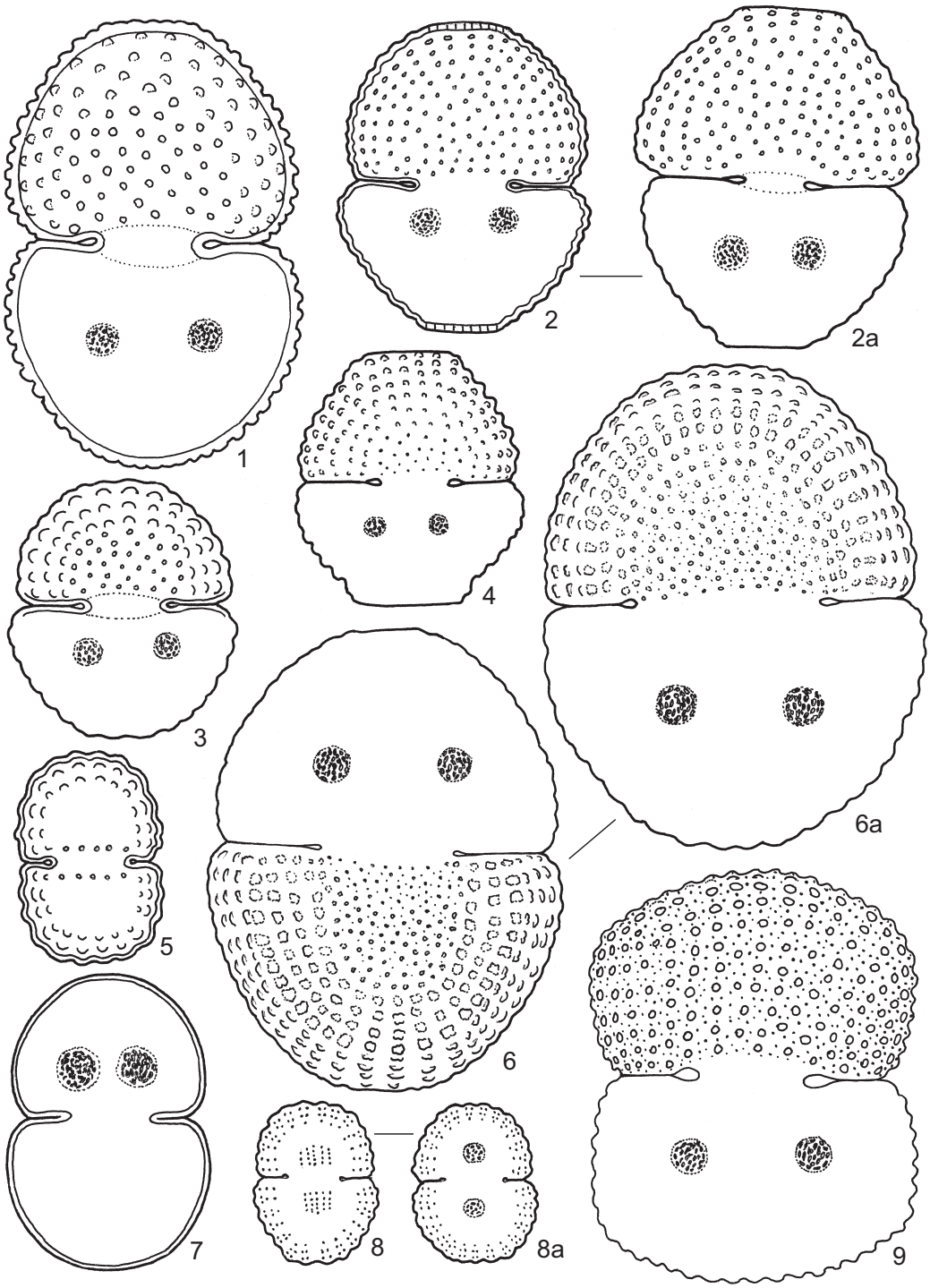

Figure 25. *Cosmarium*. 1 – *Cosmarium tetraophthalmum*; 2, 2a – *Co. botrytis*; 3 – *Co. obtusatum*; 4 – *Co. sportella*; 5 – *Co. subnotabile*; 6, 6a – *Co. ochthodes*; 7 – *Co. subcucumis*; 8, 8a – *Co. subspeciosum*; 9 – *Co. conspersum*. Drawings E. Nowotarska.

Habitat. Moist soil and puddles on roads, pH range 6.1–7.5, altitude range 580–610 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 2 (0.006): **94**, **137**.
Lubań range: Not recorded.
Foothill zone: 1 (0.021), Lower montane zone: 1 (0.003).

Cosmarium tatricum Raciborski
(Figs 23: 19; 24: 19; Map 143)

Description. Cells hexagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with concave apices and strongly convex margins near base and concave in the middle part; lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall punctate. L: 30–55, W: 20–35, I: 10–15, L/W: 1.5–2.0.

Distribution in Poland. Carpathian Mts (Gutwiński 1909).

Habitat. *Sphagnum* puddles, wet mosses of *Bryidae* class in marshes, pH range 6.0–7.5, altitude range 910–1250 m.

Number of localities in the Gorce Mts: 4 (0.01).
Turbacz range: 4 (0.012): **90**, **208**, **296**, **301**.
Lubań range: Not recorded.
Lower montane zone: 2 (0.006), Upper montane zone: 2 (0.051).

Cosmarium tetragonum (Nägeli) W. Archer
(Figs 15: 13, 13a; 16: 13a–b; Map 144)

Description. Cells rectangular, deeply constricted. Sinus linear, broadening in outer part. Semicells rectangular, with abrupt apices with two swellings and straight margins with three swellings; lower and apical angles straight. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 32.5–50, W: 25–30, I: 10, L/W: 1.4–2.0.

Notes. Only specimens belonging to var. *ornatum* Krieger et Gerloff were recorded in the material.

Di stribution in Poland. Carpathian Mts (Gutwiński 1909), Lublin Upland (Eichler 1890).

Habitat. Puddles and moist soil on roads, wet mosses of *Bryidae* class, old wells in marshes, pH range 5.1–8.0, altitude range 530–1240 m.

Number of localities in the Gorce Mts: 14 (0.034).
Turbacz range: 12 (0.042): **80**, **102**, **134**, **246**, **375**.
Lubań range: 2 (0.025): **60**.
Foothill zone: 2 (0.042), Lower montane zone: 9 (0.028), Upper montane zone: 3 (0.077).

Cosmarium tetraophthalmum Brébisson ex Ralfs
(Figs 25: 1; 26: 1; Map 145)

Description. Cells elliptical, deeply constricted. Sinus linear, broadening in outer part. Semicells semicircular to trapezoidal, with slightly convex apices and strongly rounded margins; lower and apical angles rounded. Top

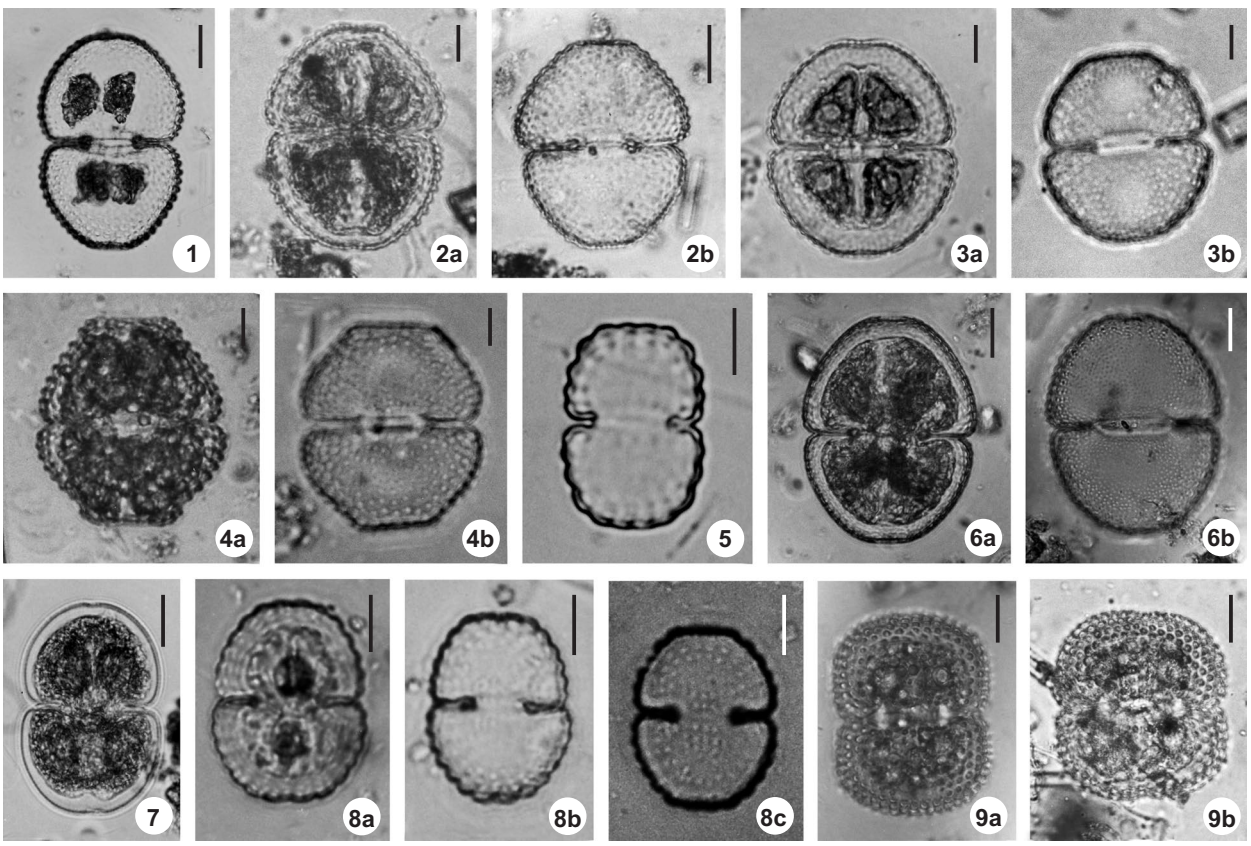

Figure 26. *Cosmarium*. 1 – *Cosmarium tetraophthalmum*; 2a–b – *Co. botrytis*; 3a–b – *Co. obtusatum*; 4a–b – *Co. sportella*; 5 – *Co. subnotabile*; 6a–b – *Co. ochthodes*; 7 – *Co. subcucumis*; 8a–c – *Co. subspeciosum*; 9a–b – *Co. conspersum*. Scales: 1, 2b, 6a–7, 9a–b = 20 µm; 2a, 3a–5, 8a–c = 10 µm. LM by M. Wayda.

view elliptical. Chloroplasts contain pair of pyrenoids. Cell wall furnished with rows of large granules. L: 85–125, W: 55–75, I: 20–25, L/W: 1.5–1.7.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic waterbodies, *Sphagnum* puddles, moist soil on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes, oxbow lakes, pH range 5.5–8.8, altitude range 510–1240 m.

Number of localities in the Gorce Mts: 62 (0.152).
Turbacz range: 42 (0.127): **101**, **138**, **257**.
Lubań range: 20 (0.253): **4**, **21**, **46**, **67**, **74**.
Foothill zone: 7 (0.146), Lower montane zone: 48 (0.149), Upper montane zone: 7 (0.179).

Cosmarium thwaitesii Ralfs [*Dy. thwaitesii* (Ralfs) Reinsch] (Figs 15: 3; 16: 3; Map 146)

Description. Cells nearly rectangular, with shallow constriction. Sinus very shallow and open, with acute apex. Semicells rectangular, with convex apices and margins; lower and apical angles rounded. Top view broadly elliptical. Chloroplasts contain pair of pyrenoids. Cell wall smooth. L: 55, W: 30, I: 20, L/W: 1.8.

Notes. The specimens from the Gorce Mts belong to var. *rotundatum* Klebs.

Distribution in Poland. Carpathian Mts (Gutwiński 1909), Lublin Upland (Eichler 1895), Pomeranian Lakeland (Torka 1906), Masurian Lakeland (Klebs 1880).

Habitat. Wet mosses of *Bryidae* class in marshes, pH range 7.4, altitude range 670 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **227**.
Lubań range: Not recorded.
Lower montane zone: 1 (0.003).

Cosmarium tinctum Ralfs (Figs 23: 7; 24: 7; Map 147)

Description. Cells nearly rectangular, moderately constricted. Sinus open. Semicells elliptical, with convex apices and strongly convex margins, lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Cell wall smooth. L: 12.5–15, W: 10–12.5, I: 7.5–10, L/W: 1.2–1.3.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Puddles and moist soil on roads, wet mosses of *Bryidae* class, puddles in marshes, pH range 5.8–7.7, altitude range 610–1270 m.

Number of localities in the Gorce Mts: 7 (0.014).
Turbacz range: 7 (0.024): **137**, **158**, **255**, **280**, **297**, **314**, **375**.
Lubań range: Not recorded.
Lower montane zone: 5 (0.015), Upper montane zone: 2 (0.051).

Cosmarium turpinii Brébisson (Figs 15: 4; 16: 4; Map 148)

Description. Cells hexagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with slightly concave apices and margins concave in apical parts; lower and apical angles rounded. Top view elliptical, with two inflations on each lateral side. Chloroplasts contain pair of pyrenoids. Cell wall furnished with granules that are larger on inflations below isthmus. L: 70, W: 50–55, I: 15, L/W: 1.3–1.4.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Moist soil on roads, pH range 6.5–7.5, altitude range 720–750 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 2 (0.006): **89**, **349**.
Lubań range: Not recorded.
Lower montane zone: 2 (0.006).

Cosmarium venustum (Brébisson) W. Archer [*Co. trilobulatum* Reinsch fo. *elongatum* Gutwiński, var. *basichondrum* Nordstedt, var. *excavatum* B. Eichler et Gutwiński] (Figs 15: 6; 16: 6a–b; Map 149)

Description. Cells hexagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with straight apices and margins with three swellings; lower and apical angles rounded. Top view elliptical. Chloroplasts contain single pyrenoid. Prominent tubercule in central part of each semicell. Cell wall punctate. L: 35–40, W: 25, I: 10–15, L/W: 1.4–1.6.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. *Sphagnum* puddles, pH range 6.0–6.3, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Cosmarium vexatum West (Figs 15: 12; 16: 12a–b; Map 150)

Description. Cells hexagonal, deeply constricted. Sinus linear, broadening in outer part. Semicells trapezoidal, with straight apices and convex undulated margins (undulations increase in apical direction), lower and apical angles rounded. Top view elliptical. Chloroplasts contain pair of pyrenoids. Cell wall furnished with concentric rows of granules. Granules become smaller towards center of cell. L: 50–55, W: 40–50, I: 15, L/W: 1.0–1.3.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, puddles on roads, moist soil on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes, oxbow lakes, temporary waterbodies, pH range 5.9–9.1, altitude range 440–1240 m.

Number of localities in the Gorce Mts: 133 (0.325).
Turbacz range: 110 (0.333): **80**, **117**, **138**, **172**, **257**.
Lubań range: 23 (0.291): **2**, **17**, **48**, **52**, **61**, **76**.
Foothill zone: 20 (0.417), Lower montane zone: 104 (0.323), Upper montane zone: 9 (0.231).

Cylindrocystis Meneghini ex de Bary

Cylindrocystis brebissonii (Ralfs) de Bary [*C. polonica* B. Eichler et Gutwiński, *C. tatrica* Raciborski, *C. turgida* Schmidle, *P. brebissonii* Ralfs]
(Figs 39: 3; 40: 3; Map 151)

Description. Cells cylindrical, with broadly rounded poles. Chloroplasts (two in each cell) with radiating ridges and pyrenoid in center. L: 30–55, W: 10–15, L/W: 2.0–3.7.

Distribution in Poland. Species very frequently reported, probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles and moist soil on roads and paths, puddles, wet mosses of *Bryidae* class and old wells in marshes, stream springs, pH range 4.4–7.9, altitude range 500–1270 m.

Number of localities in the Gorce Mts: 139 (0.34).
Turbacz range: 125 (0.379): **83**, **109**, **85**, **160**, **176**, **240**.
Lubań range: 14 (0.177): **3**, **21**, **54**, **62**, **73**.
Foothill zone: 7 (0.146), Lower montane zone: 104 (0.254), Upper montane zone: 28 (0.718).

Cylindrocystis crassa de Bary
(Figs 39: 4; 40: 4; Map 152)

Description. Cells broadly elliptical, with rounded poles. Two star-shaped chloroplasts with central pyrenoid on each cell. L: 25–40, W: 15–20, L/W: 1.5–2.0.

Distribution in Poland. Sudety Mts (Grönblad 1926), Wielkopolska Lowland (Gołowin 1964), Mazovian Lowland (Tomaszewicz 1988).

Habitat. *Sphagnum* puddles, moist soil on roads and paths, wet mosses of *Bryidae* class, puddles and old wells in marshes, pH range 6.0–7.2, altitude range 530–1270 m.

Number of localities in the Gorce Mts: 19 (0.046).
Turbacz range: 15 (0.045): **80**, **96**, **175**, **240**, **283**.
Lubań range: 3 (0.051): **21**, **69**, **73**.
Foothill zone: 4 (0.083), Lower montane zone: 13 (0.04), Upper montane zone: 2 (0.51).

Desmidium C. Agardh ex Ralfs

Desmidium grevillei (Kützing ex Ralfs) de Bary [*D. cylindricum* Greville] (Figs 47: 5, 5a; 48: 5a–b; Map 153)

Description. Cells united into filamentous coenobia. Cells rectangular, with shallow constriction. Sinus shallow, with rounded apex. Semicells trapezoidal, with abrupt apices and concave margins. Lower and upper angles acute. Top view elliptical, with mammilate poles. Cell wall smooth. L: 20, W: 55, I: 32.5, L/W: 0.6.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. Polyhumic pond, puddles on road, pH range 6.7–7.0, altitude range 660–870 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 2 (0.006): **280**, **360**.
Lubań range: Not recorded.
Lower montane zone: 2 (0.006).

Desmidium swartzii C. Agardh ex Ralfs [*D. quadrangulare* Kützing] (Figs 47: 6; 48: 6; Map 154)

Description. Cells united into filamentous coenobia. Cells rectangular, with shallow constriction. Sinus linear, with rounded apex. Semicells trapezoidal, with abrupt apices and slightly convex margins. Lower angles rounded, middle and apical angles acute. Top view triangular, with rounded angles and concave margins. Cell wall smooth. L: 15–20, W: 40, I: 30, L/W: 0.5.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic pond, *Sphagnum* puddles, puddles on paths, pH range 6.0–7.2, altitude range 660–870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **115**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Euastrum Ehrenberg ex Ralfs

Euastrum ansatum Ehrenberg ex Ralfs
(Figs 29: 2, 2a; 30: 2a–b; Map 155)

Description. Cells rhomboidal, deeply constricted. Sinus closed, broadening in outer part. Semicells trapezoidal, with broadly rounded basal angles, abruptly tapering to apical lobe with parallel margins. Apices with shallow, enclosed invagination. On each semicell are five distinct tubercules ordered in two rows above isthmus. Cell wall punctate. L: 75–95, W: 32.5–40, I: 10–15, Ap: 15–25, L/W: 1.8–2.1.

Notes. Specimens belonging to var. *pyxidatum* Delponte, which have distinct bulges on the basal part of the semicells, were recorded in the material.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads, old wells in marshes, pH range 5.4–7.0, altitude range 610–1260 m.

Number of localities in the Gorce Mts: 9 (0.022).
Turbacz range: 8 (0.024): **137**, **222**, **280**, **278**, **290**, **305**, **360**, **382**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 6 (0.019), Upper montane zone: 3 (0.077).

Euastrum bidentatum Nägeli [*Eu. rostratum* Ralfs ex Ralfs] (Figs 27: 9, 9a; 28: 9a–b; Map 156)

Description. Semicells elliptical, deeply constricted. Sinus closed, broadening in outer part. Semicells semi-elliptical, basal lobes with two swellings, apical lobes broad with deep enclosed invagination, top with four swellings. Ornamented with clusters of large granules above isthmus and small granules near margins of semicells. L: 40–62.5, W: 30–37.7, I: 10–15, Ap: 30–37.5, L/W: 1.3–1.7.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads and paths, puddles and old wells in marshes, pH range 4.9–7.0, altitude range700–1270 m.

Number of localities in the Gorce Mts: 17 (0.042).
Turbacz range: 16 (0.048): **109**, **185**, **229**, **295**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 12 (0.037), Upper montane zone: 5 (0.128).

Euastrum binale Ehrenberg ex Ralfs
(Figs 27: 7, 7a; 28: 7a–b; Map 157)

Description. Cells elliptical, deeply constricted. Sinus closed, broadening in outer part. Semicells trapezoidal, with broadly rounded basal angles, tapering to broad apical lobe. Top of apical lobe with shallow, open incision. Distinct inflation above isthmus on each semicell. Cell wall smooth. L: 20–25, W: 15–20, I: 5, Ap: 10–15, L/W: 1.3–1.8.

Notes. Specimens belonging to var. *gutwinskii* (Schmidle) Homfeld, which is swollen in the basal part of the semicell, were recorded in the material.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads and paths, moist soil on roads, wet mosses of *Bryidae* class in marshes, pH range 4.7–7.3, altitude range 610–1270 m.

Number of localities in the Gorce Mts: 22 (0.054).
Turbacz range: 20 (0.061): **109**, **137**, **229**, **359**.
Lubań range: 2 (0.025): **21**.
Lower montane zone: 17 (0.053), Upper montane zone: 5 (0.128).

Euastrum crassicolle P. Lundell
(Figs 27: 8, 8a; 28: 8a–b; Map 158)

Description. Cells rectangular, deeply constricted. Sinus closed, broadening in outer part. Semicells rectangular; basal lobes with two incurvations and parallel margins; apical lobe broad, broadening to apices. Apices rounded, with shallow, open incision. Prominent inflation above isthmus. Cell wall smooth. L: 25, W: 12.5, I: 5, Ap: 10, L/W: 2.0.

Distribution in Poland. Carpathian Mts (Gutwiński 1909).

Habitat. Puddles on roads, moist soil on roads, pH range 6.1–7.5, altitude range 610–900 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 2 (0.006): **137**, **319**.
Lubań range: Not recorded.
Lower montane zone: 2 (0.006).

Euastrum denticulatum F. Gay [*Eu. amoenum* Gay]
(Figs 27: 1, 1a; 28: 1a–b; Map 159)

Description. Cells broadly rectangular, deeply constricted. Sinus closed, broadening in outer part. Semicells

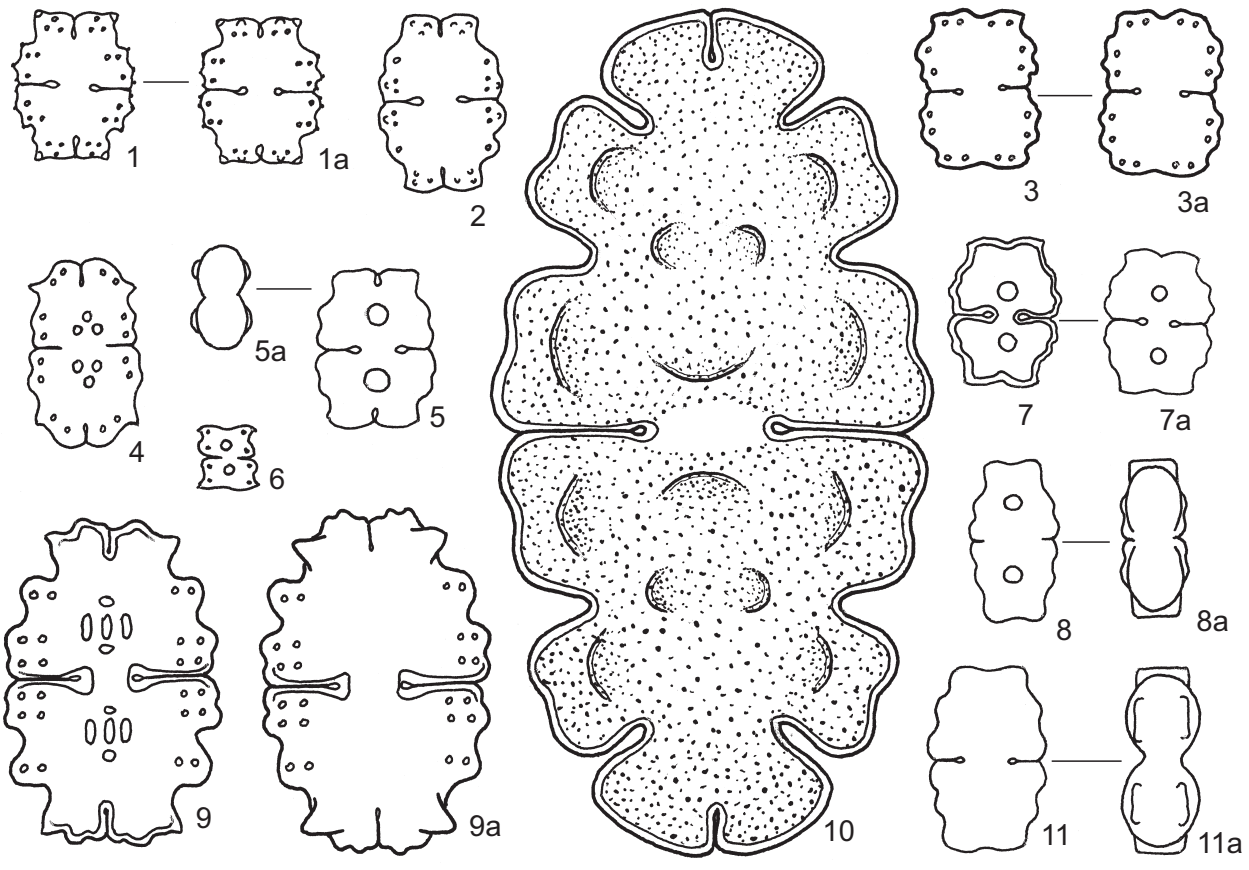

Figure 27. *Euastrum*. 1, 1a – *Euastrum denticulatum*; 2 – *Eu. dubium*; 3, 3a – *Eu. montanum*; 4 – *Eu. elegans*; 5, 5a – *Eu. dissimile*; 6 – *Eu. gayanum*; 7, 7a – *Eu. binale*; 8, 8a – *Eu. crassicolle*; 9, 9a – *Eu. bidentatum*; 10 – *Eu. oblongum* 11, 11a – *Eu. erosum*. Drawings E. Nowotarska.

rectangular, with broadly rounded basal angles and denticulate or waved margins. Apical lobes short and broad. Apices with deep open incision and angles furnished with short single pines. Five tubercules arranged in two rows above isthmus. L: 25–30, W: 15–20, I: 5, Ap: 10–12.5, L/W: 1.5–1.7.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Puddles on roads and paths, moist soil on roads, old wells, pH range 6.4–8.4, altitude range 620–1150 m.

Number of localities in the Gorce Mts: 17 (0.042).
Turbacz range: 16 (0.048): **115**, **133**, **243**, **368**.
Lubań range: 1 (0.013): **63**.
Lower montane zone: 15 (0.047), Upper montane zone: 2 (0.051).

Euastrum didelta Ralfs
(Figs 29: 1, 1a–c; 30: 1a–b; Map 160)

Description. Cells rhomboidal, deeply constricted. Sinus closed, broadening in outer part. Semicells trapezoidal, with broadly rounded basal angles and lateral lobes (distinct single swelling on margin) located in mid-region of semicell. Apical lobes with parallel margins. Apices with deep and enclosed invagination. Five distinct tubercules ordered in two rows above isthmus on each semicell. Cell wall punctate. L: 100–120, W: 55–65, I: 15–20, Ap: 25–30, L/W: 1.8.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads and paths, pH range 5.0–6.5, altitude range 960–1230 m.

Number of localities in the Gorce Mts: 7 (0.017).
Turbacz range: 7 (0.017): **5**, **195**, **229**, **360**, **276**, **278**, **280**, **382**, **288**.
Lubań range: Not recorded.
Lower montane zone: 5 (0.016), Upper montane zone: 2 (0.051).

Euastrum dissimile (Nordstedt) Schmidle
(Figs 27: 5, 5a; 28: 5; Map 161)

Description. Cells rectangular, deeply constricted. Sinus closed, broadening in outer part. Short lateral lobes with waved margins. Apical lobe short and broad, with deep open incision. Apical angles acute and protracted. Distinct inflation in central part of each semicell. Cell wall smooth. L: 25–30, W: 15–22.5, I: 5, Ap: 12.5, L/W: 1.3–1.7.

Distribution in Poland. Southern Wielkopolska Lowland (Lesiak 1990).

Habitat. *Sphagnum* puddles, moist soil on path, pH range 4.9–7.4, altitude range 870–1250 m.

Number of localities in the Gorce Mts: 2 (0.002).
Turbacz range: 1 (0.003): **300**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003), Upper montane zone: 1 (0.026).

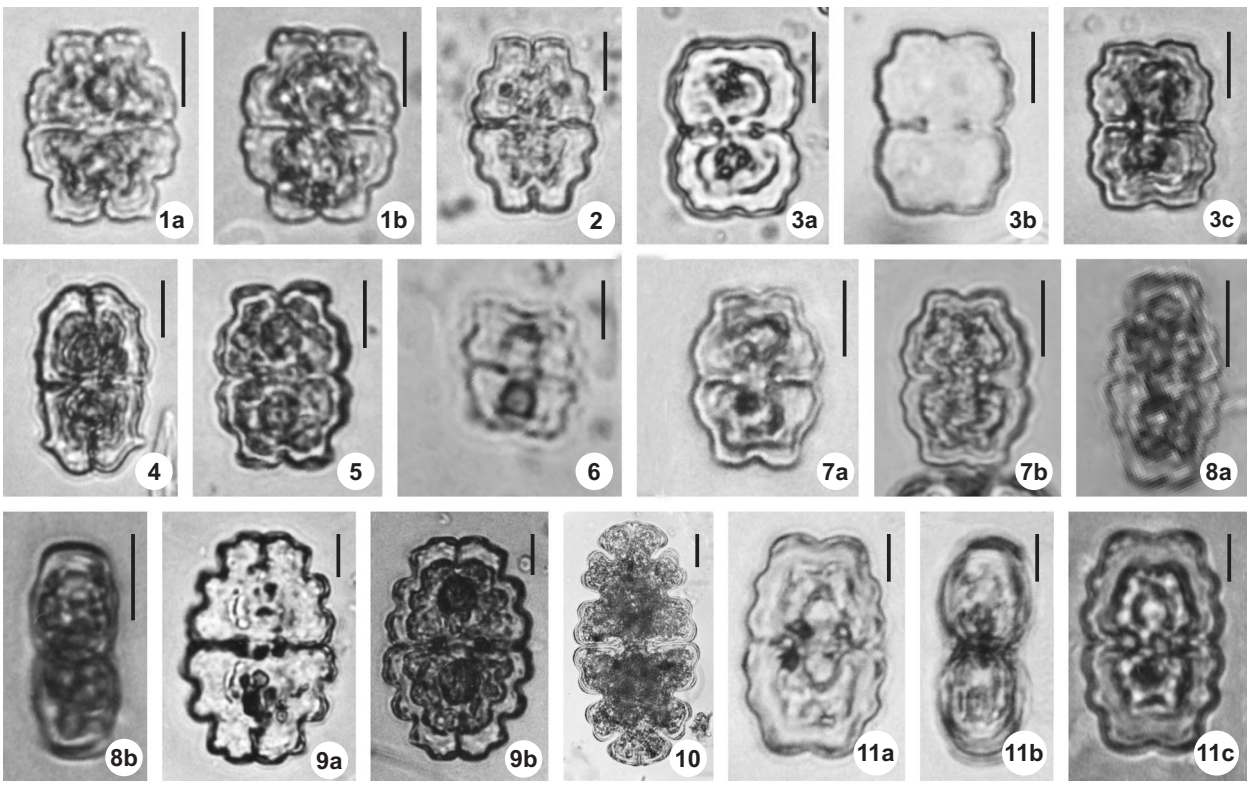

Figure 28. *Euastrum*. 1a–b – *Euastrum denticulatum*; 2 – *Eu. dubium*; 3a–c – *Eu. montanum*; 4 – *Eu. elegans*; 5 – *Eu. dissimile*; 6 – *Eu. gayanum*; 7a–b – *Eu. binale*; 8a–b – *Eu. crassicolle*; 9a–b – *Eu. bidentatum*; 10 – *Eu. oblongum* 11a–c – *Eu. erosum.* Scales: 1a–4, 3c–9b = 10 μm; 5, 10 = 20 μm; 6, 11a–c = 5 μm. LM by M. Wayda.

Euastrum dubium Nägeli (Figs 27: 2; 28: 2; Map 162)

Description. Cells broadly elliptical to rectangular, deeply constricted. Sinus closed, broadening in outer part. Semicells trapezoidal. Lateral lobes with two swellings, parallel or slightly convex. Apical lobe broad and short, with deep, rather wide incision. Ornamented with clusters of large granules above isthmus and small granules near margins of semicells. L: 30, W: 15–20, I: 5, Ap: 12.5, L/W: 1.5–2.0.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, pH range 5.7–7.1, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Euastrum elegans Ralfs (Figs 27: 4; 28: 4; Map 163)

Description. Cells elliptical, deeply constricted. Sinus closed, broadening in outer part. Semicells trapezoidal. Semicells semi-elliptic, with six swellings on margin; highest pair of swellings occur as short, firm spines with lateral orientation. Apices rounded, with deep, closed invagination. Ornamented with clusters of large granules above isthmus and small granules near margins of semicells. L: 30, W: 20, I: 5, Ap: 15, L/W: 1.5.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Puddles on road, pH range 6.8, altitude range 960 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **280**.
Lubań range: Not recorded.
Lower montane zone: 1 (0.003).

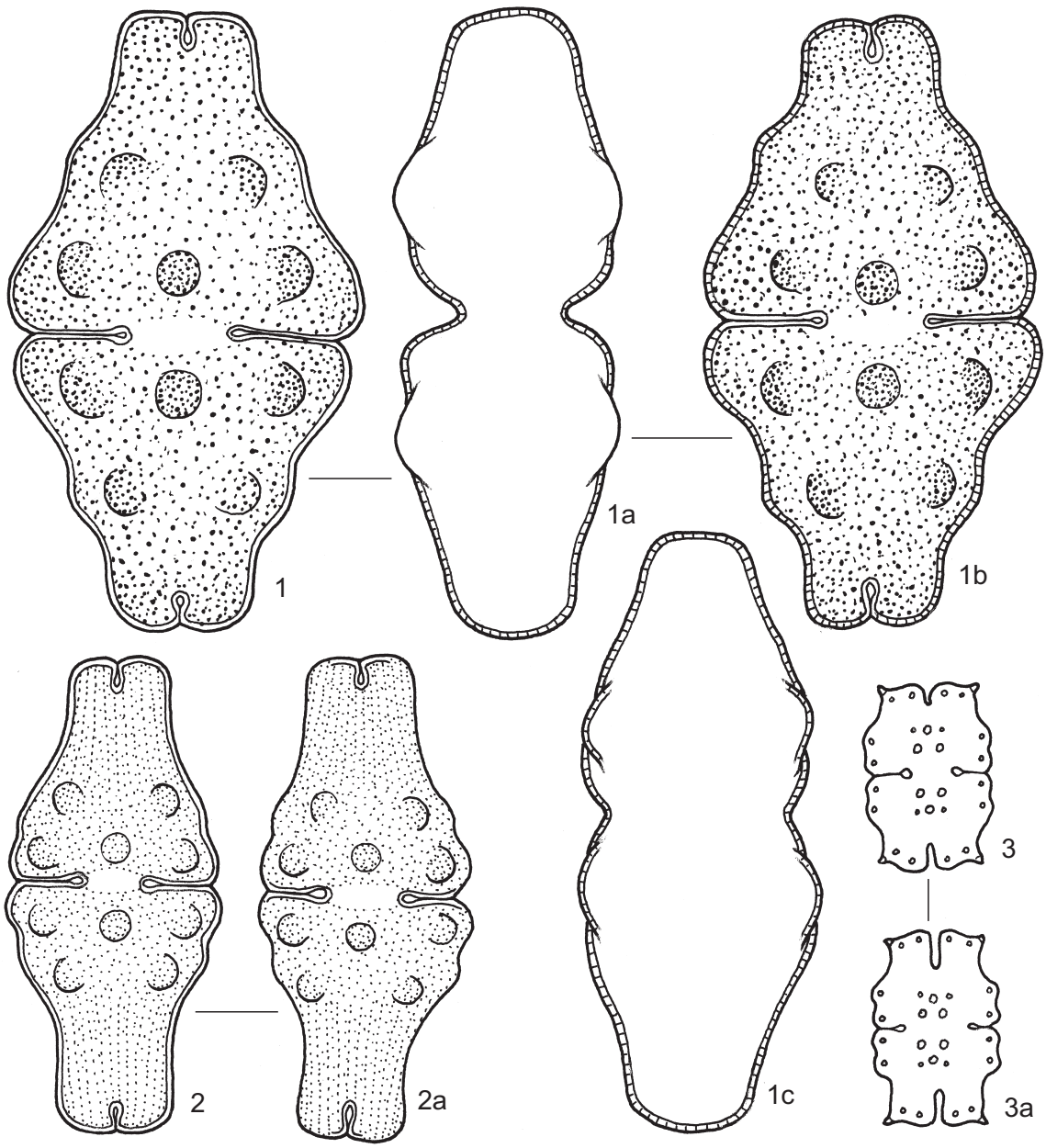

Figure 29. *Euastrum.* 1, 1a–c – *Euastrum didelta*; 2, 2a – *Eu. ansatum*; 3, 3a – *Eu. pulchellum*. Drawings E. Nowotarska.

Euastrum erosum P. Lundell
(Figs 27: 11, 11a; 28: 11a–c; Map 164)

Description. Cells rectangular to elliptical, deeply constricted. Sinus closed, broadening in outer part. Semicells rectangular, with four swellings on margins. Apices with shallow, open incision. Cell wall smooth. L: 25–30, W: 15–20, I: 5, Ap: 10–12.5, L/W: 1.5–2.0.

Distribution in Poland. Sudety Mts (Schröder 1896), Carpathian Mts (Gutwiński 1909), Southern Wielkopolska Lowland (Lesiak 1990).

Habitat. Puddles on roads and paths, moist soil on roads, pH range 6.1–7.3, altitude range 530–980 m.

Number of localities in the Gorce Mts: 12 (0.029).
Turbacz range: 7 (0.021): **80**, **96**, **134**, **163**, **375**.
Lubań range: 5 (0.063): **3**, **53**, **69**, **73**.
Foothill zone: 2 (0.042), Lower montane zone: 10 (0.031).

Euastrum gayanum De Toni [*Eu. formosum* Gay]
(Figs 27: 6; 28: 6; Map 165)

Description. Cells rectangular, deeply constricted. Sinus closed, broadening in outer part. Semicells broadly trapezoidal, with acute basal angles and concave margins. Apices short, broad, with shallow and open incision. Ornamented with small granules near margins. L: 12.5, W: 10, I: 2.5, Ap: 7.5, L/W: 1.3.

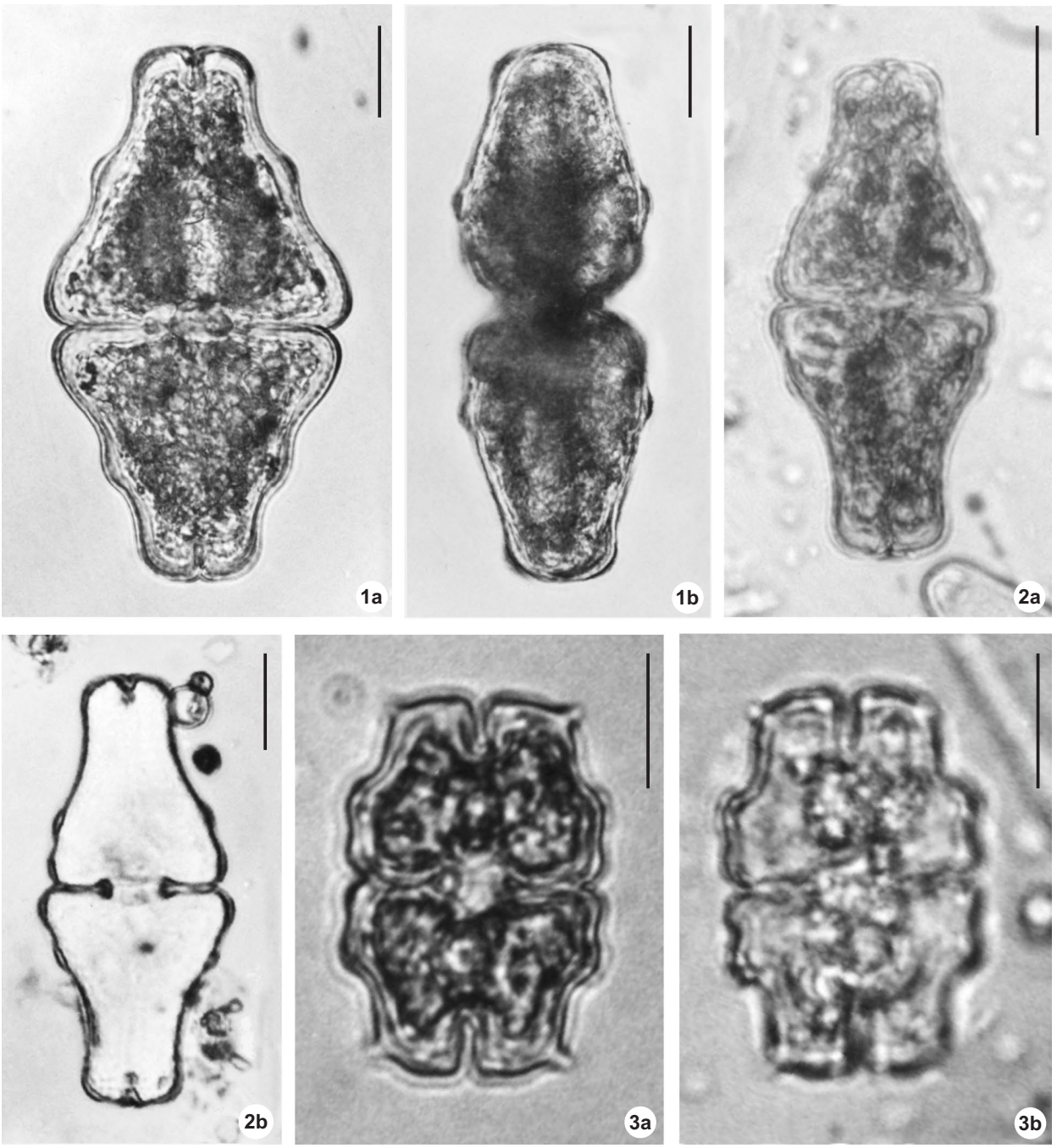

Figure 30. *Euastrum*. 1a–b – *Euastrum didelta*; 2a–b – *Eu. ansatum*; 3a–b – *Eu. pulchellum*. Scales: 1a–2b = 20 µm; 3a–b = 10 µm. LM by M. Wayda.

Distribution in Poland. Sudety Mts (Grönblad 1926), Carpathian Mts (Siemińska 1967), Mazovian Lowland (Tomaszewicz 1988).

Habitat. Polyhumic pond, pH range 6.5–7.0, altitude range 970 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **360**.
Lubań range: Not recorded.
Lower montane zone: 1 (0.003).

Euastrum humerosum Ralfs
(Figs 31: 4, 4a–b; 32: 4a–b; Map 166)

Description. Cells rhomboidal, deeply constricted. Sinus closed, broadening in outer part. Semicells pyramidal; basal lobes with two swellings and convex margins, lateral lobes prominent directed obliquely upward. Apical lobe with parallel margins. Apices with deep, open invagination. On each semicell, five distinct tubercules ordered in two rows above isthmus. Cell wall punctate. L: 120–135, W: 60–70, I: 15–25, Ap: 25–35, L/W: 1.8–2.0.

Notes. Specimens belonging to var. *affine* (Ralfs) Raciborski (Figs 32: 4c) were recorded in the material (cells rectangular, basal lobes with nearly parallel margins, lateral lobes directed at nearly right angles to cell axis, broad capitate apices; L: 120, W: 70, I: 20, Ap: 30, L/W: 1.7).

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads and paths, old wells om mountain meadows, pH range 4.5–7.9, altitude range 730–1230 m.

Number of localities in the Gorce Mts: 8 (0.002).
Turbacz range: 6 (0.018): **204**, **280**, **288**, **335**, **360**, **382**.
Lubań range: 2 (0.025): **21**, **34**.
Lower montane zone: 6 (0.019), Upper montane zone: 2 (0.051).

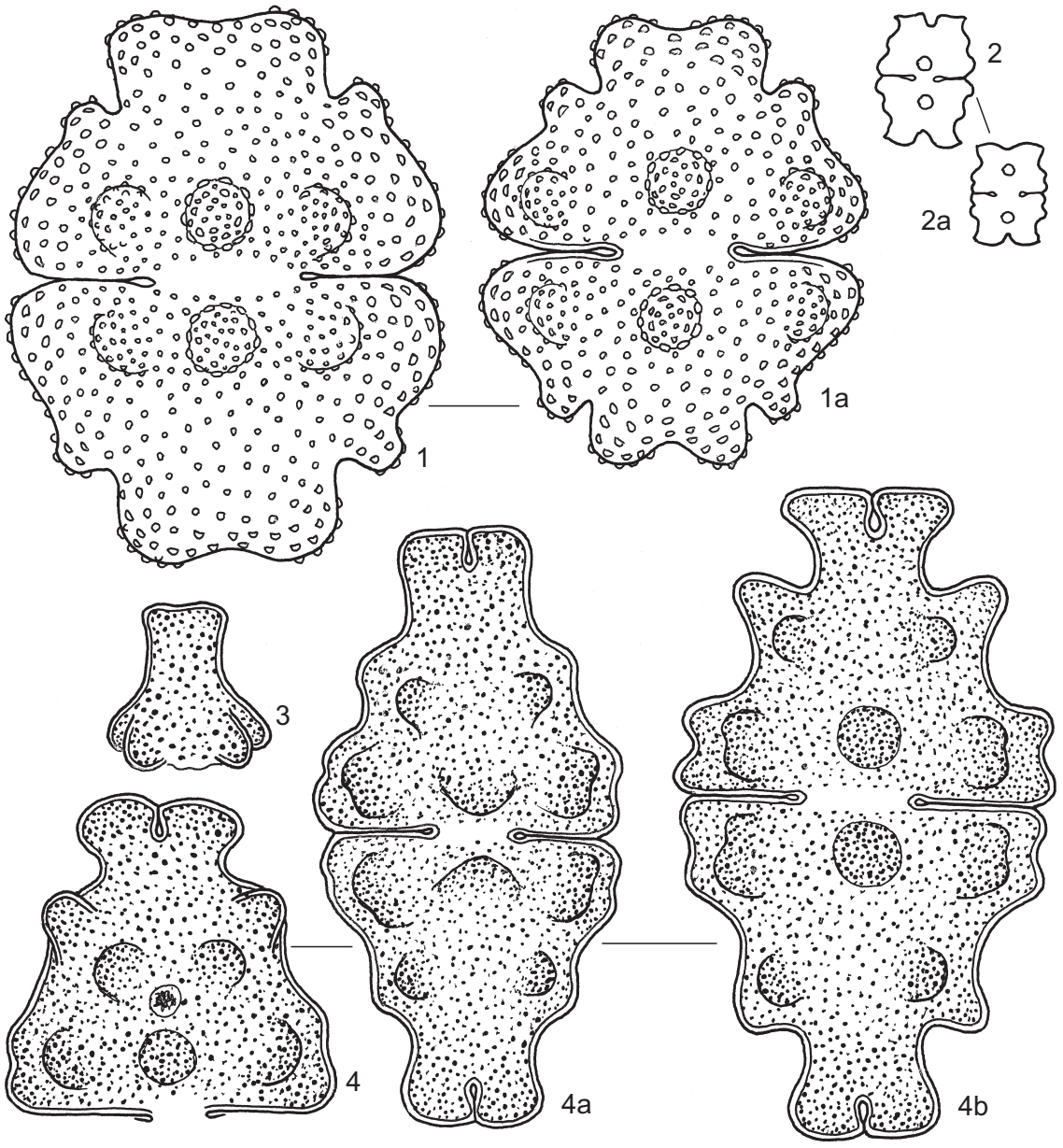

Figure 31. *Euastrum.* 1, 1a – *Euastrum verrucosum*; 2, 2a – *Eu. subalpinum*; 3 – *Eu. insigne*; 4, 4a–b – *Eu. humerosum*. Drawings E. Nowotarska.

Euastrum insigne Hassall ex Ralfs
(Figs 31: 3; 32: 3; Map 167)

Description. Semicells trapezoidal, abruptly tapering to slightly broadening apical lobe. Three acute tubercules above isthmus. Cell wall punctate. L: 55, W: 55, Ap: 30.

Notes. Only semicells were recorded in the material collected in 2000.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. *Sphagnum* puddles, pH range 4.4, altitude range 1260 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **306**.
Lubań range: Not recorded.
Upper montane zone: 1 (0.026).

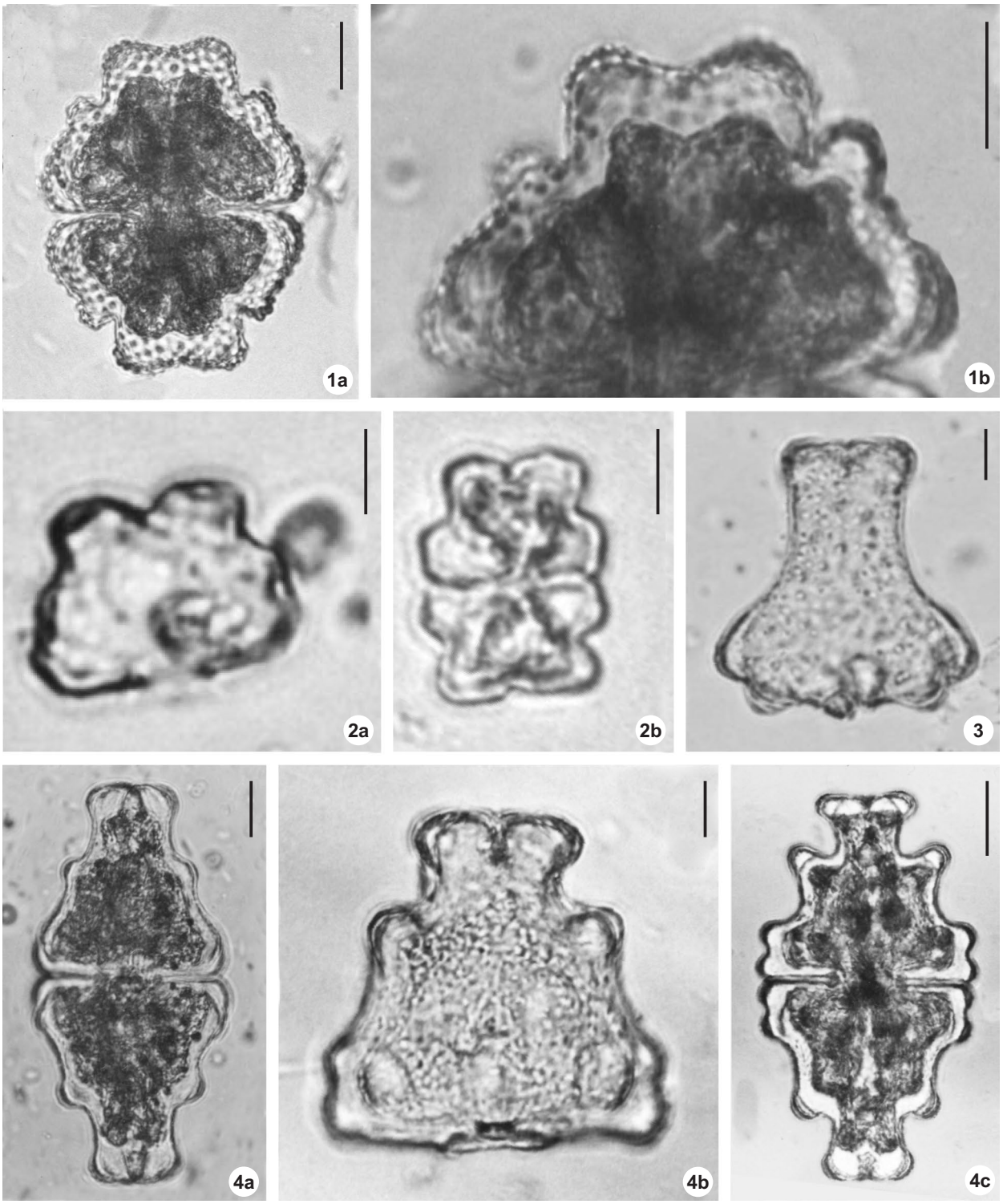

Figure 32. *Euastrum*. 1a–b – *Euastrum verrucosum*; 2a–b – *Eu. subalpinum*; 3 – *Eu. insigne*; 4a–b – *Eu. humerosum* var. *humerosum*; 4c – *Eu. humerosum* var. *affine*. Scales: 1a–b, 4a, 4c = 20 µm; 2a–b = 5 µm; 3, 4b = 10 µm. LM by M. Wayda.

Euastrum montanum West et G. S. West
(Figs 27: 3, 3a; 28: 3a–c; Map 168)

Description. Cells rectangular, deeply constricted. Sinus closed, broadening in outer part. Semicells rectangular, margins with two swellings, in basal part slightly divergent, in apical part convergent. Apices short, broad, with shallow, open incision. Two tubercules on each semicell above isthmus. Cell wall smooth. L: 25, W: 20–15, I: 5, Ap: 15, L/W: 1.3.

Distribution in Poland. Sudety Mts (Grönblad 1926), Carpathian Mts (Kawecka 1965), Southern Wielkopolska Lowland (Lesiak 1990), Mazovian Lowland (Tomaszewicz 1974).

Habitat. *Sphagnum* puddles, pH range 5.0–6.2, altitude range 730–1050 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 2 (0.006): **278**, **382**.
Lubań range: Not recorded.
Lower montane zone: 2 (0.006).

Euastrum oblongum Greville ex Ralfs
(Figs 27: 10; 28: 10; Map 169)

Description. Cells elliptical, deeply constricted. Sinus closed, broadening in outer part. Semicells semi-elliptical, basal lobes with two swellings and slightly convergent margins, lateral lobes directed obliquely upward, with two swellings on margin, apical lobes distinctly broadening toward apex. Rounded apices with deep, closed invagination. Three distinct tubercules above isthmus, smaller tubercules near lobe margins. Cell wall punctate. L: 140–185, W: 70–95, I: 15–25, Ap: 40–50, L/W: 1.9–2.2.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads, paths and marshes, moist soil on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes, pH range 4.9–7.6, altitude range 660–1270 m.

Number of localities in the Gorce Mts: 18 (0.044).
Turbacz range: 17 (0.052): **115**, **209**, **297**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 12 (0.04), Upper montane zone: 6 (0.154).

Euastrum pulchellum Brébisson
(Figs 29: 3, 3a; 30: 3a–b; Map 170)

Description. Cells rectangular, deeply constricted. Sinus closed, broadening in outer part. Lateral lobes with two swellings on slightly convergent margins. Apical lobe short, with parallel margins. Apices with deep, open incision, and angles furnished with single short spines directed laterally. Ornamented with large granules above isthmus and small granules near margins of semicells. L: 30–35, W: 20–25, I: 5, Ap: 12.5–17.5, L/W: 1.4–1.5.

Distribution in Poland. Sudety Mts (Grönblad 1926), Southern Wielkopolska Low- land (Lesiak 1990), Wielkopolska Lowland (Smoluchowska-Jaroszewska 1933), Kaszubian Lakeland (Torka 1913).

Habitat. Polyhumic pond, pH range 6.9–7.2, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Euastrum subalpinum Messikommer
(Figs 31: 2, 2a; 32: 2a–b; Map 171)

Description. Semicells rectangular, deeply constricted. Sinus closed, broadening in outer part. Semicells rectangular. Basal lobes short, with incisions at top, apical lobe short and broad; apices with shallow, open incision. Distinct tubercules below isthmus, small granules near margins. L: 15–25, W: 12.5–15, I: 5, Ap: 10, L/W: 1.3–1.6.

Notes. Specimens belonging to var. *crassum* Messikomer, which is larger and has broader apical lobes, were recorded in material.

Distribution in Poland. Carpathian Mts (Růžička 1964).

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads, pH range 5.0–6.9, altitude range 730–1270 m.

Number of localities in the Gorce Mts: 9 (0.022).
Turbacz range: 7 (0.021): **276**, **278**, **280**, **297**, **301**, **359**, **360**, **382**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 6 (0.019), Upper montane zone: 3 (0.077).

Euastrum verrucosum Ehrenberg ex Ralfs
(Figs 31: 1, 1a; 32: 1a–b; Map 172)

Description. Cells broadly hexangular, deeply constricted. Sinus parallel in apical part, closed in mid-region, broadening in outer part. Semicells trapezoidal, basal lobes very broad, with convergent margins and an appendix in apical part. Apical lobe short and broad. Apices with broad and shallow incision. Three distinct tubercules below isthmus. Cell wall with dispersed acute granules. L: 85–100, W: 75–80, I: 20–25, Ap: 30–40, L/W: 1.3.

Notes. The specimens collected in the Gorce Mts correspond to var. *alpinum* (Huber-Pestalozzi) Krieger.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, puddles on roads and paths, puddles and old wells in mountain meadows, pH range 6.7–7.5, altitude range 660–1160 m.

Number of localities in the Gorce Mts: 7 (0.017).
Turbacz range: 7 (0.021): **115**, **226**, **264**, **272**, **278**, **292**, **313**.
Lubań range: Not recorded.
Lower montane zone: 6 (0.019), Upper montane zone: 1 (0.026).

Gonatozygon de Bary

Gonatozygon brebissonii de Bary [*G. asperum* (Brébisson ex Ralfs) Cleve, *G. kjelmanii* Raciborski, *G. leave* Hilse] (Figs 33: 5; 34: 5; Map 173)

Description. Cells elongate fusiform-cylindrical, tapering to capitate poles, sometimes curved. Single chloroplast

with central row of pyrenoids. Cell wall with many small and acute granules. L: 45–125, W: 5–10, L/W: 9–20.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. Puddles and moist soil on roads and paths, wet mosses of *Bryidae* class, puddles and old wells in mountain wetlands, pH range 5.8–7.9, altitude range 480–1230 m.

Number of localities in the Gorce Mts: 30 (0.073).
Turbacz range: 28 (0.085): **80**, **115**, **162**, **185**, **213**, **331**, **385**.
Lubań range: 2 (0.025): **53**, **60**.
Foothill zone: 3 (0.063), Lower montane zone: 24 (0.074), Upper montane zone: 3 (0.077).

Gonatozygon monotaenium de Bary [*G. ralfsii* de Bary] (Figs 33: 4; 34: 4; Map 174)

Description. Cells elongate-cylindrical, slightly dilated toward truncate poles. Single chloroplast with central row of pyrenoids. Cell wall ornamented with many small and acute granules. L: 275, W: 15, L/W: 18.3.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. temporary waterbodies, pH range 6.1–8.2, altitude range 840 m

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **9**.
Lower montane zone: 1 (0.003).

Haplotaenium Bando

Haplotaenium rectum (Delponte) Bando [*Pl. rectum* Delponte, *Pl. trabecula* Ehrenberg. ex Nägeli var. *rectum* (Delponte) West et G. S. West] (Figs 39: 6, 6a; 40: 6a–b; Map 175)

Description. Cells cylindrical elongate, with very shallow pit-shaped sinus. Semicells cylindrical, with one basal inflation, parallel margins tapering near slightly convex apices without granules. Cell wall smooth. L: 360–400, W: 30, I: 25, L/W: 13,3–14,4.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. Polyhumic pond, *Sphagnum* puddles, pH range 5.7–7.2, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Hyalotheca Ehrenberg ex Ralfs

Hyalotheca dissiliens Brébisson ex Ralfs (Figs 47: 7, 7a; 48: 7a–b; Map 176)

Description. Cells united into filamentous coenobia surrounded by thick mucilaginous sheaths. Cells rectangular, with shallow constriction. Sinus very shallow. Semicells rectangular, with abrupt apices and straight margins. Top view elliptical. Cell wall smooth. L: 15–20, W: 20–30, I: 12.5–17.5, L/W: 0.5–0.8.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic waterbodies, *Sphagnum* puddles, puddles on roads, paths and marshes, old wells, temporary ponds, pH range 4.9–7.3, altitude range 650–1270 m.

Number of localities in the Gorce Mts: 22 (0.054).
Turbacz range: 20 (0.061): **109**, **137**, **185**, **222**, **296**.
Lubań range: 2 (0.025): **21**.
Lower montane zone: 15 (0.047), Upper montane zone: 7 (0.179).

Mesotaenium Nägeli

Mesotaenium degreyi W. B. Turner (Figs 33: 1; 34: 1; Map 177)

Description. Cells cylindrical in outline, with broadly rounded poles, sometimes slightly curved. Chloroplast single, plate-shaped. Many oil droplets in cytoplasm. L: 60–100, W: 15–25, L/W: 3.0–4.7.

Distribution in Poland. Mazovian Lowland (Tomaszewicz 1988).

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles and moist soil on roads and paths, puddles in marshes, old wells, pH range 4.7–7.0, altitude range 580–1270 m.

Number of localities in the Gorce Mts: 40 (0.098).
Turbacz range: 37 (0.112): **146**, **185**, **251**, **357**.
Lubań range: 3 (0.038): **21**.
Foothill zone: 1 (0.021), Lower montane zone: 23 (0.071), Upper montane zone: 16 (0.41).

Mesotaenium endlicherianum Nägeli (Figs 33: 2; 34: 2; Map 178)

Description. Cells cylindrical in outline, with broadly rounded poles. Chloroplast single, plate-shaped, with two pyrenoids. L: 55, W: 12.5, L/W: 4.4.

Distribution in Poland. Species frequently reported, probably common in the whole country.

Habitat. Puddles on roads, pH range 6.5, altitude range 660 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **145**.
Lubań range: Not recorded.
Lower montane zone: 1 (0.003).

Mesotaenium macrococcum (Kützing ex Kützing) R. Roy et Bisset [*M. braunii* de Bary, *M. micrococcum* (Kützing) Kirchner] (Figs 33: 3; 34: 3; Map 179)

Description. Cells cylindrical in outline, with broadly rounded poles. Chloroplast single, plate-shaped, with constriction in middle and toothed margin; single pyrenoid present. L: 45, W: 20, L/W: 2.3.

Notes. Var. *micrococcum* W. et G. S. West was also recorded in the material: L: 22.5, W: 10, L/W: 2.3.

Distribution in Poland. Species frequently reported, probably common in the whole country.

Habitat. Puddles and moist soil on roads, pH range 6.1–7.4, altitude range 610–1230 m.

Number of localities in the Gorce Mts: 4 (0.01).
Turbacz range: 3 (0.009): **137**, **241**, **302**.
Lubań range: 1 (0.013): **3**.
Lower montane zone: 3 (0.01), Upper montane zone: 1 (0.026).

Micrasterias C. Agardh ex Ralfs

Micrasterias americana Ehrenberg ex Ralfs
(Figs 35: 1, 1a–b; 36: 1a–d; Map 180)

Description. Cells hexangular, deeply constricted. Sinus open, with acute apex. Semicells 5-lobed. Apical lobe distinctly separated, strongly dilatated towards apex. Apical angles extended into two pairs of short appendices. Lateral lobes divided into second-order elongate lobules with acute granules. Some acute granules near cell margins, mostly in lateral and apical lobes. L: 130, W: 120, I: 30, Ap: 60, L/W: 1.1.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Puddles on roads, pH range 5.4–6.5, altitude range 680 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.002): **109**.
Lubań range: Not recorded.
Lower montane zone: 1 (0.003).

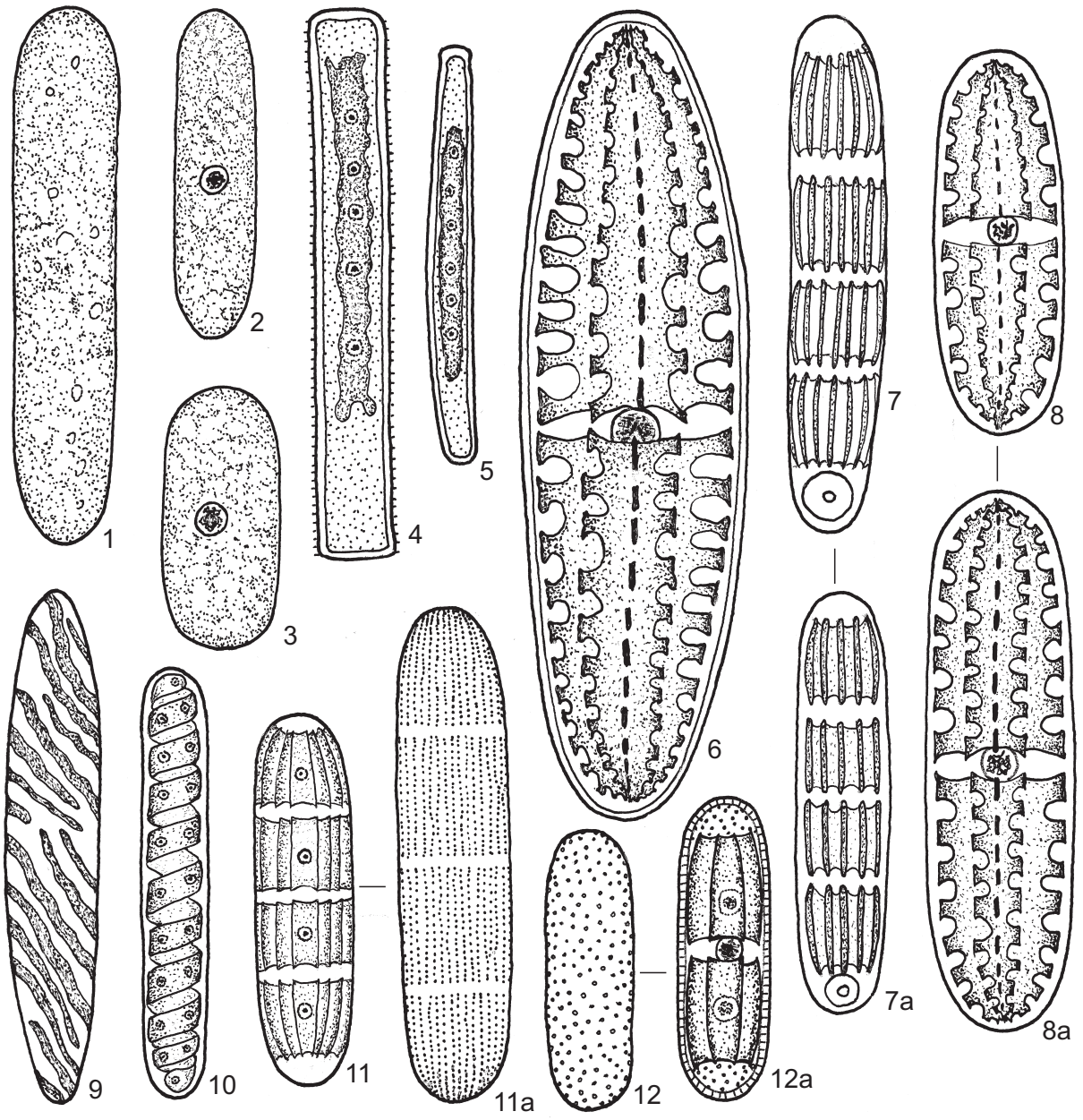

Figure 33. *Mesotaenium, Gonatozygon, Netrium, Spirotaenia, Penium.* 1 – *Mesotaenium degrei*; 2 – *M. endlicherianum*; 3 – *M. macrococcum*; 4 – *Gonatozygon monotaenium*; 5 – *G. brebissonii*; 6 – *Netrium digitus*; 7, 7a – *Planotaenium interruptum*; 8, 8a – *Nt. oblongum*; 9 – *Spirotaenia obscura*; 10 – *S. condensata*; 11, 11a – *Penium margaritaceum*; 12, 12a – *P. cylindrus*. Drawings E. Nowotarska.

Micrasterias dickiei (Ralfs) Škaloud, Nemjová, Veselá, Černá & Neustupa [*Std. dickiei* Ralfs, *St. dickiei* (Ralfs) S. Lillieroth] (Figs 35: 2, 2a–b; 36: 2a–c; Map 181)

Description. Cells elliptical, deeply constricted. Sinus open, triangular, with acute apex. Semicells elliptical, with convex apices and margins. Lower angles rounded, apical angles furnished with short, stout convergent spines. Top view triangular, with rounded angles furnished with short spines and concave margins. Cell wall smooth. L: 30–40, W: 25–40, I: 10–15, L/W: 0.9–1.2.

Notes. Specimens belonging to var. *circularis* (Turner) Croasdale were recorded in the material; they have semicircular semicells, strongly convex apices, and a parallel sinus in the apical part.

Distribution in Poland. Sudety Mts (Grönblad 1926), Carpathian Mts (Siemińska 1967), Wielkopolska Lowland (Gołowin 1964), Southern Wielkopolska Lowland (Lesiak 1990), Mazovian Lowland (Tomaszewicz 1988).

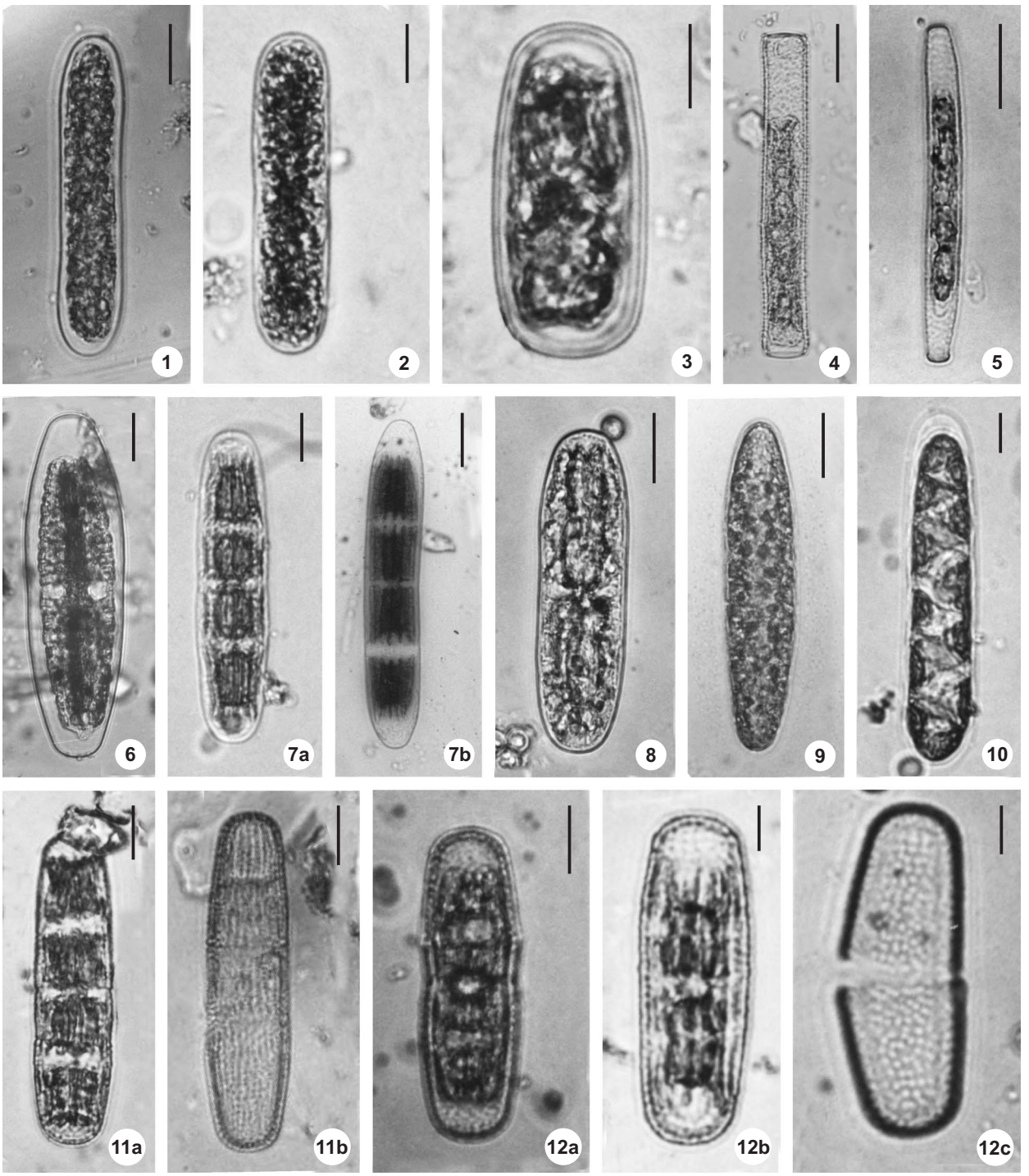

Figure 34. *Mesotaenium, Gonatozygon, Netrium, Spirotaenia, Penium, Actinotaenium*. 1 – *Mesotaenium degrei*; 2 – *M. endlicherianum*; 3 – *M. macrococcum*; 4 – *Gonatozygon monotaenium*; 5 – *G. brebissonii*; 6 – *Netrium digitus*; 7a–b – *Planotaenium interruptum*; 8 – *Nt. oblongum*; 9 – *Spirotaenia obscura*; 10 – *S. condensata*; 11a–b – *Penium margaritaceum*; 12a–c – *P. cylindrus*. Scales: 1, 4–6, 8–9 = 20 µm; 2–3, 7a, 10–13b = 10 µm; 7b = 50 µm. LM by M. Wayda.

Habitat. *Sphagnum* puddles, polyhumic pond, pH range 5.3–7.1, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Micrasterias papillifera Brébisson ex Ralfs (Figs 37: 1; 38: 1; Map 182)

Description. Cells circular, deeply constricted. Sinus linear, open. Semicells semicircular. Apical lobe gradually dilatated towards apex. Apices with distinct shallow incision in middle part and two smaller incisions in lateral margins. Lateral lobes radially subdivided into three lobules. Last-order lobules and margin of apical lobe with short, stout spines. Cell wall ornamented with small acute granules near lobe margins. L: 110–140, W: 100–130, I: 15–20, Ap: 30–40, L/W: 1.1.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads, pH range 5.4–7.2, altitude 660–1050 m.

Number of localities in the Gorce Mts: 5 (0.012).
Turbacz range: 4 (0.012): **117**, **278**, **360**, **359**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 5 (0.016).

Micrasterias rotata Ralfs (Figs 35: 3; 36: 3; Map 183)

Description. Cells circular, deeply constricted. Sinus linear, open. Semicells semicircular. Apical lobe gradually dilatated towards apex. Apices with distinct shallow

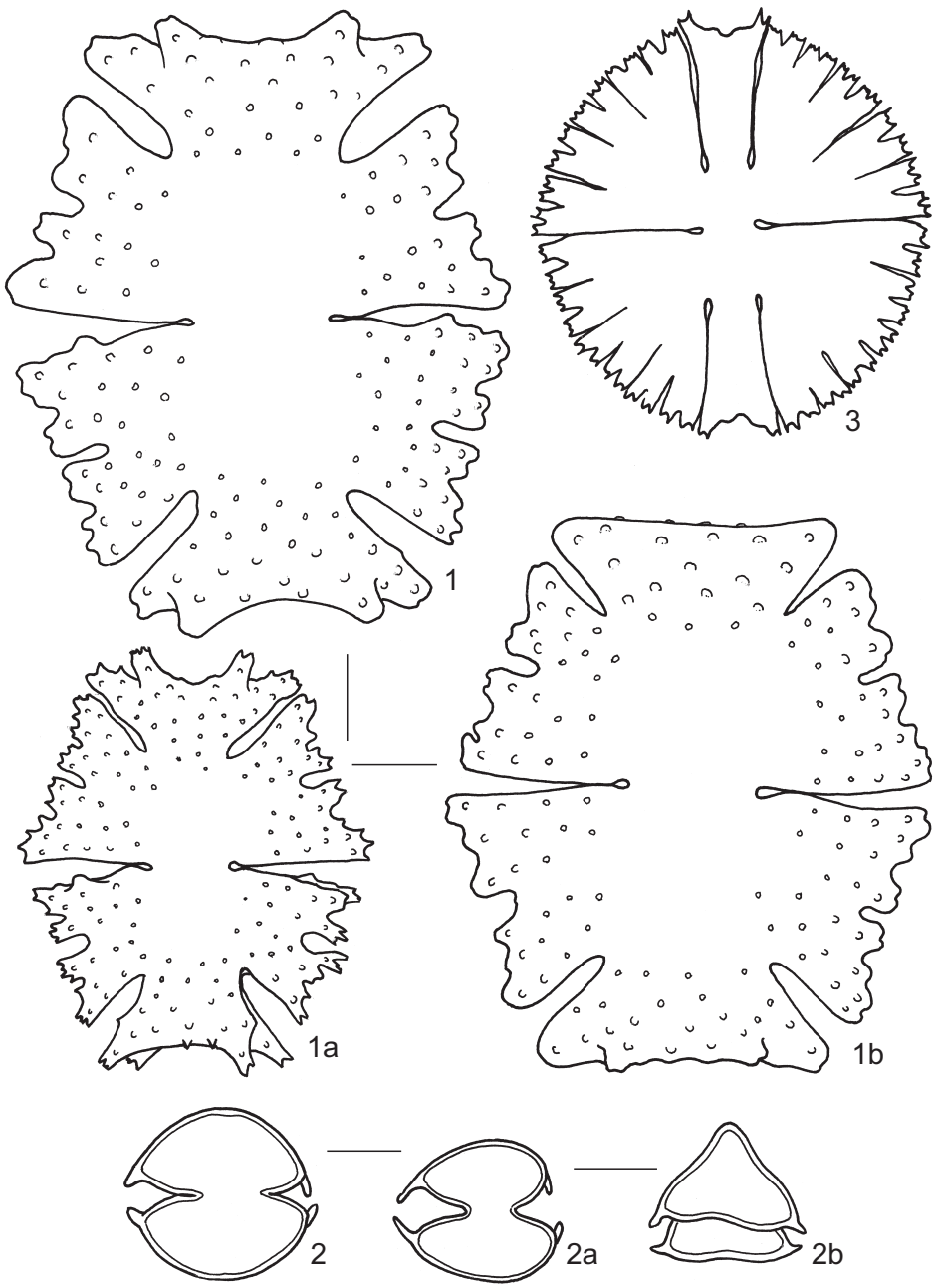

Figure 35. *Micrasterias.* 1, 1a–b – *Micrasterias americana*; 2, 2a–b – *Mc. dickiei*; 3 – *Mc. rotata*. Drawings E. Nowotarska.

incision in median margin and two smaller incisions in lateral margins. Lateral lobes radially subdivided into three lobules. Last-order lobules and margin of apical lobe furnished with short denticules, sometimes without them. Cell wall punctate. L: 250–300, W: 200–250, I: 25–37.5, Ap: 25–55, L/W: 1.0–1.3.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads, pH range 5.4–7.2, altitude range 660–1050 m.

Number of localities in the Gorce Mts: 5 (0.012).
Turbacz range: 4 (0.012): **117**, **278**, **359**, **360**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 5 (0.016).

Micrasterias truncata Brébisson ex Ralfs [*Mc. crenata* Brébisson in Ralfs] (Figs 37: 2; 38: 2; Map 184)

Description. Cells broadly elliptical, deeply constricted. Sinus linear, open. Semicells semicircular. Apical lobe very broad, fusiform. Apices slightly convex, without incision, with pair of denticules on each corner. Lateral lobes subdivided into two lobules. Outer margins of lateral lobes denticulate. Cell wall punctate. L: 95–105, W: 75–95, I: 15–25, Ap: 40–70, L/W: 1.1–1.2.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads and marshes, pH range 4.9–7.0, altitude range 700–1270 m.

Number of localities in the Gorce Mts: 7 (0.017).
Turbacz range: 6 (0.018): **109**, **226**, **278**, **297**, **359**, **360**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 6 (0.014), Upper montane zone: 1 (0.026).

Netrium (Nägeli) Itzigsohn et Rothe

Netrium digitus (Brébisson ex Ralfs) Itzigsohn et Rothe [*P. lamellosum* Brébisson ex Kützing, *P. naegelii* Brébisson in A. Pritchard, *P. digitus* Brébisson ex Ralfs, *N. lamellosum* (Brébisson ex Kützing) Lütkemüller] (Figs 33: 6; 34: 6; Map 185)

Description. Cells fusiform, sometimes slightly constricted in middle part, with broadly rounded poles. Chloroplast (two in each cell) with longitudinal pectinate ridges. L: 110–310, W: 40–55, L/W: 2.8–6.9.

Distribution in Poland. Species very frequently reported, probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles and moist soil on roads and paths, puddles, wet mosses of *Bryidae* class and old wells in marshes, pH range 4.5–8.4, altitude range 600–1270 m.

Number of localities in the Gorce Mts: 77 (0.188).
Turbacz range: 74 (0.224): **101**, **138**, **158**, **185**, **240**.
Lubań range: 3 (0.038): **21**, **66**.
Lower montane zone: 61 (0.189), Upper montane zone: 16 (0.41).

Netrium oblongum (de Bary) Lütkemüller [*P. oblongum* de Bary] (Figs 33: 8, 8a; 34: 8; Map 186)

Description. Cells cylindrical, with broadly rounded poles. Chloroplasts (two in each cell) with pectinate ridges. L: 65–87.5, W: 20, L/W: 3.3–4.4.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Puddles and moist soil on roads, pH range 6.1–7.4, altitude range 570–810 m.

Number of localities in the Gorce Mts: 5 (0.012).
Turbacz range: 3 (0.009): **96**, **137**, **382**.
Lubań range: 2 (0.025): **69**, **73**.
Foothill zone: 1 (0.021), Lower montane zone: 4 (0.013).

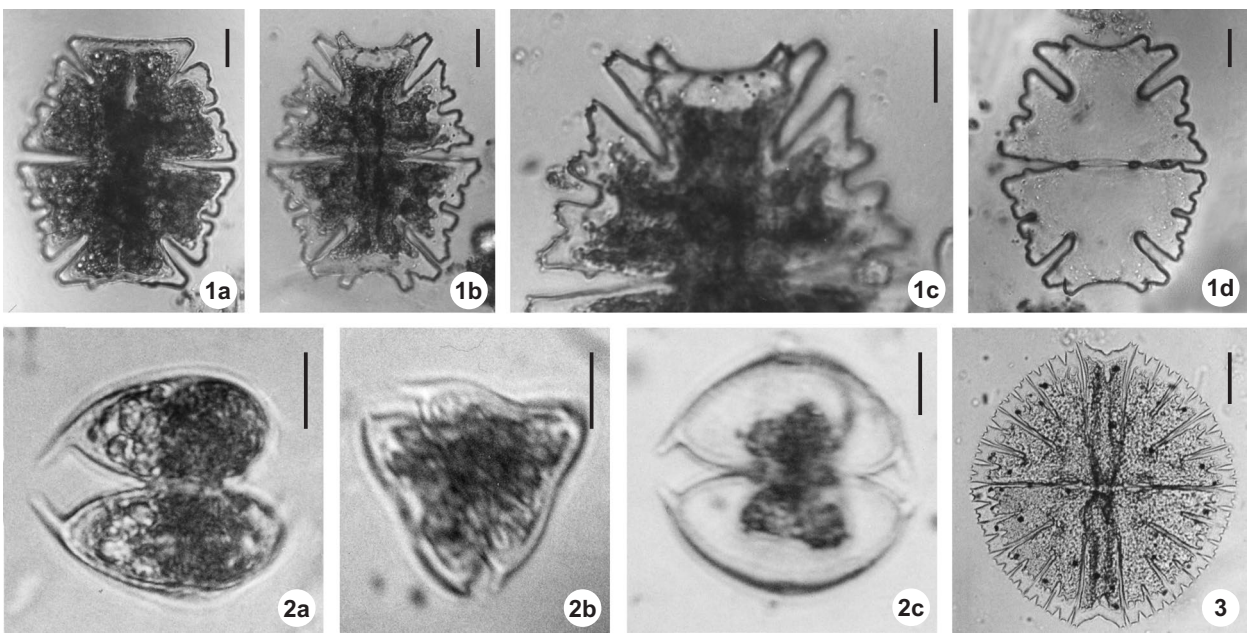

Figure 36. *Micrasterias*. 1a–d – *Micrasterias americana*; 2a–c – *Mc. dickiei*; 3 – *Mc. rotata*. Scales: 1a–d = 20 µm; 2a–c = 10 µm; 3 = 50 µm. LM by M. Wayda.

Penium Brébisson ex Ralfs

Penium cylindrus Brébisson ex Ralfs
(Figs 33: 12, 12a; 34: 12a–c; Map 187)

Description. Cells cylindrical, with truncate apices. Girdle bands prominent. Cell wall ornamented with small granules irregularly arranged. L: 35–60, W: 12.5–20, L/W: 2.3–4.0.

Distribution in Poland. Species often recorded, but its distribution in Poland needs further study.

Habitat. Polyhumic waterbody, puddles on roads and paths, wet mosses of *Bryidae* class in marshes, pH range 5.8–7.4, altitude range 580–1230 m.

Number of localities in the Gorce Mts: 29 (0.071).
Turbacz range: 27 (0.081): **103**, **160**, **185**, **240**, **351**.
Lubań range: 2 (0.025): **33**, **63**.
Foothill zone: 1 (0.021), Lower montane zone: 23 (0.071), Upper montane zone: 5 (0.128).

Penium margaritaceum (Ehrenberg) Brébisson
(Figs 33: 11, 11a; 34: 11a–b; Map 188)

Description. Cells cylindrical, sometimes with slight contraction in middle, tapering toward rounded apices. Girdle bands prominent. Cell wall ornamented with small granules, less regular in apical parts and more regular in middle of cell, where they form longitudinal rows. L: 60–145, W: 15–25, L/W: 4.0–6.0.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles and moist soil on roads and paths, puddles, old wells and wet mosses of *Bryidae* class in marshes, pH range 5.1–7.4, altitude range 580–1270 m.

Number of localities in the Gorce Mts: 40 (0.098).
Turbacz range: 38 (0.115): **89**, **115**, **160**, **163**, **206**, **366**.
Lubań range: 2 (0.025): **33**.

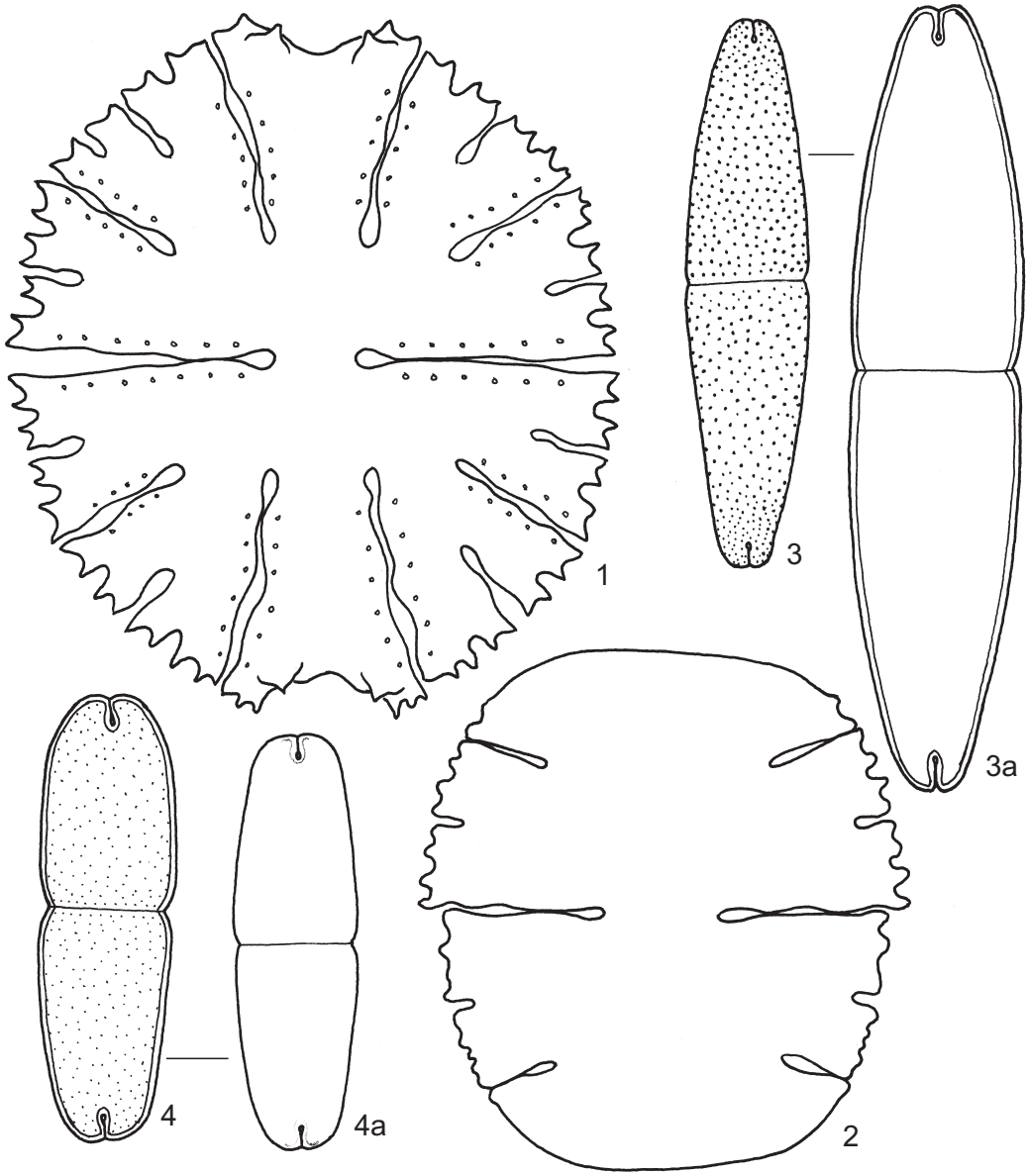

Figure 37. *Micrasterias, Tetmemorus*. 1 – *Micrasterias papillifera*; 2 – *Mc. truncata* 3, 3a – *Tetmemorus granulatus*; 4, 4a – *T. laevis*. Drawings E. Nowotarska.

Foothill zone: 1 (0.021), Lower montane zone: 29 (0.09), Upper montane zone: 10 (0.256).

Penium spirostriolatum J. Barker
(Figs 39: 1, 1a; 40: 1a–b; Map 189)

Description. Cells elongate, cylindrical, tapering to rounded apices, sometimes with slight median constriction. Girdle bands distinct. Cell wall with longitudinal and spirally arranged striae; rows of granules in apical parts. L: 100–200, W: 20–25, L/W: 4.0–8.0.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads and paths, puddles in marshes, pH range 5.1–7.5, altitude range 650–1230 m.

Number of localities in the Gorce Mts: 23 (0.056).
Turbacz range: 23 (0.07): **115**, **137**, **217**, **295**.
Lubań range: Not recorded.
Lower montane zone: 18 (0.056), Upper montane zone: 5 (0.128).

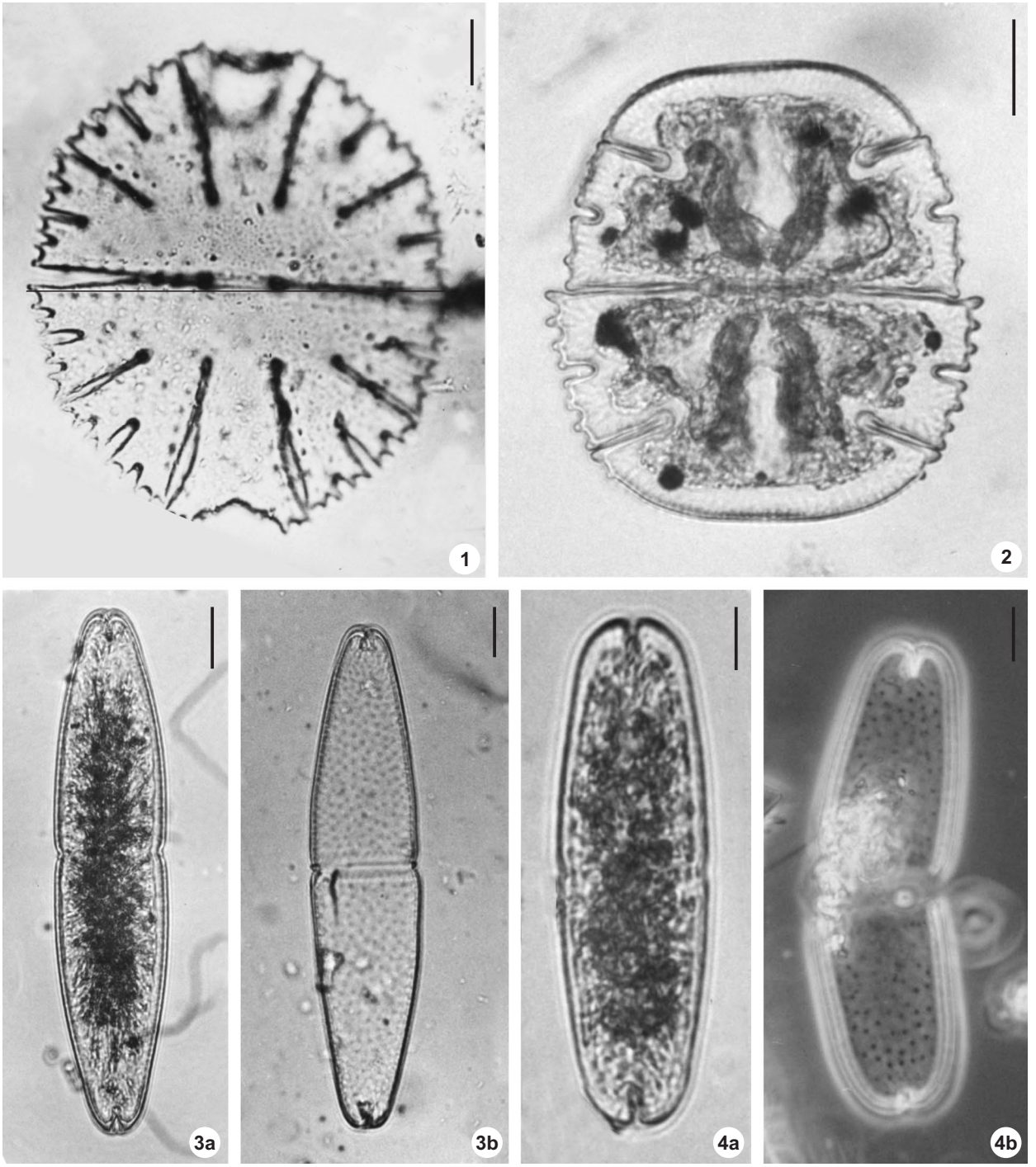

Figure 38. *Micrasterias, Tetmemorus*. 1 – *Micrasterias papillifera*; 2 – *Mc. truncata*; 3a–b – *Tetmemorus granulatus*; 4a–b – *T. laevis*. Scales: 1–3b = 20 µm; 4a–b = 10 µm. LM by M. Wayda.

Planotaenium (Ohtani) Petlovany et Palamar-Mordvintseva

Planotaenium interruptum (Brébisson ex Ralfs) Petlovany et Palamar-Mordvintseva [*Nt. interruptum* (Brébisson ex Ralfs) Lütkemüller]
(Figs 33: 7, 7a; 34: 7a–b; Map 190)

Description. Cells cylindrical, with conically tapering rounding poles. Axial chloroplasts (four in each cell) with pectinate ridges. L: 80–155, W: 20–40, L/W: 4.0.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. *Sphagnum* puddles, puddles on paths, moist soil on roads, pH range 5.7–7.1, altitude range 870–950 m.

Number of localities in the Gorce Mts: 3 (0.007).
Turbacz range: 2 (0.006): **175**, **204**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 3 (0.009).

Pleurotaenium Nägeli

Pleurotaenium crenulatum (Ehrenberg ex Ralfs) Rabenhorst (Figs 39: 8, 8a; 40: 8a–c; Map 191)

Description. Cells cylindrical, elongate, with very shallow sinus. Semicells cylindrical, with one basal inflation and parallel margins tapering to 2/3 of length; slightly convex apices with eight small granules. Cell wall smooth. L: 250–380, W: 30–40, I: 20–30, L/W: 6.3–12.6.

Distribution in Poland. Carpathian Mts (Raciborski 1888), Silesian Lowland (Kirchner 1878).

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads and paths, moist soil on roads, pH range 5.1–8.5, altitude range 600–1230 m.

Number of localities in the Gorce Mts: 11 (0.027).
Turbacz range: 10 (0.031): **103**, **155**, **243**, **349**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 8 (0.025), Upper montane zone: 3 (0.077).

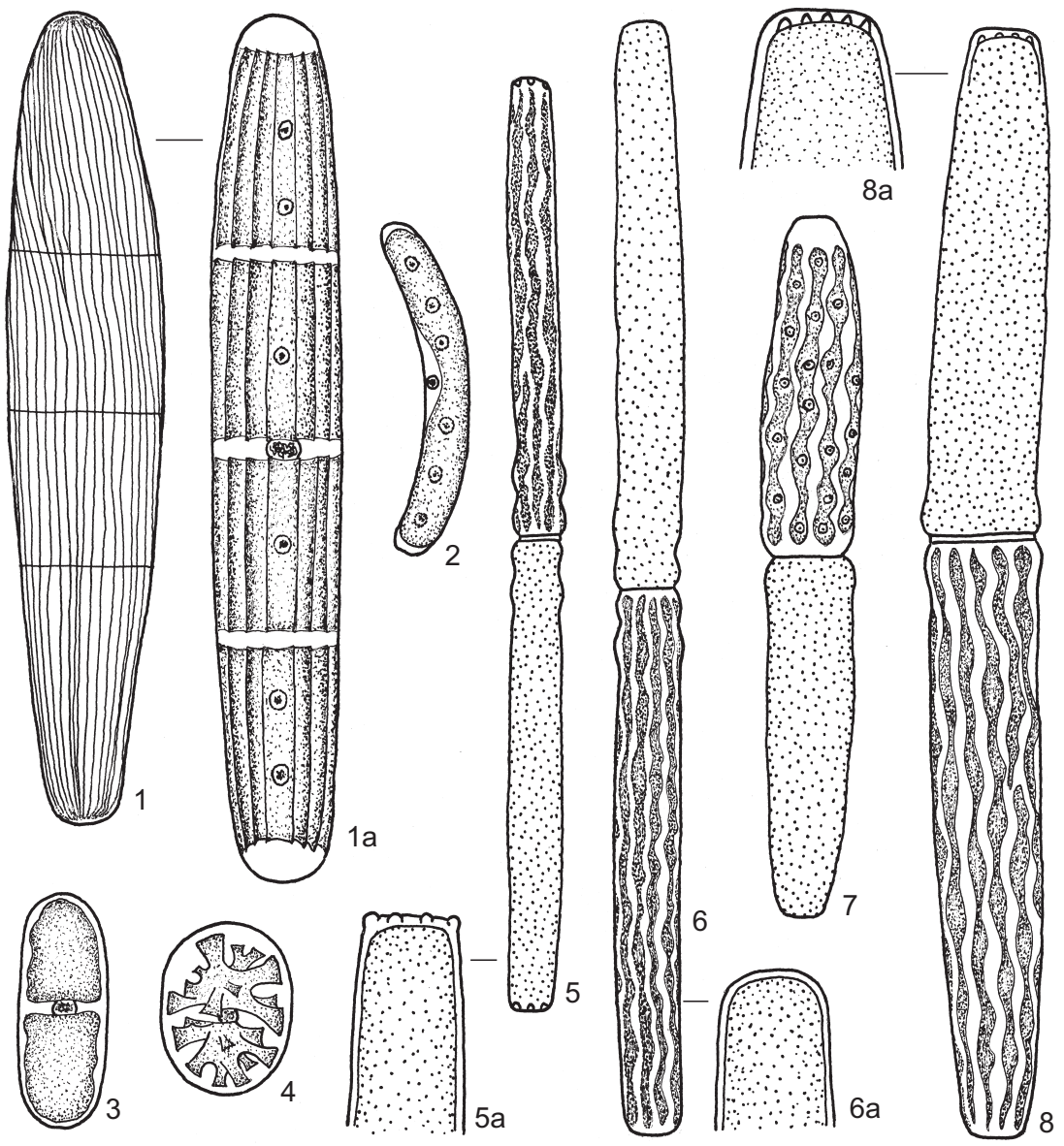

Figure 39. *Penium, Roya, Cylindrocystis, Haplotaenium, Pleurotaenium.* 1, 1a – *Penium spirostriolatum*; 2 – *Roya obtusa*; 3 – *Cylindrocystis brebissonii*; 4 – *C. crassa*; 5, 5a – *Pleurotaenium ehrenbergii*; 6, 6a – *Haplotaenium rectum*; 7, 7a – *Pleurotaenium trabecula*; 8, 8a – *Pl. crenulatum*. Drawings E. Nowotarska.

Pleurotaenium ehrenbergii (Ralfs) de Bary
(Figs 39: 5, 5a; 40: 5a–c; Map 192)

Description. Cells cylindrical, very elongated, with very shallow sinus. Semicells cylindrical, with two basal inflations with parallel margins slightly tapering near convex apices with eight small granules. Cell wall smooth. L: 680–710, W: 35–40, I: 25, L/W: 17–18.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, pH range 6.2, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Pleurotaenium trabecula Nägeli
(Figs 39: 7, 7a; 40: 7; Map 193)

Description. Cells cylindrical, elongated, with very shallow sinus. Semicells cylindrical, with one basal inflation, broadest in mid-region, tapering toward slightly convex apices without granules. Cell wall smooth. L: 305–475, W: 30–50, I: 20–30, L/W: 6.8–15.8.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, puddles on roads, moist soil on roads, wet mosses of *Bryidae* class, puddles, old wells in marshes, temporary waterbodies, oxbow lakes, pH range 6.1–8.0, altitude range 390–1270 m.

Number of localities in the Gorce Mts: 23 (0.056).
Turbacz range: 20 (0.061): **115**, **137**, **262**, **407**.
Lubań range: 3 (0.038): **4**, **21**.
Foothill zone: 1 (0.021), Lower montane zone: 18 (0.056), Upper montane zone: 4 (0.106).

Roya West et G. S. West

Roya obtusa (Brébisson) West et G. S. West
(Figs 39: 2; 40: 2; Map 194)

Description. Cells cylindrical in outline, slightly curved, with rounded poles. Single chloroplast with prominent notch in middle and with central row of pyrenoids. L: 37.5–112.5, W: 5–10, L/W: 4.8–22.5.

Notes. Specimens belonging to var. *montana* West et G. S. West were also recorded very often in the material; they can be distinguished by their smaller size.

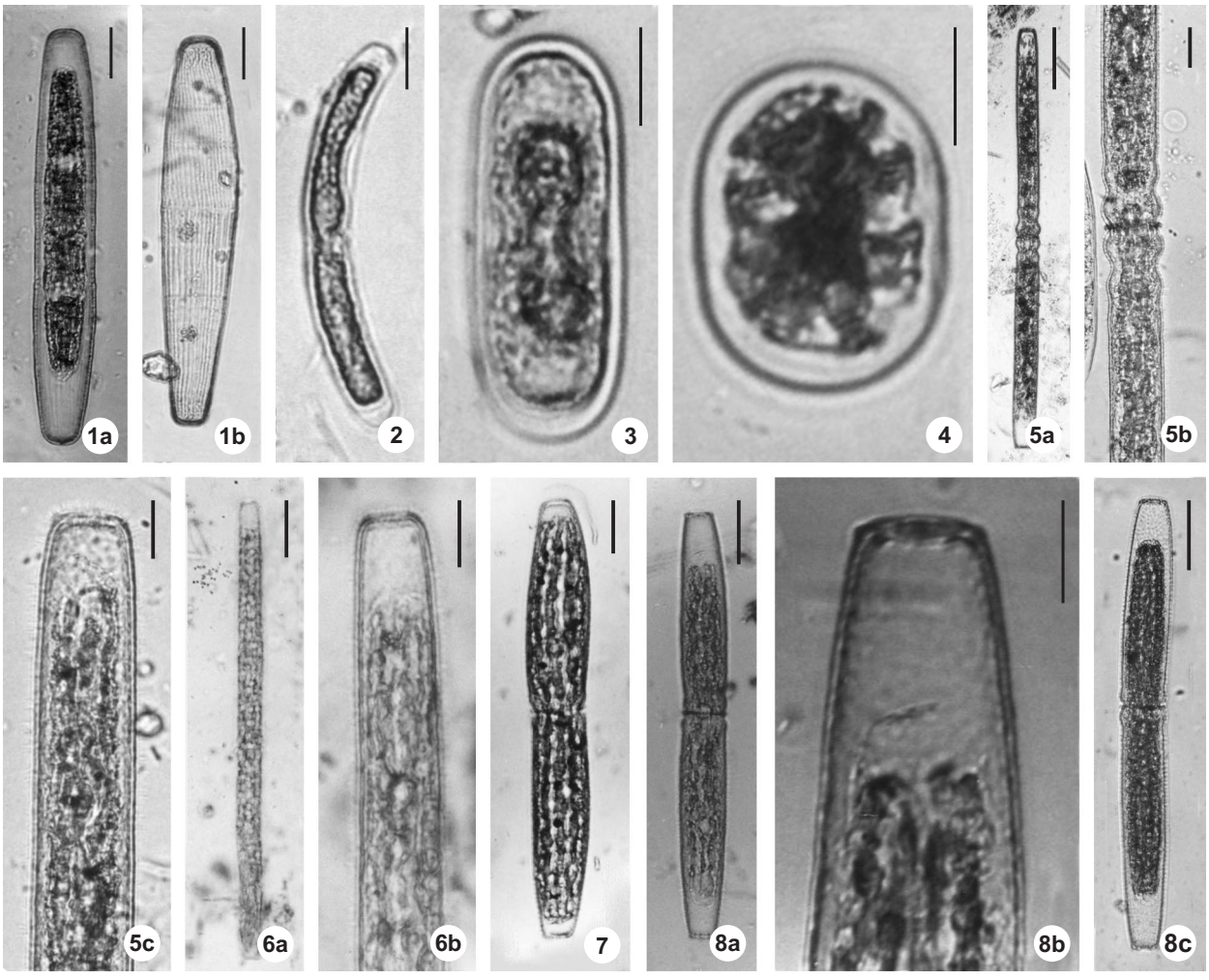

Figure 40. *Penium, Roya, Cylindrocystis, Haplotaenium, Pleurotaenium*. 1a–b – *Penium spirostriolatum*; 2 – *Roya obtusa*; 3 – *Cylindrocystis brebissonii*; 4 – *C. crassa*; 5a–c – *Pleurotaenium ehrenbergii*; 6a–b – *Haplotaenium rectum*; 7 – *Pleurotaenium trabecula*; 8a–c – *Pl. crenulatum*. Scales: 1a–b, 5c, 6b, 8b = 20 µm; 2–4 = 10 µm; 5a = 100 µm; 5b = 25 µm; 6a, 8a, c = 50 µm; 7 = 30 µm. LM by M. Wayda.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, puddles on roads and paths, moist soil on roads, wet mosses of *Bryidae* class and puddles in marshes, pH range 5.7–7.5, altitude range 670–1270 m.

Number of localities in the Gorce Mts: 19 (0.046).
Turbacz range: 19 (0.058): **160**, **185**, **251**, **268**, **382**.
Lubań range: Not recorded.
Lower montane zone: 15 (0.037), Upper montane zone: 4 (0.103).

Spirotaenia Brébisson

Spirotaenia condensata Brébisson (Figs 33: 10; 34: 10; Map 195)

Description. Cells cylindrical in outline, tapering to rounded poles. Chloroplast in the form of a ribbon tightly twisted ~7 times. Pyrenoids numerous and diffused. L: 87.5, W: 15, L/W: 5.8.

Distribution in Poland. Species frequently reported, probably common in the whole country.

Habitat. Puddles on roads, pH range 5.8, altitude range 960 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **280**.
Lubań range: Not recorded.
Lower montane zone: 1 (0.003).

Spirotaenia obscura Ralfs (Figs 33: 9; 34: 9; Map 196)

Description. Cells elliptical, gradually tapering to broadly rounded poles. Single chloroplast with prominent spiraling ridges and with 3–5 pyrenoids. L: 90–100, W: 20, L/W: 4.5–5.0.

Distribution in Poland. Sudetes Mts (Grönblad 1926), Carpathian Mts (Gutwiński 1897), Silesian Lowland (Kirchner 1878), Mazovian Lowland (Tomaszewicz 1988).

Habitat. Puddles on roads, wet mosses of *Bryidae* class in marshes, pH range 7.4, altitude range 750–820 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 2 (0.006): **159**, **217**.
Lubań range: Not recorded.
Lower montane zone: 2 (0.006).

Spondylosium Brebisson ex Kützing

Spondylosium pulchellum (W. Archer) W. Archer [*Sphaerozosma pulchellum* (W. Archer)] (Figs 47: 4; 48: 4; Map 197)

Description. Cells united into filamentous coenobia. Cells hexagonal, deeply constricted. Sinus linear, closed. Semicells trapezoidal, with slightly concave apices and concave margins. Lower and apical angles rounded. Top view elliptical. Cell wall smooth. L: 10, W: 10, I: 5, L/W: 1.0.

Notes. Only specimens belonging to var. *bambusinoides* (Wittrock) Lundell were recorded in the material.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic pond, pH range 6.5–7.0, altitude range 960 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **360**.
Lubań range: Not recorded.
Lower montane zone: 1 (0.003).

Staurastrum Meyen ex Ralfs

Staurastrum aculeatum Meneghini ex Ralfs [*St. trachynotum* West var. *annulatum*] (Figs 41: 13, 13a; 42: 13a–b; Map 198)

Description. Cells hexagonal, deeply constricted. Sinus open, triangular, with acute apex. Semicells subfusiform, with slightly convex apices and slightly convex margins. Lower angles rounded, apical angles outstretched into short, stout appendices. Top view triangular, with rounded angles furnished with six appendices, each with two short spines. Cell wall ornamented with some stout spines. L: 45–50, W: 50, I: 15–20, L/W: 0.9–1.0.

Distribution in Poland. Carpathian Mts (Gutwiński 1909), Southern Wielkopolska Lowland (Lesiak 1990), Masurian Lakeland (Szymańska 1984).

Habitat. Polyhumic pond, *Sphagnum* puddles, pH range 6.3–7.2, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Staurastrum acutum var. *varians* (Raciborski) Coesel & Meesters [*St. varians* Raciborski] (Figs 45: 5; 46: 5; Map 199)

Description. Cells hexagonal, deeply constricted. Sinus open, nearly rectangular, with acute apex. Semicells hexagonal, with abrupt apices and straight margins. Lower angles rounded, middle and apical angles acute. Top view triangular, with rounded angles and slightly convex margins. Cell wall furnished with concentric, dense rows of small granules around angles. L: 35–40, W: 35–40, I: 15, L/W: 1.0.

Distribution in Poland. Sudety Mts (Schröder 1897), Carpathian Mts (Gutwiński 1909).

Habitat. Polyhumic waterbodies, puddles on roads, puddle in marsh, pH range 5.9–7.1, altitude range 370–870 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 1 (0.003): **407**.
Lubań range: 1 (0.013): **21**.
Foothill zone: 1 0.021), Lower montane zone: 1 (0.003).

Staurastrum alternans Brébisson [*Cos. alternans* (Brébisson) Palamar-Mordvintseva] (Figs 41: 2, 2a; 42: 2a–c; Map 200)

Description. Cells rectangular, deeply constricted. Sinus open, triangular, with rounded apex. Semicells elliptical,

with flat apices and convex margins. Lower and apical angles rounded. Top view triangular, with rounded angles and concave margins. Angles of both semicells arranged alternately. Cell wall furnished with concentric rows of granules near angles and chaotically arranged granules in central part of each semicell. L: 25–30, W: 25–27.5, I: 10–15, L/W: 1.0–1.2.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, pH range 5.3–7.1, altitude range 870–960 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 1 (0.003): **360**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 2 (0.005).

Staurastrum arcuatum Nordstedt
(Figs 41: 12, 12a; 42: 12a–b; Map 201)

Description. Cells hexagonal, deeply constricted. Sinus open, triangular, with acute apex. Semicells fusiform, with flat apices, furnished with bifurcate spines and slightly convex margins. Lower angles rounded, apical angles outstretched into bifurcate appendices. Top view triangular, with acute angles extending into spines and concave margins; six bifurcate appendices visible. Series of granules near angles. L: 25–30, W: 25–30, I: 10–12.5, L/W: 1.0.

Distribution in Poland. Not recorded.

Habitat. Polyhumic pond, pH range 6.0, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Staurastrum avicula Brébisson [*St. papilosum* Kirchner, *Rhaphidiastrum avicula* (Brébisson) Palamar-Mordvintseva] (Figs 41: 7; 42: 7; Map 202)

Description. Cells hexagonal, deeply constricted. Sinus open, parallel in apical part. Semicells semi-elliptical, with slightly convex apices and strongly convex margins. Lower angles rounded, apical angles outstretched into single divergent appendices. Top view triangular, with acute angles outstretched into single appendices and concave margins. Cell wall furnished with concentric rows of granules near angles. L: 30–35, W: 25–35, I: 12.5–15, L/W: 1.0–1.2.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. Polyhumic waterbodies, pH range 6.0–7.1, altitude range 870–960 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 1 (0.003): **360**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 2 (0.005).

Staurastrum bieneanum Rabenhorst
(Figs 41: 8, 8a; 42: 8a–b; Map 203)

Description. Cells broadly elliptical, deeply constricted. Sinus parallel in apical part, broadening in outer part. Semicells elliptical to hexagonal, with abrupt, sometimes convex apices and convex margins. Lower and apical angles rounded. Top view triangular, with rounded angles and concave margins. Cell wall punctate. L: 30–40, W: 30–40, I: 10–20, L/W: 1.0–1.2.

Distribution in Poland. Wielkopolska Lowland (Dąmbska et al. 1978, Torka 1930), Mazovian Lowland (Ligowski 1974, Tomaszewicz 1988), Sudety Mts and Silesian Lowland (Grönblad 1926, Schröder 1896).

Habitat. *Sphagnum* puddles, polyhumic pond, pH range 5.7–7.2, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Staurastrum botrophilum Wolle
(Figs 41: 5; 42: 5a–b; Map 204)

Description. Cells hexagonal, deeply constricted. Sinus parallel in apical part, broadening in outer part. Semicells trapezoidal, with abrupt apices and convex margins. Lower and apical angles rounded. Top view triangular, with rounded angles and concave margins. Cell wall furnished with concentric rows of granules near angles. L: 50, W: 40, I: 15, L/W: 0.9–1.25.

Distribution in Poland. Recorded from Sudety Mts (Grönblad 1926) but without documentation.

Habitat. Wet mosses of *Bryidae* class in marsh, pH range 7.5, altitude range 610 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **5**.
Lower montane zone: 1 (0.003).

Staurastrum capitulum Brébisson [*St. amoenum* Hilse]
(Figs 41: 1, 1a; 42: 1a–b; Map 205)

Description. Cells rectangular, with shallow constriction. Sinus very shallow, open, with acute apex. Semicells bell-shaped, with slightly concave apices and concave margins. Apical part of semicell broader than basal part; two large granules near base. Lower angles rounded, apical angles strongly convex. Top view triangular, with rounded angles and straight margins. Some concentric rows of small granules near angles; rows of large, double granules below isthmus on each semicell. L: 40, W: 20–25, I: 15, L/W: 1.6–2.0.

Distribution in Poland. Lublin Upland (Eichler 1890), Sudety Mts and Silesian Lowland (Bach 1872, Hilse 1866, Grönblad 1926, Kirchner 1878, Schröder 1896), Carpathian Mts (Gutwiński 1897, 1909, Wasylik 1961).

Habitat. *Sphagnum* puddles, puddles on roads, pH range 4.9–6.1, altitude range 610–1050 m.

Number of localities in the Gorce Mts: 3 (0.002).
Turbacz range: 2 (0.006): **137**, **278**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 3 (0.009).

Staurastrum controversum Brébisson ex Ralfs
(Figs 41: 11, 11a; 42: 11a–b; Map 206)

Description. Cells hexagonal, deeply constricted. Sinus open, triangular, with acute apex. Semicells semi-elliptical, with convex apices and convex margins. Lower angles rounded, apical angles outstretched into short, stout and convergent appendices with three granules. Top view triangular, with angles outstretched into short appendices that are all bent in one direction, and slightly concave margins. Cell wall furnished with short, stout, sometimes bifurcate spines, mostly on apical part of semicells and on appendices. L: 25 (30), W: 25, I: 12.5, L/W: 1.0.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. Polyhumic pond, pH range 6.5–7.0, altitude range 960 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **360**.
Lubań range: Not recorded.
Lower montane zone: 1 (0.003).

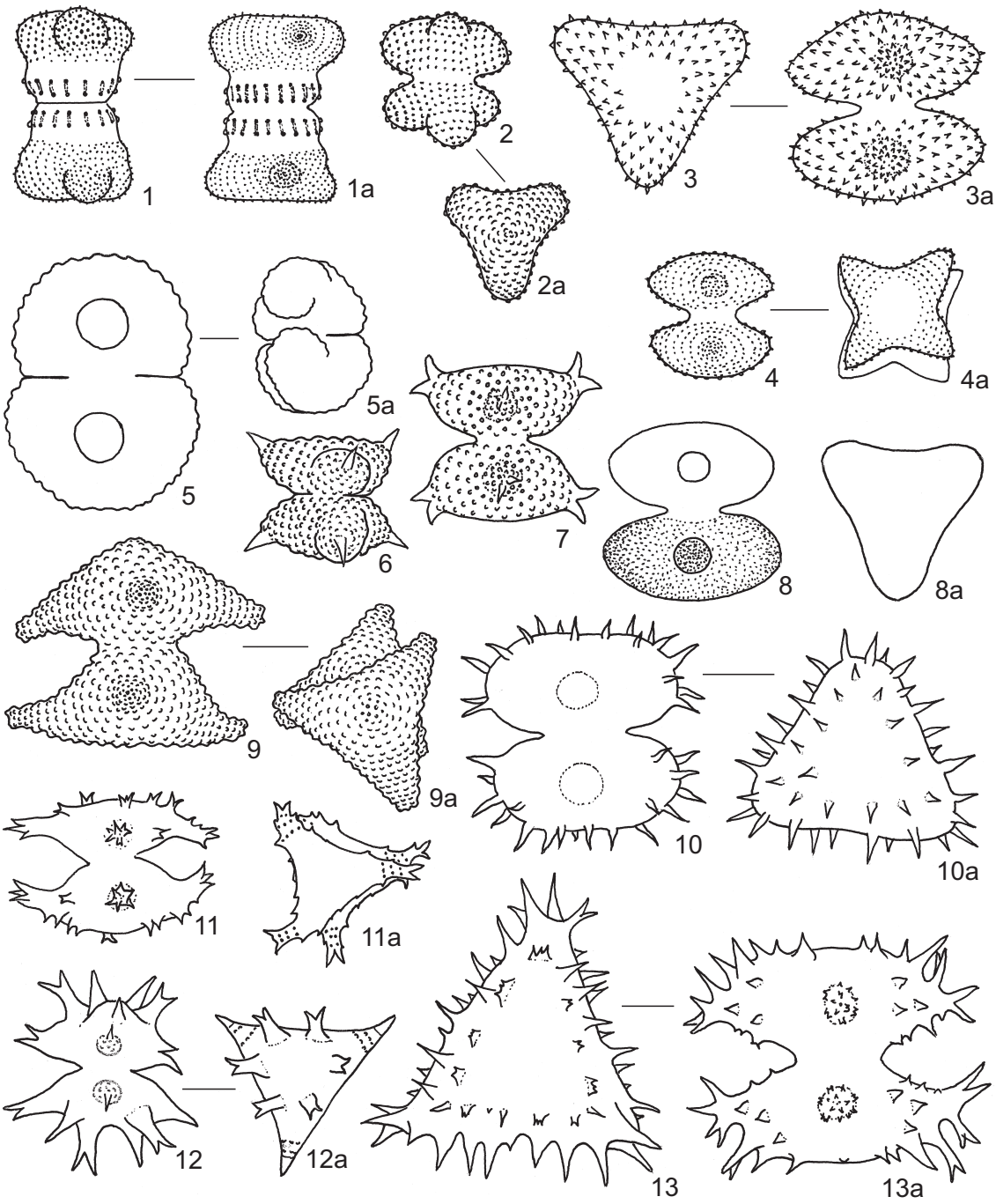

Figure 41. *Staurastrum.* 1, 1a – *Staurastrum capitulum*; 2, 2a – *St. alternans*; 3, 3a – *St. pilosum*; 4, 4a – *St. dispar*; 5 – *St. botrophilum*; 6 – *St. lunatum*; 7 – *St. avicula*; 8, 8a – *St. bieneanum*; 9, 9a – *St. hexacerum*; 10, 10a – *St. teliferum* var. *gladiosum*; 11, 11a – *St. controversum*; 12, 12a – *St. arcuatum*; 13, 13a – *St. aculeatum*. Drawings E. Nowotarska.

Staurastrum cyrtocerum var. *inflexum* (Brébisson) Coesel & Meesters [*St. inflexum* Brébisson]
(Figs 43: 3, 3a; 44: 3a–b; Map 207)

Description. Cells hexagonal, deeply constricted. Sinus widely open, with acute apex. Semicells cup-shaped, with convex apices and margins. Lower angles rounded, apical angles outstretched into short, slightly incurved appendices with two acute granules. Top view triangular, with angles outstretched into short appendices and concave margins. Cell wall furnished with concentric rows of small granules around angles, very prominent on appendices. L: 20–25, W: 12.5 (25) – 15 (30), I: 10–15, L/W: 1.7.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, pH range 6.0–7.1, altitude range 870–960 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 1 (0.003): **360**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 2 (0.005).

Staurastrum dispar Brébisson [*Cos. dispar* (Brébisson) Palamar-Mordvintseva]
(Figs 41: 4, 4a; 42: 4a–b; Map 208)

Description. Cells quadrangular, deeply constricted. Sinus open, triangular, with acute apex. Semicells elliptico-rhomboidal, with convex apices and margins. Lower and apical angles rounded. Top view quadrangular, with acute angles furnished with very short bifurcate appendices. Cell wall furnished with concentric rows of granules around the angles. L: 25, W: 25, I: 10–15, L/W: 1.0.

Distribution in Poland. Mazovian Lowland (Tomaszewicz 1988), Sudety Mts and Silesian Lowland (Hilse 1866, Grönblad 1926), Wyżyna Śląska (Sieminiak 1984).

Habitat. *Sphagnum* puddles, pH range 6.0–6.3, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Staurastrum furcatum Brébisson [*St. detonii* Eichler et Gutwiński, *St. spinosum* Ralfs]
(Figs 45: 11; 46: 11; Map 209)

Description. Cells hexagonal, deeply constricted. Sinus open, triangular, with acute apex. Semicells elliptical, with convex apices and convex margins. Lower angles rounded, middle and apical angles outstretched into short, stout bifurcate appendices arranged in horizontal direction. Top view triangular, with acute angles outstretched into short appendices and slightly concave margins. Cell wall smooth. L: 25–30, W: 25–30, I: 10–12.5, L/W: 1.0.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic pond, pH range 6.8–7.1, altitude range 870 m.

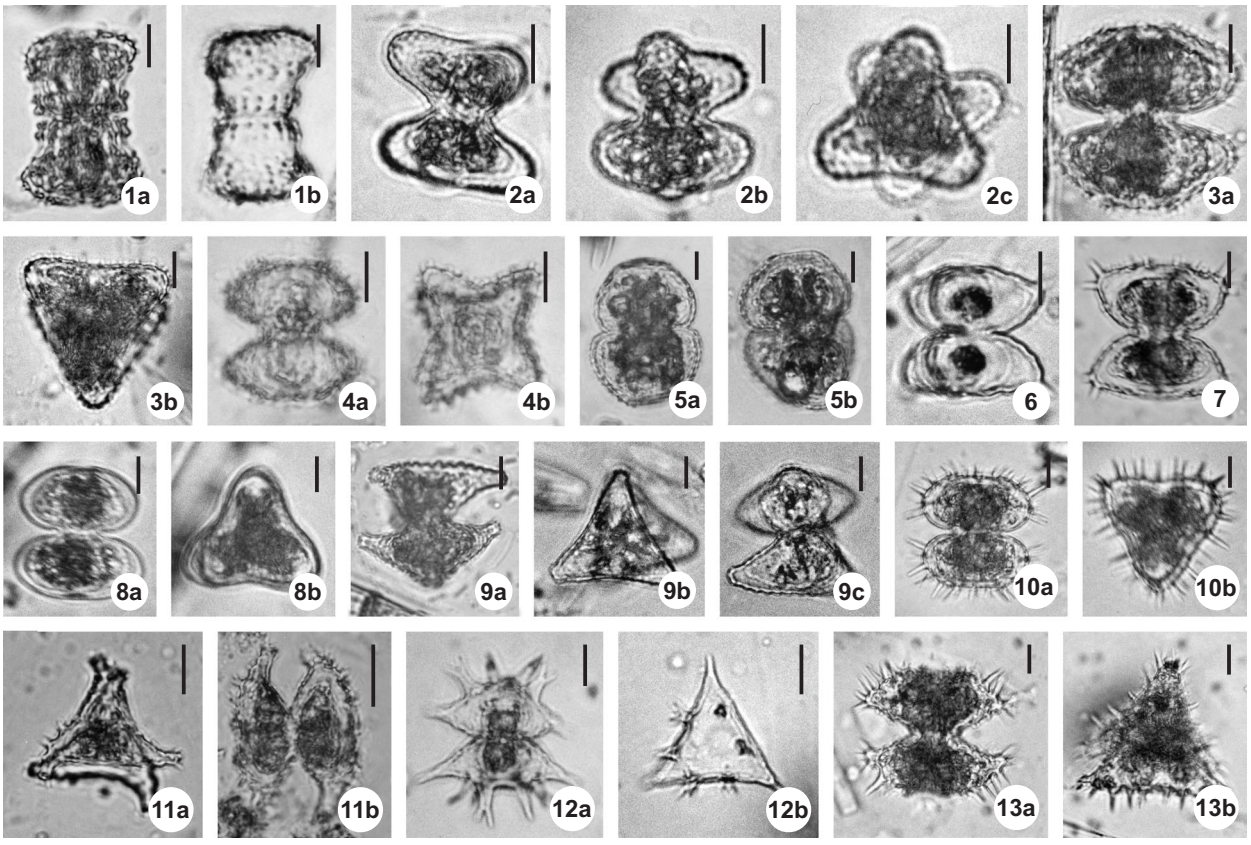

Figure 42. *Staurastrum*. 1a–b – *Staurastrum capitulum*; 2a–c – *St. alternans*; 3a–b – *St. pilosum*; 4a–b – *St. dispar*; 5a–b – *St. botrophilum*; 6 – *St. lunatum*; 7 – *St. avicula*; 8a–b – *St. bieneanum*; 9a–9c – *St. hexacerum*; 10a–b – *St. teliferum* var. *gladiosum*; 11a–b – *St. controversum*; 12a–b – *St. arcuatum*; 13a–b – *St. aculeatum*. Scales = 10 µm. LM by M. Wayda.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Staurastrum hexacerum Wittrock [*St. tricorne* Meneghini ex Ralfs] (Figs 41: 9, 9a; 42: 9a–c; Map 210)

Description. Cells hexagonal, deeply constricted. Sinus broadly open, with acute apex. Semicells fusiform, with strongly convex apices and convex margins. Lower angles rounded, apical angles outstretched into short, stout appendices with three granules. Top view triangular, with rounded angles and slightly concave margins. Cell wall furnished with concentric rows of small granules around angles. L: 40–50, W: 35–40, I: 10–15, L/W: 1.0–1.3.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. Oxbow lakes, temporary waterbodies, puddles on roads, pH range 7.5–9.2, altitude range 750–880 m.

Number of localities in the Gorce Mts: 4 (0.01).
Turbacz range: 3 (0.009): **147**, **289**, **294**.
Lubań range: 1 (0.013): **10**.
Lower montane zone: 4 (0.012).

Staurastrum hirsutum Ehrenberg ex Ralfs [*Cos. hirsutum* (Ralfs) Palamar-Mordvintseva] (Figs 43: 12, 12a; 44: 12a–b; Map 211)

Description. Cells nearly elliptical, deeply constricted. Sinus open, parallel in apical part, with acute apex. Semicells trapezoidal to semi-elliptical, with abrupt or convex apices and convex margins. Lower and apical angles rounded. Top view triangular, with rounded angles and convex margins. Cell wall furnished with concentric rows of very thin spines around angles. L: 40–50, W: 35–40, I: 10–15, L/W: 1.0–1.3.

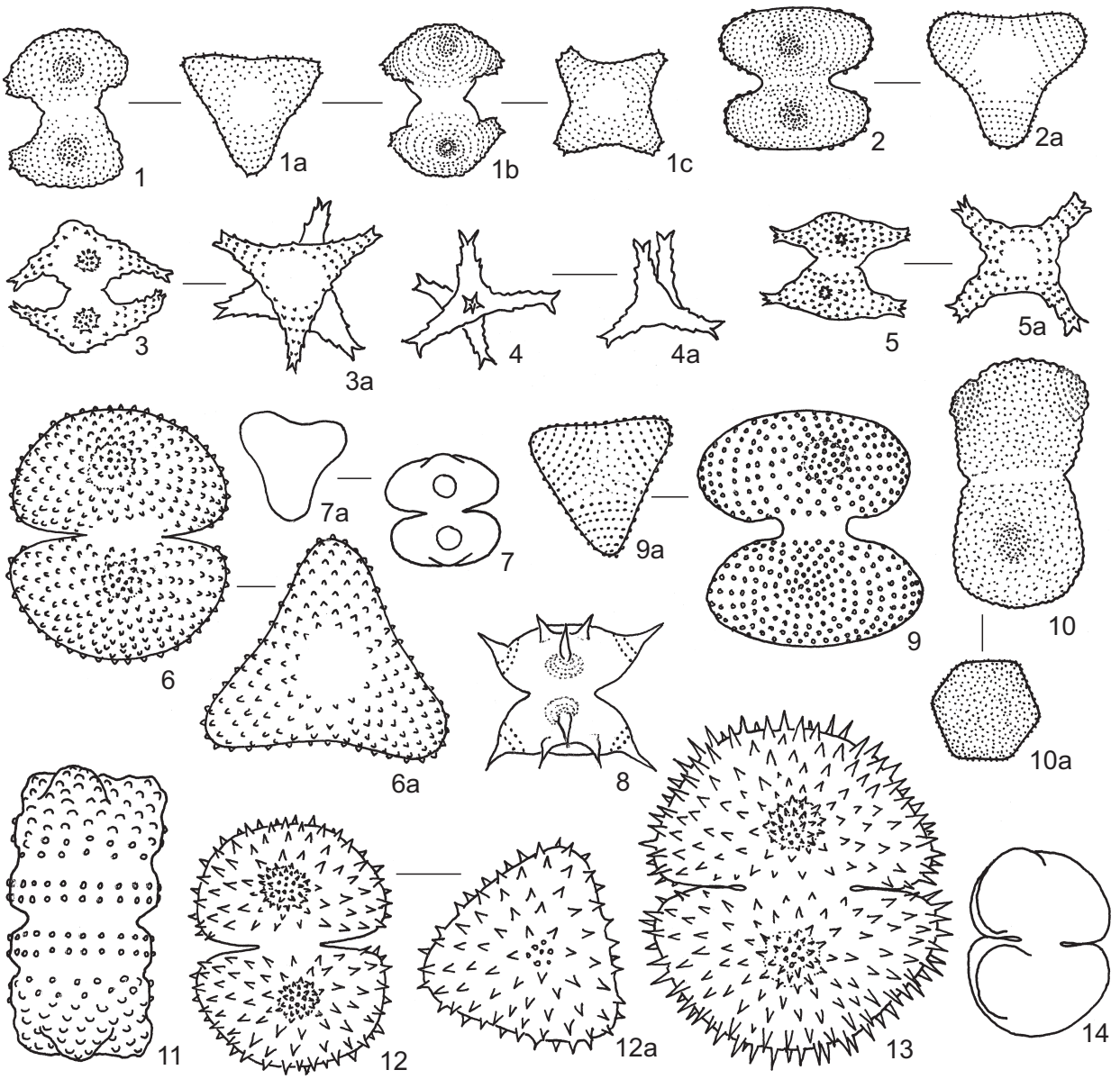

Figure 43. *Staurastrum*. 1, 1a–c – *Staurastrum margaritaceum*; 2, 2a – *St. lapponicum*; 3, 3a – *St. cyrtocerum*; 4, 4a – *St. tetracerum*; 5, 5a – *St. polymorphum*; 6, 6a – *St. muricatum*; 7, 7a – *St. muticum*; 8 – *St. pungens*; 9, 9a – *St. punctulatum*; 10, 10a – *St. merianii*; 11 – *St. pileolatum*; 12, 12a – *St. hirsutum*; 13 – *St. pyramidatum*; 14 – *St. orbiculare*. Drawings E. Nowotarska.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, puddles on roads and paths, moist soil on roads, old wells, pH range 4.9–7.3, altitude range 570–1270 m.

Number of localities in the Gorce Mts: 27 (0.063).
Turbacz range: 27 (0.081): **96**, **155**, **246**, **357**, **382**.
Lubań range: Not recorded.
Foothill zone: 1 (0.02), Lower montane zone: 15 (0.005), Upper montane zone: 11 (0.28).

Staurastrum lapponicum (Schmidle) Grönblad [*Cos. lapponicum* (Schmidle) Palamar-Mordvintseva]
(Figs 43: 2, 2a; 44: 2a–b; Map 212)

Description. Cells square, deeply constricted. Sinus widely open, with rounded apex. Semicells elliptical, with flattened apices and convex margins. Lower and apical angles rounded. Top view triangular, with rounded angles and concave margins. Cell wall furnished with concentric rows of very small granules around angles. L: 30, W: 30, I: 12.5, L/W: 1.0.

Notes. The specimens from the Gorce Mts belong to fo. *depressa* Jackson.

Distribution in Poland. Sudety Mts (Grönblad 1926), Carpathian Mts (Mrozińska 1989), Mazovian Lowland (Tomaszewicz 1988), Masurian Lakeland (Szymańska 1984).

Habitat. Moist soil on road, pH range 6.5, altitude range 750 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **118**.
Lubań range: Not recorded.
Lower montane zone: 1 (0.003).

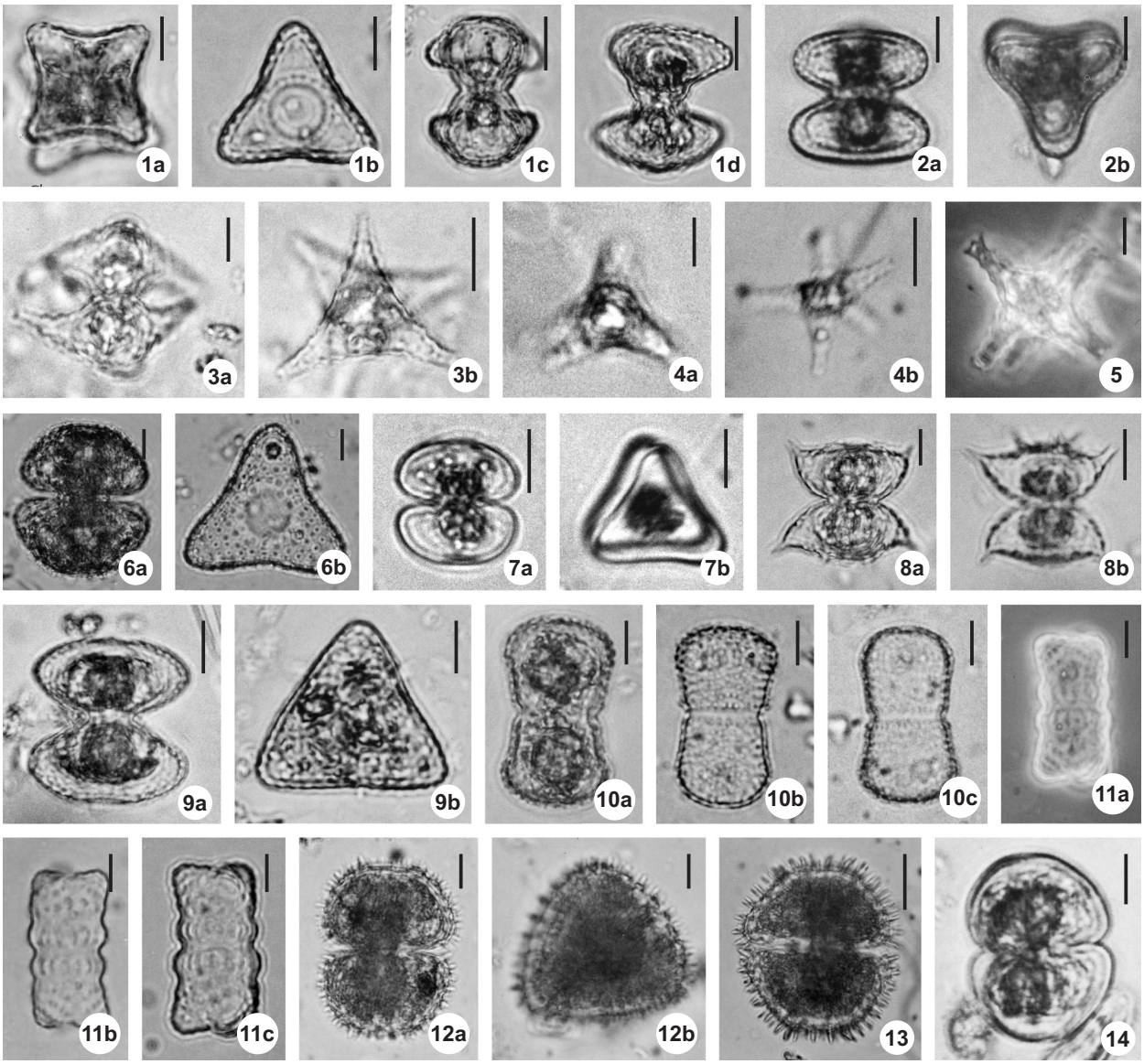

Figure 44. *Staurastrum*. 1a–d – *Staurastrum margaritaceum*; 2a–b – *St. lapponicum*; 3a–b – *St. cyrtocerum*; 4a–b – *St. tetracerum*; 5 – *St. polymorphum*; 6a–b – *St. muricatum*; 7a–b – *St. muticum*; 8a–b – *St. pungens*; 9a–b – *St. punctulatum*; 10a–c – *St. merianii*; 11a–c – *St. pileolatum*; 12a–b – *St. hirsutum*; 13 – *St. pyramidatum*; 14 – *St. orbiculare*. Scales: 1a–3b, 6a–12b, 14 = 10 µm; 4a–5 = 5 µm; 13 = 20 µm. LM by M. Wayda.

Staurastrum lunatum Ralfs
(Figs 41: 6; 42: 6; Map 213)

Description. Cells hexagonal, deeply constricted. Sinus open, triangular, with acute apex. Semicells cup-shaped, with slightly convex apices and strongly convex margins. Lower angles rounded, apical angles with single stout spines. Top view triangular, with angles furnished with single spines and concave margins. Cell wall furnished with concentric rows of very small granules around angles. L: 20–30, W: 25, I: 10–18, L/W: 0.8–1.2.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. Polyhumic pond, pH range 6.9–7.2, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Staurastrum margaritaceum Meneghini ex Ralfs
(Figs 43: 1, 1a–c; 44: 1a–d; Map 214)

Description. Cells hexagonal, deeply constricted. Sinus broadly open, with acute apex. Semicells fusiform, hexagonal or bell-shaped. Apices abrupt or convex, margins convex. Lower angles rounded, apical angles outstretched into short, stout, often incurved appendices. Top view triangular or square, with angles outstretched into short appendices and concave margins. Cell wall furnished with concentric rows of small granules around angles. Sometimes a row of prominent granules below isthmus. L: 25–35, W: 20–30, I: 10–15, L/W: 1.2–2.0.

Notes. The species is quite variable and often displays high polymorphism within a population.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on ground roads and paths, puddles and old wells in marshes, moist soil o roads, pH range 3.7–7.5, altitude range 610–1240 m.

Number of localities in the Gorce Mts: 51 (0.12).
Turbacz range: 47 (0.14): **85**, **120**, **162**, **172**, **185**, **217**.
Lubań range: 4 (0.05): **3**, **21**.
Lower montane zone: 35 (0.11), Upper montane zone: 16 (0.41).

Staurastrum merianii Reinsch [*Ca. cylindrus* Kirchner b. *hexagona* Raciborski, *St. hexagonum* (Raciborski) Raciborski] (Figs 43: 10, 10a; 44: 10a–c; Map 215)

Description. Cells nearly rectangular, with shallow constriction. Sinus shallow and narrow. Semicells rec- tangular to trapezoidal, broader in apical than basal part. Apices flattened or slightly convex, margins slightly concave in apical parts. Lower and apical angles rounded. Top view hexagonal, with broadly rounded angles and straight margins. Cell wall furnished with concentric rows of very small granules around angles. Cell wall free of granules below isthmus. L: 40–47.5, W: 17–25, I: 10–15, L/W: 1.8.

Distribution in Poland. Carpathian Mts (Gutwiński 1897, 1909).

Habitat. Wet mosses of *Bryidae* class, puddles and old wells in marshes, moist soil on roads, oxbow lakes, pH range 7.2–8.4, altitude range 520–1230 m.

Number of localities in the Gorce Mts: 31 (0.076).
Turbacz range: 27 (0.082): **80**, **85**, **109**, **134**, **175**, **240**, **280**.
Lubań range: 4 (0.051): **16**, **52**, **66**.
Foothill zone: 1 (0.042), Lower montane zone: 27 (0.085), Upper montane zone: 3 (0.077).

Staurastrum muricatum Brébisson ex Ralfs [*Cos. muricatum* (Brébisson) Palamar-Mordvintseva]
(Figs 43: 6, 6a; 44: 6a–b; Map 216)

Description. Cells elliptical, deeply constricted. Sinus parallel in apical part, broadening in outer part, with acute apex. Semicells trapezoidal to elliptical, with abrupt or convex apices and convex margins. Lower and apical angles rounded. Top view triangular, with rounded angles and straight margins. Cell wall furnished with concentric rows of very large conical granules around angles. L: 35–50, W: 30–45, I: 15–20, L/W: 1.0–1.3.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads and paths, moist soil on roads, old wells in marshes, pH range 4.4–8.5, altitude range 610–1260 m.

Number of localities in the Gorce Mts: 39 (0.095).
Turbacz range: 37 (0.112): **145**, **182**, **219**, **369**.
Lubań range: 2 (0.025): **34**.
Lower montane zone: 24 (0.074), Upper montane zone: 15 (0.385).

Staurastrum muticum Brébisson ex Ralfs [*Cos. muticum* (Brébisson) Palamar-Mordvintseva]
(Figs 43: 7, 7a; 44: 7a–b; Map 217)

Description. Cells elliptical, deeply constricted. Sinus open, triangular, with acute apex. Semicells elliptical, with convex apices and margins. Lower and apical angles rounded. Top view triangular, with rounded angles and concave margins. Cell wall smooth. L: 20, W: 20, I: 5–10, L/W: 1.0.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, pH range 4.5–7.2, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Staurastrum orbiculare Meneghinii ex Ralfs [*Cos. orbiculare* (Ralfs) Palamar-Mordvintseva, *St. cordatum* Gay] (Figs 43: 14; 44: 14; Map 218)

Description. Cells circular or elliptical, deeply constricted. Sinus parallel in apical part, broadening in outer part. Semicells elliptical, semicircular or trapezoidal,

with slightly convex or abrupt apices and convex margins. Lower and apical angles rounded. Top view triangular, with rounded angles and concave margins. Cell wall punctate. L: 25–40, W: 25–42.5, I: 10–15, L/W: 1.0–1.6.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads and paths, moist soil on roads and paths, wet mosses of *Bryidae* class in marshes, pH range 5.1–7.5, altitude range 580–1230 m.

Number of localities in the Gorce Mts: 29 (0.071).
Turbacz range: 28 (0.085): **160**, **172**, **185**, **251**.
Lubań range: 1 (0.013): **21**.
Foothill zone: 1 (0.021), Lower montane zone: 23 (0.071), Upper montane zone: 5 (0.128).

Staurastrum oxyacanthum W. Archer [*St. scorpioideum* Delponte var. *brevius* Gutwiński] (Figs 45: 10; 46: 10a–b; Map 219)

Description. Cells hexagonal, deeply constricted. Sinus open, nearly rectangular, with acute apex. Semicells cup-shaped, with convex apices furnished with short, stout spines and convex margins. Lower angles rounded, apical angles outstretched into short, curved appendices furnished with three or four rows of short spines, each with three spines. Top view triangular, with angles outstretched into short appendices and straight margins with two spines. Cell wall furnished with concentric rows of small granules around angles and some granules near isthmus. L: 30–35, W: 15(35) – 20(45), I: 10–15, L/W: 1.5–2.0.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, pH range 5.7–7.1, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Staurastrum pileolatum Brébisson (Figs 43: 11; 44: 11a–c; Map 220)

Description. Cells nearly rectangular, with shallow constriction. Sinus shallow, with acute apex. Semicells rectangular slightly broader in apical parts. Apices slightly concave, margins convex in basal part with two prominent granules, slightly concave in apical part of semicells. Lower angles rounded, apical angles conical. Top view triangular, with rounded angles and slightly concave margins. Cell wall furnished, with concentric rows of small granules around angles and a row of ridges below isthmus. L: 40, W: 20, I: 15, L/W: 2.0.

Distribution in Poland. Sudety Mts (Grönblad 1926), Carpathian Mts (Gutwiński 1897, 1909), Silesian Lowland (Schröter 1884).

Habitat. *Sphagnum* puddles, puddles on roads and paths, moist soil on roads, pH range 4.7–5.8, altitude range 8100–1260 m.

Number of localities in the Gorce Mts: 10 (0.024).
Turbacz range: 9 (0.027): **208**, **249**, **276**, **285**, **296**, **297**, **301**, **306**, **382**.
Lubań range: 1 (0.013): **41**.
Lower montane zone: 5 (0.016), Upper montane zone: 5 (0.128).

Staurastrum pilosum Brébisson [*St. brebissonii* W. Archer] (Figs 41: 3, 3a; 42: 3a–b; Map 221)

Description. Cells broadly elliptical, deeply constricted. Sinus open, triangular, with acute apex. Semicells elliptical to trapezoidal, with abrupt apices and convex margins. Lower and apical angles rounded. Top view triangular, with rounded angles and slightly concave margins. Cell wall furnished with concentric, dense rows of short spines (~2.5 μm long). L: 40–50, W: 40–45, I: 15–20, L/W: 0.9–1.1.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles and old wells in marshes, puddles on paths, puddles and moist soil on roads, pH range 4.9–7.3, altitude range 600–1260 m.

Number of localities in the Gorce Mts: 13 (0.031).
Turbacz range: 12 (0.036): **109**, **137**, **226**, **304**, **371**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 10 (0.031), Upper montane zone: 3 (0.076).

Staurastrum polymorphum Brébisson (Figs 43: 5, 5a; 44: 5; Map 222)

Description. Cells hexagonal, deeply constricted. Sinus open, nearly rectangular, with acute apex. Semicells semi-elliptical, with slightly convex apices and convex margins. Lower angles rounded, apical angles outstretched into short, straight, stout appendices with three short spines. Top view quadrangular, with angles outstretched into short appendices. Cell wall furnished with concentric rows of small granules around angles and four transversal rows of granules. L: 20–25, W: 15 (25), I: 10–15, L/W: 1.3–1.6.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, pH range 6.5–7.0, altitude range 870–960 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 1 (0.003): **360**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 2 (0.005).

Staurastrum polytrichum (Perty) Rabenhorst [*Cos. polytrichum* (Perty) Palamar-Mordvintseva, *St. pringsheimii* Reinsch] (Figs 45: 2; 46: 2a–b; Map 223)

Description. Cells elliptical, deeply constricted. Sinus open, triangular, with acute apex. Semicells elliptical, with

abrupt or convex apices and convex margins. Lower and apical angles rounded. Top view triangular, with rounded angles and straight margins. Cell wall furnished with concentric rows of long and thin spines around angles. L: 60–75, W: 55–70, I: 20–25, L/W: 1.0–1.4.

Distribution in Poland. Species often recorded, but mostly from southern Poland.

Habitat. Puddles on roads and marshes, on moist soil on roads, pH range 6.4–7.9, altitude range 830–1200 m.

Number of localities in the Gorce Mts: 10 (0.024).
Turbacz range: 10 (0.024): **146**, **148**, **155**, **243**, **263**, **271**, **280**, **292**, **295**, **315**.
Lubań range: Not recorded.
Lower montane zone: 8 (0.025), Upper montane zone: 2 (0.051).

Staurastrum proboscideum (Brébisson) W. Archer
(Figs 45: 9, 9a; 46: 9a–b; Map 224)

Description. Cells hexagonal, deeply constricted. Sinus nearly rectangular, with acute apex. Semicells cup-shaped, with convex apices and margins. Lower angles rounded, apical angles outstretched into very short, abrupt appendices. Top view cells triangular, with abrupt angles and slightly concave margins. Cell wall furnished with concentric rows of small granules around angles and transversal row of granules below isthmus. L: 30–40, W: 30–40, I: 15, L/W: 1.0–1.3.

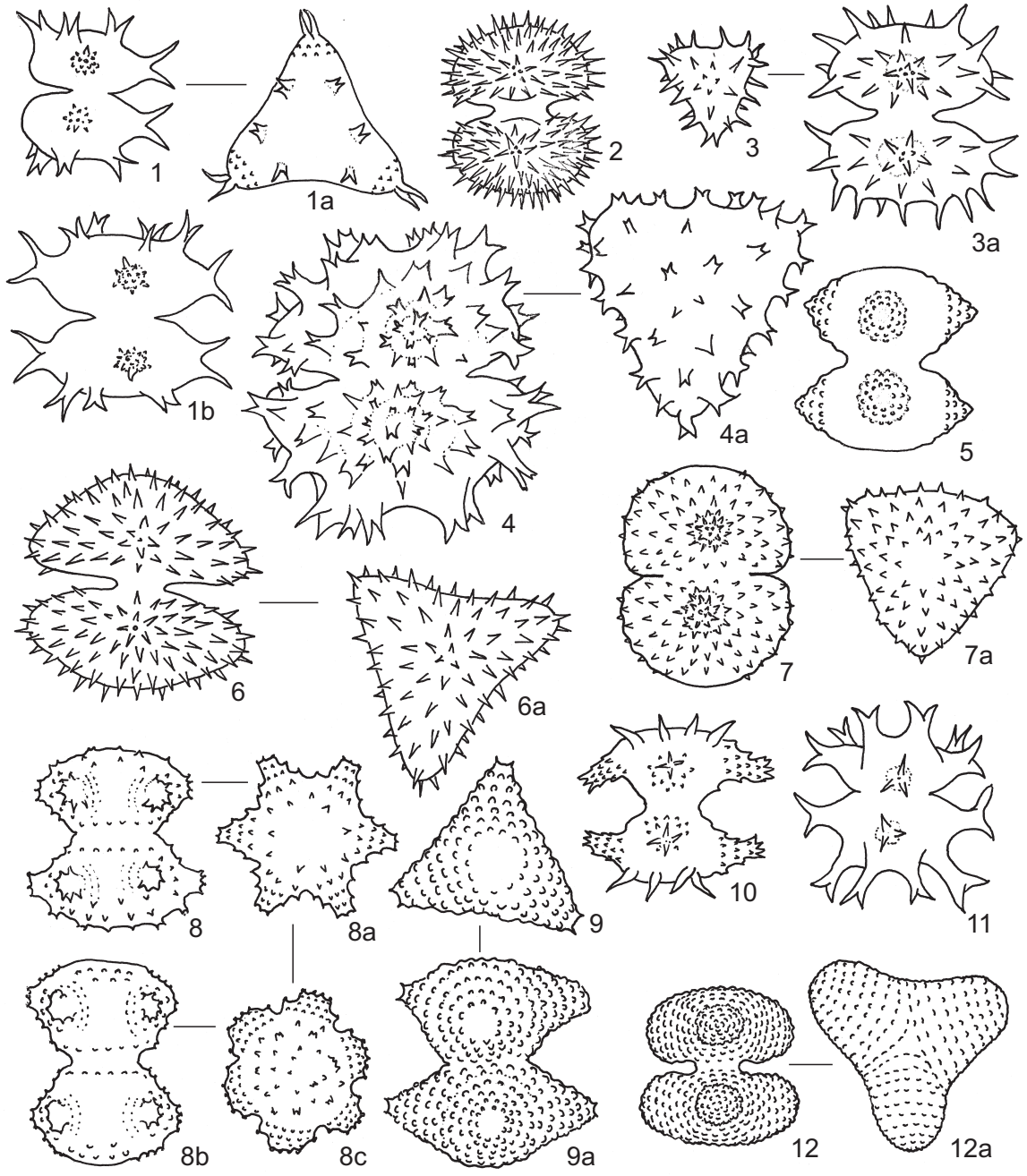

Figure 45. *Staurastrum*. 1, 1a–b – *Staurastrum subavicula*; 2 – *St. polytrichum*; 3, 3a – *St. teliferum*; 4, 4a – *St. spongiosum*; 5 – *St. acutum* var. *varians*; 6, 6a – *St. subbrebissonii*; 7, 7a – *St. scabrum*; 8, 8a–c – *St. sexcostatum*; 9, 9a – *St. proboscideum*; 10 – *St. oxyacanthum*; 11 – *St. furcatum*; 12, 12a – *St. turgescens*. Drawings E. Nowotarska.

Distribution in Poland. Sudety Mts (Grönblad 1926), Carpathian Mts (Gutwiński 1909), Southern Wielkopolska Lowland (Lesiak 1984), Mazovian Lowland (Tomaszewicz 1974).

Habitat. *Sphagnum* puddles, polyhumic waterbodies, pH range 5.9–7.1, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Staurastrum punctulatum Brébisson [*Cos. punctulatum* (Brébisson) Palamar-Mordvintseva, *St. pygmaeum* Brébisson] (Figs 43: 9, 9a; 44: 9a–b; Map 225)

Description. Cells hexagonal, deeply constricted. Sinus open, triangular, with acute apex. Semicells rhomboidal, hexagonal or elliptico-hexagonal, with convex or abrupt apices and convex margins. Lower and apical angles rounded, middle angles sometimes acute. Top view triangular, with rounded angles and straight or slightly concave margins. Cell wall furnished with concentric rows of small granules around angles. L: 25–35, W: 20–35, I: 10–25, L/W: 0.8–1.4.

Notes. Specimens belonging to var. *muricatiforme* (Schmidle) W. West. et G. S West were recorded in the material; they are very similar to *St. muricatum* but are smaller and have smaller granules.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic waterbodies, puddles on roads and paths, moist soil on roads, wet mosses of *Bryidae* class, puddles and old wells in marshes, oxbow lakes, fish ponds, pH range 5.5–9.2, altitude range 520–1240 m.

Number of localities in the Gorce Mts: 97 (0.237).
Turbacz range: 91 (0. 237): **89**, **99**, **158**, **182**, **255**.
Lubań range: 6 (0.0.76): **6**, **21**, **52**, **66**.
Foothill zone: 5 (0.104), Lower montane zone: 78 (0.242), Upper montane zone: 14 (0.358).

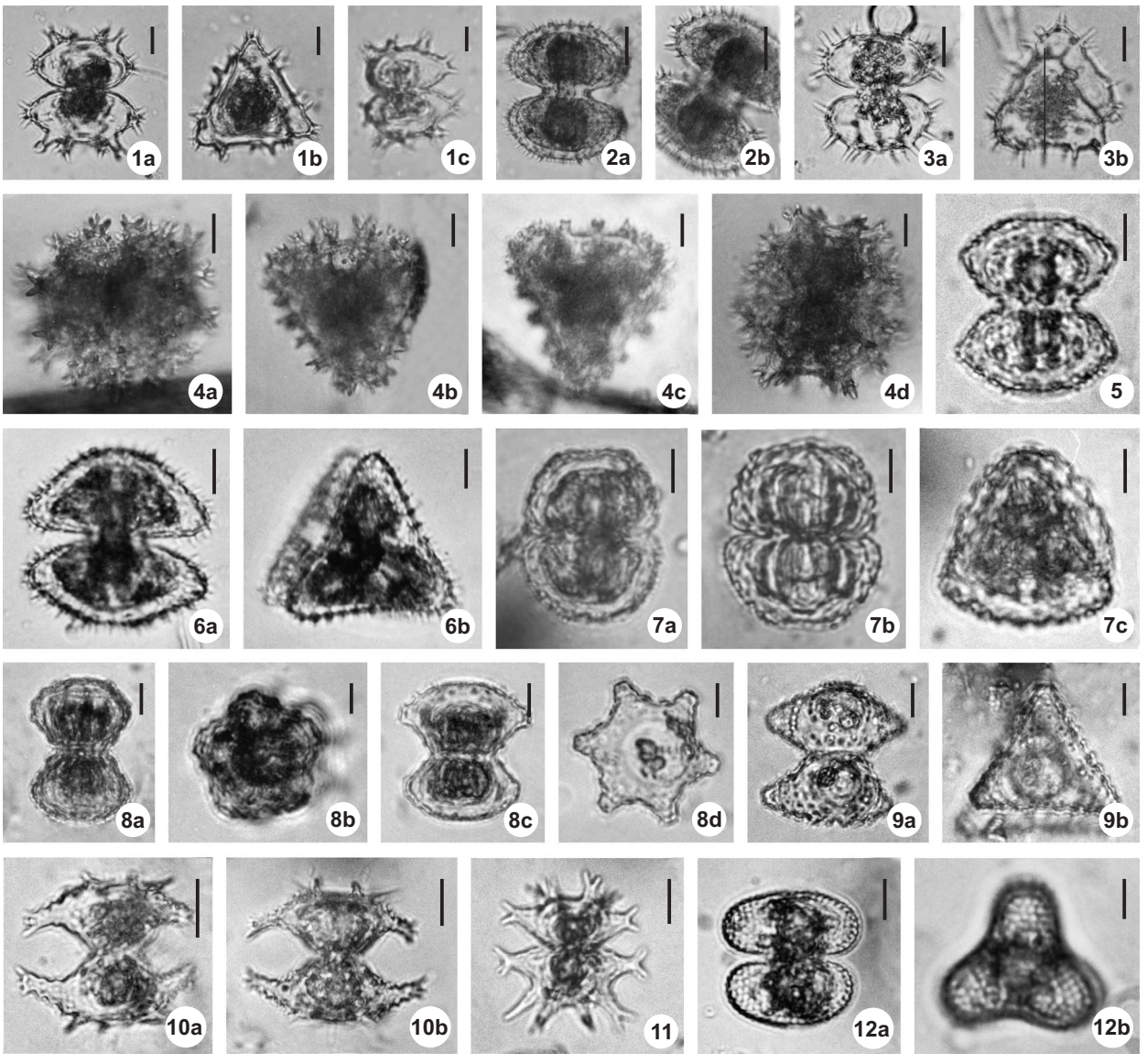

Figure 46. *Staurastrum*. 1a–c – *Staurastrum subavicula*; 2a–b – *St. polytrichum*; 3a–b – *St. teliferum*; 4a–d – *St. spongiosum*; 5 – *St. acutum* var. *varians*; 6a–b – *St. subbrebissonii*; 7a–c – *St. scabrum*; 8a–d – *St. sexcostatum*; 9a–b – *St. proboscideum*; 10a–b – *St. oxyacanthum*; 11 – *St. furcatum*; 12a–b – *St. turgescens*. Scales: 1a–c, 3a–12b = 10 µm; 2a–b = 20 µm. LM by M. Wayda.

Staurastrum pungens Brébisson
(Figs 43: 8; 44: 8a–b; Map 226)

Description. Cells hexagonal, deeply constricted. Sinus open, triangular, with acute apex. Semicells semi- elliptical, with slightly convex apices and strongly convex margins. Lower angles rounded, apical angles outstretched into stout, upward spines. Top view triangular, with angles outstretched into stout spines and six upward spines. Cell wall furnished with concentric rows of small granules around angles. L: 25–30, W: 25, I: 12.5, L/W: 1.2.

Distribution in Poland. Wielkopolska Lowland (Gołowin 1964).

Habitat. Polyhumic pond, pH range 6.0–6.2, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Staurastrum pyramidatum West
(Figs 43: 13; 44: 13; Map 227)

Description. Cells broadly elliptical, deeply constricted. Sinus open, parallel in apical part with acute apex. Semicells broadly trapezoidal, with abrupt apices and convex margins. Lower and apical angles rounded. Top view triangular, with rounded angles and straight margins. Cell wall furnished with dense, concentric rows of long, thin spines around angles. L: 60, W: 50, I: 20, L/W: 1.2.

Distribution in Poland. Not recorded.

Habitat. Puddle in a meadow, pH range 4.8, altitude range 1050 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: 1 (0.003): **226**.
Lubań range: Not recorded.
Lower montane zone: 1 (0.003).

Staurastrum scabrum Brébisson [*Cos. scabrum* (Brébisson) Palamar-Mordvintseva]
(Figs 45: 7, 7a; 46: 7a–c; Map 228)

Description. Cells elliptical, deeply constricted. Sinus parallel in apical part, broadening in outer part, apex acute. Semicells trapezoidal, with abrupt or slightly convex apices and convex margins. Lower and apical angles rounded. Top view triangular, with rounded angles and straight margins. Cell wall furnished with concentric rows of acute granules around angles. L: 40, W: 35, I: 15, L/W: 1.1.

Distribution in Poland. Southern Wielkopolska Lowland (Lesiak 1990), Mazovian Lowland (Tomaszewicz 1988).

Habitat. Moist soil on roads, oxbow lakes, pH range 7.5, altitude range 660–800 m.

Number of localities in the Gorce Mts: 4 (0.01).
Turbacz range: 4 (0.012): **145**, **207**, **239**, **289**.
Lubań range: Not recorded.
Lower montane zone: 4 (0.012).

Staurastrum sexcostatum Brébisson ex Ralfs
(Figs 45: 8, 8a–c; 46: 8a–d; Map 229)

Description. Cells hexagonal, deeply constricted. Sinus open, nearly rectangular, with acute apex. Semicells elliptical to hexagonal, with abrupt or slightly convex apices and convex margins. Lower angles rounded, apical angles outstretched into short, stout appendices. Top view star-shaped, with obtuse arms. Cell wall furnished with large, acute granules on appendices, near margins and apices of semicells, and below isthmus. L: 40–45, W: 30–40, I: 12.5–20, L/W: 1.0–1.3.

Notes. Specimens belonging to the var. *productum* were recorded in the material; they have longer appendices and larger granules.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, puddles on roads, paths and marshes, moist soil on roads, pH range 5.9–8.1, altitude range 570–1270 m.

Number of localities in the Gorce Mts: 17 (0.042).
Turbacz range: 15 (0.045): **96**, **160**, **163**, **246**, **280**.
Lubań range: 2 (0.025): **21**, **69**.
Foothill zone: 1 (0.021), Lower montane zone: 14 (0.043), Upper montane zone: 2 (0.051).

Staurastrum spongiosum Brébisson ex Ralfs
(Figs 45: 4, 4a; 46: 4a–d; Map 230)

Description. Cells hexagonal, deeply constricted. Sinus parallel in apical part, broadening in outer part, apex acute. Semicells trapezoidal, with abrupt apices and convex margins. Lower and apical angles rounded, ended with bifurcate appendices. Top view triangular, with rounded angles and straight margins. Cell wall furnished with short, thick and bifurcate appendices. L: 50 (55), W: 40 (45), I: 15–20, L/W: 1.25.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. *Sphagnum* puddles, puddles on roads, pH range 5.9–6.5, altitude range 680–870 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 1 (0.003): **109**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 2 (0.006).

Staurastrum subavicula (West) West. et G. S. West
(Figs 45: 1, 1a–b; 46: 1a–c; Map 231)

Description. Cells hexagonal, deeply constricted. Sinus open, triangular, with acute apex. Semicells hexagonal, with abrupt apices with six upwards-bifurcate appendices and straight margins. Lower margins rounded, middle and apical angles outstretched into bifurcate appendices. Top view triangular, with rounded angles (pair of spines on each angle) and straight margins. Cell wall furnished with two concentric rows of granules near angles. L: 30–37.5, W: 25–40, I: 10–15, L/W: 1.0–1.2.

Distribution in Poland. Sudety Mts (Grönblad 1926).

Habitat. Polyhumic waterbodies, puddles on roads, pH range 6.1–6.8, altitude range 870–1080 m.

Number of localities in the Gorce Mts: 4 (0.01).
Turbacz range: 3 (0.009): **335**, **360**, **357**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 4 (0.012).

Staurastrum subbrebissonii Schmidle
(Figs 45: 6, 6a; 46: 6a–b; Map 232)

Description. Cells broadly elliptical, deeply constricted. Sinus open, triangular, with acute apex. Semicells elliptical to elliptico-trapezoidal, with abrupt or slightly convex apices and convex margins. Lower and apical angles rounded. Top view triangular, with rounded angles and concave margins. Cell wall furnished with concentric, dense rows of short spines. L: 40–45, W: 40–45, I: 10–15, L/W: 0.8–1.1.

Distribution in Poland. Carpathian Mts (Gutwiński 1909).

Habitat. *Sphagnum* puddles, puddles on roads, paths and marshes, old wells, pH range 5.4–8.4, altitude range 520–1230 m.

Number of localities in the Gorce Mts: 18 (0.044).
Turbacz range: 18 (0.055): **85**, **111**, **158**, **185**, **222**, **382**.
Lubań range: Not recorded.
Foothill zone: 1(0.021), Lower montane zone: 12 (0.037), Upper montane zone: 5 (0.13).

Staurastrum teliferum Ralfs [*Cos. teliferum* (Ralfs) Palamar-Mordvintseva]
(Figs 45: 3, 3a; 46: 3a–b; Map 233)

Description. Cells broadly elliptical, deeply constricted. Sinus open, triangular, with acute apex. Semicells elliptical, with slightly convex apices and convex margins. Low and apical angles rounded. Top view triangular, with rounded angles and slightly concave margins. Cell wall furnished with concentric, dense rows of short spines (~6 μm). L: 30–55, W: 30–35, I: 10, L/W: 1.0.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic waterbodies, pH range 5.3–7.0, altitude range 870–960 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 1 (0.003): **360**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 2 (0.006).

Staurastrum teliferum var. ***gladiosum*** (W.B.Turner) Coesel & Meesters. [*Cos. gladiosum* (Turner) Palamar-Mordvintseva; *St. gladiosum* W.B. Turner]
(Figs 41: 10, 10a; 42: 10a–b; Map 234)

Description. Cells nearly rounded, deeply constricted. Sinus open, parallel in apical part, triangular, with acute apex. Semicells elliptical, with convex apices and margins. Lower and apical angles rounded. Top view rectangular, with rounded angles and concave margins. Cell wall furnished with concentric rows of thin spines (~9 μm long) around angles. L: 35–45, W: 30–40, I: 10–15, L/W: 1.1–1.2.

Distribution in Poland. Pomeranian Lakeland (Bohr 1967), Wyżyna Małopolska (Lesiak 1984, 1987), Mazovian Lowland (Tomaszewicz 1988).

Habitat. *Sphagnum* puddles, polyhumic waterbodies, pH range 4.5–7.2, altitude range 870–1050 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 1 (0.003): **278**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 2 (0.006).

Staurastrum tetracerum Ralfs ex Ralfs
(Figs 43: 4, 4a; 44: 4a–b; Map 235)

Description. Cells octagonal, with shallow constriction. Sinus very shallow, open. Semicells rectangular, with slightly concave apices and convex margins. Lower angles rounded, apical angles outstretched into long, divergent appendices furnished with four or five undulations. Top view triangular, with angles outstretched into long appendices and concave margins. Cell wall smooth. L: 10–15, W: 10(15)–15(25), I: 5, L/W: 1.0.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic pond, pH range 6.9–7.1, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone:1 (0.003).

Staurastrum turgescens De Notaris [*Cos. turgescens* (De Notaris) Palamar-Mordvintseva]
(Figs 45: 12, 12a; 46: 12a–b; Map 236)

Description. Cells elliptical, deeply constricted. Sinus open, triangular, with acute apex. Semicells elliptical, with slightly convex apices and strongly convex margins. Lower and apical angles rounded. Top view triangular, with rounded angles and concave margins. Cell wall furnished with concentric, dense rows of small granules around angles. L: 30–40, W: 20–35, I: 10–15, L/W: 1.0–1.3.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. Moist soil on roads, wet mosses of *Bryidae* class, puddles and old wells in marshes, pH range 6.4–7.9, altitude range 660–1150 m.

Number of localities in the Gorce Mts: 13 (0.032).
Turbacz range: 12 (0.036): **130**, **160**, **165**, **226**, **280**.
Lubań range: 1 (0.013): **45**.
Lower montane zone: 12 (0.037), Upper montane zone: 1 (0.026).

Staurodesmus Teiling

Staurodesmus controversus (West et G. S. West) Teiling [*St. zachariasii* Schröder, *Arthrodesmus controversus* West et G. S. West]
(Figs 47: 12, 12a; 48: 12a–b; Map 237)

Description. Cells hexagonal, moderately constricted. Sinus open, nearly rectangular, with acute apex. Semicells

trapezoidal, with slightly convex apices and straight margins. Lower angles rounded, apical angles furnished with short spines. Top view elliptical, with short spines at poles. Cell wall smooth. L: 12.5, W: 12.5, I: 5–7.5, L/W: 1.0.

Distribution in Poland. Sudety Mts (Schröder 1898), Carpathian Mts (Wasylik 1961).

Habitat. Puddles on roads and paths, pH range 5.1–6.5, altitude range 1000–1270 m.

Number of localities in the Gorce Mts: 3 (0.007).
Turbacz range: 3 (0.009): **222**, **276**, **305**.
Lubań range: Not recorded.
Lower montane zone: 1 (0.003), Upper montane zone: 2 (0.051).

Staurodesmus convergens (Ehrenberg ex Ralfs) S. Lileroth [*Arthrodesmus convergens* Ehrenberg ex Ralfs] (Figs 47: 9; 48: 9; Map 238)

Description. Cell elliptical, deeply constricted. Sinus closed in apical part, open in outer part. Semicells elliptical, with abrupt apices and convex margins. Lower angles rounded, apical angles furnished with long and stout spines convergent in direction. Top view elliptical, with long spines at poles. Cell wall smooth. L: 40, W: 50(70), I: 12.5, L/W: 0.8.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic pond, pH range 5.5–7.1, altitude range 870 m.

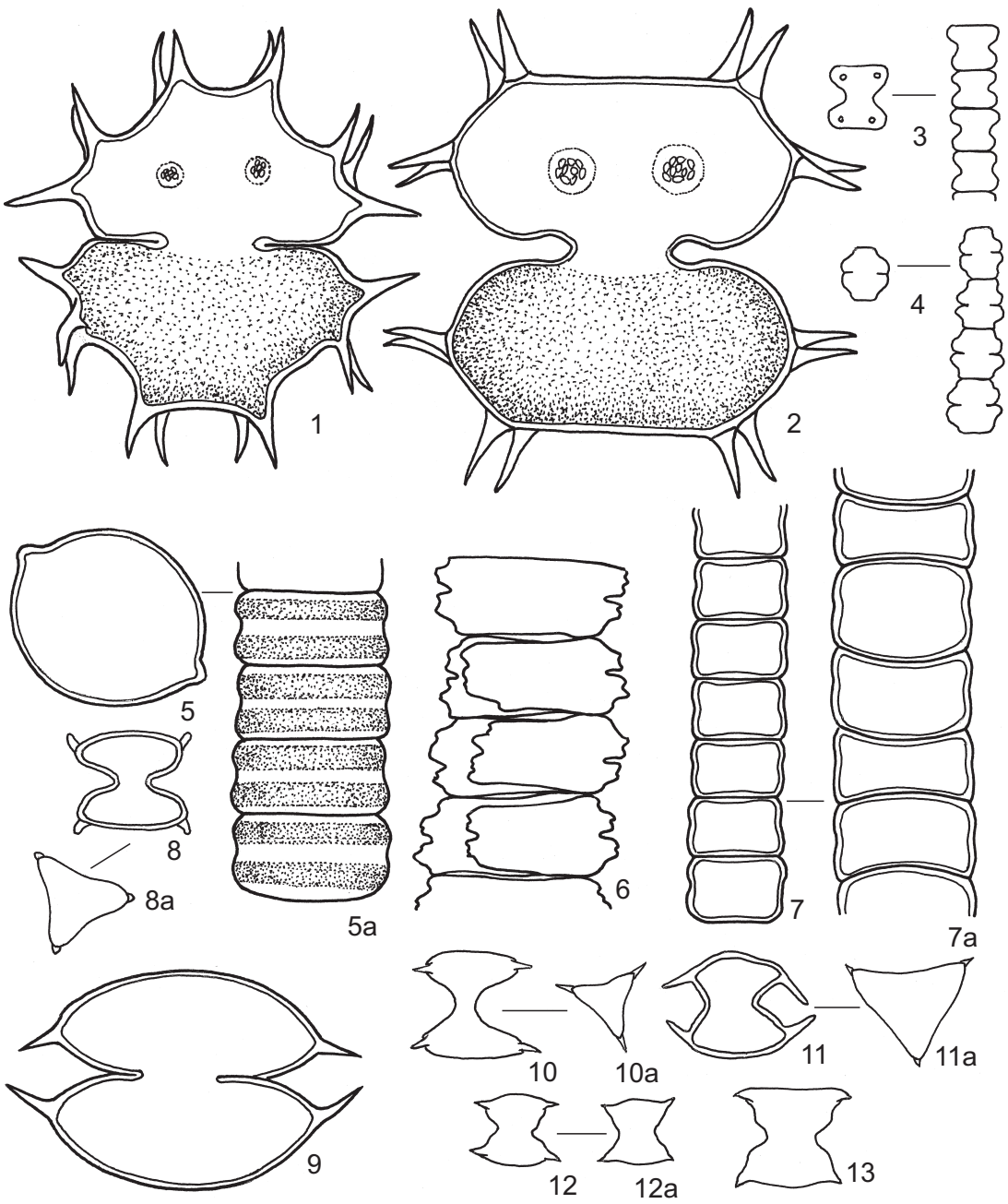

Figure 47. *Xanthidium, Teilingia, Spondylosium, Desmidium, Hyalotheca, Staurodesmus*. 1 – *Xanthidium cristatum*; 2 – *X. antilopaeum*; 3 – *Teilingia granulata*; 4 – *Spondylosium pulchellum*; 5, 5a – *Desmidium grevillei*; 6 – *D. swartzii*; 7, 7a – *Hyalotheca dissiliens*; 8, 8a – *Staurodesmus patens*; 9 – *Std. convergens*; 10, 10a – *Std. cuspidatus*; 11, 11a – *Std. glaber*; 12, 12a – *Std. controversus*; 13 – *Std. extensus*. Drawings E. Nowotarska.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Staurodesmus cuspidatus (Brébisson) Teiling [*St. cuspidatum* (Brébisson ex Ralfs)] (Figs 47: 10, 10a; 48: 10; Map 239)

Description. Cells octagonal, deeply constricted. Sinus open, trapezoidal; isthmus elongate, cylindrical. Semicells trapezoidal, with abrupt apices and straight margins. Lower angles rounded, apical angles furnished with short, stout spines. Top view triangular, with rounded angles furnished with short spines and concave margins. Cell wall punctate. L: 20, W: 15 (25), I: 5, L/W: 1.3.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic pond, pH range 5.5–7.1, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Staurodesmus extensus (O. F. Andersson) Teiling [*Arthrodesmus extensus* Borge, *A. incus* Brébisson var. *extensus* Borge, fo. *longispinum* W. et G. S. West, *A. incus* Brébisson var. *vulgaris* B. Eichler et Gutwiński, fo. *joschue* Gutwiński] (Figs 47: 13; 48: 13; Map 240)

Description. Cells hexagonal, moderately constricted. Sinus open, triangular, with rounded apex. Semicells trapezoidal, with abrupt apices and convex margins. Lower angles rounded, apical angles furnished with very short spines. Top view elliptical, with short spines at poles. Cell wall smooth. L: 20, W: 15, I: 5, L/W: 1.3.

Figure 48. *Xanthidium, Teilingia, Spondylosium, Desmidium, Hyalotheca, Staurodesmus*. 1 – *Xanthidium cristatum*; 2 – *X. antilopaeum*; 3a–b – *Teilingia granulata*; 4 – *Spondylosium pulchellum*; 5a–b – *Desmidium grevillei*; 6 – *D. swartzii*; 7a–b – *Hyalotheca dissiliens*; 8 – *Staurodesmus patens*; 9 – *Std. convergens*; 10 – *Std. cuspidatus*; 11a–b – *Std. glaber*; 12a–b – *Std. controversus*; 13 – *Std. extensus*. Scales: 1–2, 5a, 6–7b = 20 µm; 3a, 5b, 8–11b, 13 = 10 µm; 3b, 4, 12a–b = 5 µm. LM by M. Wayda.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. *Sphagnum* puddles, pH range 4.6–4.9, altitude range 1210 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **34**.
Upper montane zone: 1 (0.026).

Staurodesmus glaber (Ralfs) Teiling [*St. glabrum* Ralfs] (Figs 47: 11, 11a; 48: 11a–b; Map 241)

Description. Cells hexagonal, deeply constricted. Sinus open, triangular, with acute apex. Semicells trapezoidal, with abrupt or slightly convex apices and convex margins. Lower angles rounded, apical angles furnished with stout, convergent spines. Top view triangular, with rounded angles furnished with stout spines and concave margins. Cell wall smooth. L: 20–25, W: 15(25), I: 10, L/W: 1.9–1.7.

Distribution in Poland. Carpathian Mts (Siemińska 1967), Oświęcim Basin (Krzyżanek & Krzyżanek 1987), Southern Wielkopolska Lowland (Lesiak 1990), Mazovian Lowland (Tomaszewicz 1988), Pomeranian Lakeland (Oleksowicz 1978).

Habitat. *Sphagnum* puddles, polyhumic pond, pH range 5.5–7.0, altitude range 930–970 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 2 (0.006): **357**, **360**.
Lubań range: Not recorded.
Lower montane zone: 2 (0.006).

Staurodesmus patens (Nordstedt) Croasdale [*St. dejectum* Brébisson ex Ralfs var. *patens* Nordstedt] (Figs 47: 8, 8a; 48: 8; Map 242)

Description. Cells hexagonal, deeply constricted. Sinus open, triangular, with acute apex. Semicells elliptical, with slightly convex apices and convex margins. Lower angles rounded, apical angles furnished with stout, divergent spines. Top view triangular, with rounded angles furnished with stout spines and concave margins. Cell wall smooth. L: 20, W: 20, I: 10, L/W: 1.0.

Distribution in Poland. Species often recorded; probably common in the whole country.

Habitat. Polyhumic waterbodies, pH range 6.5–7.1, altitude range 870–960 m.

Number of localities in the Gorce Mts: 2 (0.005).
Turbacz range: 1 (0.003): **360**.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 2 (0.006).

Teilingia Bourellu

Teilingia granulata (R. Roy et Bisset) Bourrelly [*Sphaerozosma granulata* R. Roy et Bisset] (Figs 47: 3; 48: 3a–b; Map 243)

Description. Cells united into filamentous coenobia, with very short apical appendices. Cells rectangular, deeply constricted. Sinus triangular, open, with acute apex. Semicells elliptical, with abrupt apices and convex margins. Top view elliptical. Cell wall smooth, but semicells furnished with one small granule near each margin. L: 10, W: 10, I: 5, L/W: 1.0.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic pond, pH range 7.2, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Tetmemorus Ralfs ex Ralfs

Tetmemorus granulatus Brébisson ex Ralfs (Figs 37: 3, 3a; 38: 3a–b; Map 244)

Description. Cells fusiform in frontal view, with shallow, widely open sinus. Semicells tapering from mid-region to apices with distinct invagination. Cells fusiform in lateral view. Chloroplast with longitudinal ridges and central row of pyrenoids. Cells wall punctate. L: 125–200, W: 25–40, I: 25–34, L/W: 4.0–6.7.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic waterbodies, *Sphagnum* puddles, puddles on roads and paths, wet mosses of *Bryidae* class, puddles, old wells in marshes, oxbow lakes, pH range 5.1–7.9, altitude range 580–1260 m.

Number of localities in the Gorce Mts: 23 (0.056).
Turbacz range: 22 (0.003): **109**, **148**, **171**, **222**, **266**.
Lubań range: 1 (0.013): **21**.
Foothill zone: 1 (0.021), Lower montane zone: 15 (0.047), Upper montane zone: 7 (0.18).

Tetmemorus laevis Ralfs ex Ralfs [*T. minutus* de Bary] (Figs 37: 4, 4a; 38: 4a–b; Map 245)

Description. Cells cylindrical in frontal view, with shallow, widely open sinus. Semicells elongated, with parallel margins tapering near apices with invagination. Cells cylindrical in lateral view. Chloroplast with longitudinal ridges and central row of pyrenoids. Cell wall punctate. L: 60–110, W: 20–25, I: 17.5–28, L/W: 3.0–4.0.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. Polyhumic waterbodies, *Sphagnum* puddles, puddles on roads and paths, moist soil on roads and paths, wet mosses of *Bryidae* class, puddles, old wells in marshes pH range 4.3–7.8, altitude range 530–1270 m.

Number of localities in the Gorce Mts: 70 (0.17).
Turbacz range: 65 (0.197): **80**, **85**, **109**, **160**, **169**, **240**.
Lubań range: 5 (0.063): **8**, **21**, **60**.
Foothill zone: 2 (0.042), Lower montane zone: 54 (0.168), Upper montane zone: 14 (0.359).

Xanthidium Ehrenberg ex Ralfs

Xanthidium antilopaeum Kützing [*Ho. antilopaeum* (Brébisson) Lundell] (Figs 47: 2; 48: 2; Map 246)

Description. Cells decagonal, deeply constricted. Sinus linear, broadening in outer part; apex of sinus obtuse. Semicells hexagonal, with abrupt apices and margins. Lower angles rounded, middle and apical angles furnished with pair of stout spines. Top view elliptical, with eight stout spines. Cell wall punctate. L: 70 (100) – 75 (100), W: 70 (100), I: 20–35, L/W: 1.0–1.1.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic pond, pH range 5.5–7.1, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

Xanthidium cristatum Brébisson ex Ralfs [*Ho. cristatum* (Brébisson) Lundell] (Figs 47: 1; 48: 1; Map 247)

Description. Cells decagonal, deeply constricted. Sinus linear, broadening in outer part; apex of sinus obtuse. Semicells elliptico-trapezoidal, with abrupt apices and partially convex margins, partially concave. Lower angles furnished with single stout spines, middle and apical angles with pairs of similar spines. Top view elliptical, with ten stout spines. Cell wall punctate. L: 55(80), W: 50(80), I: 55, L/W: 1.1.

Distribution in Poland. Species very often recorded; probably very common in the whole country.

Habitat. *Sphagnum* puddles, polyhumic pond, pH range 5.5–6.3, altitude range 870 m.

Number of localities in the Gorce Mts: 1 (0.002).
Turbacz range: Not recorded.
Lubań range: 1 (0.013): **21**.
Lower montane zone: 1 (0.003).

The effect of habitat pH on biodiversity

Habitat pH is considered a very important factor influencing the occurrence of desmids (Woelkering & Gough 1976; Matuła 1995; Kotkeviciene et al. 2003; Sahin 2005). In the Gorce Mts, pH ranged from 3.8 to 9.3 in the habitats where desmids were present. Too low or too high a concentration of hydrogen ions limits the occurrence of desmids. The main problem for algae living in alkaline waters is low availability of dissolved CO_2. For algae, a common solution to this problem involves the presence of carbonic anhydrase in the cell membrane (Badger 2003). Some desmid species living in alkaline waters show an ability to take up HCO_3 ions using the energy derived from ATP (Spijkerman et al. 2005). It is unlikely that the availability of inorganic carbon (DIC) had a decisive effect on the composition of desmid species in alkaline habitats in the Gorce Mts. The habitats are mostly subaerophytic, where algae can at least temporarily benefit from atmospheric CO_2, and in which the water pH often decreases, for example after periods of rainfall. Many algae have been found to collect CO_2 bound in various forms (Giordano et al. 2005); this may facilitate survival during unfavorable periods. The direct effect of high pH may be the most important one. In some species associated with acidic habitats, photosystem PSII was damaged when they were transferred to alkaline solution (Spijkerman et al. 2004). Another reason for the elimination of acidophilic species sensitive to alkalization may be their inability to maintain optimal cytoplasm pH when environmental pH exceeds the critical limit. This was observed in the acidophilic species *Euglena mutabilis* Schmitz (*Euglenophyta*) (Colman & Balkos 2005). Habitat acidification that decreases pH below a certain limit reduces the species richness of desmids, particularly unicellular ones (Hörnström 1999; Grenwood & Lowe 2006). The direct causes of this phenomenon in desmids are not clear. One factor limiting the occurrence of alkalophilic species sensitive to acidification may be decreased cytoplasm pH. This has been observed among *Dinophyta* (Dason & Colman 2004). Other negative phenomena observed in *Chlorophyta* taxa are impaired absorption of iron and manganese (Schenck et al. 1988), and toxic effects of aluminium (Hörnström et al. 1995). This last factor seems not to be significant in Gorce Mts conditions, as humic acids have the ability to reduce Al toxicity due to their chelating action (Sauvant 1999).

Environmental pH also influences living algae indirectly. The acidic waters of the Gorce Mts have low ionic conductivity, sometimes ~30 µS (for comparison, distilled water has ~20 µS), which means very low concentrations of ions in solution, including vital ones such as Ca^{2+} and K^{+}. Such is the case in acidic habitats with low ionic conductivity on the south side of the Western Carpathians at lower elevations (Hájek et al. 2002). At low concentrations, humic acids causing habitat acidification have a beneficial impact on algae, facilitating ion uptake among other processes (Gumiński 1983). At high concentrations, they may have adverse effects. They were found to have a negative impact on photosynthesis in chlorophyte taxa of *Scenedesmus* (Steinberg et al. 2006). Different species of that genus may differ in their sensitivity to the effects of humic acids (Karasyova et al. 2007). At very low pH there is a decrease of assimilable forms of nitrogen available for algae (Matuła 1995). Alkaline waters in the Gorce Mts have a high concentration of Ca^{2+} cations due to the geology of the area. High calcium concentrations can adversely affect photosynthesis (Gumiński 1990). Under such conditions there is a decrease of the availability of many d-block elements (e.g., Fe, Mn, Co) to green algae of the genus *Kirchneriella* (Issa et al. 1995). The same may hold for desmids. That the alkaline waters of the Gorce Mts have a much higher concentration of dissolved ions than the acidic waters. Ionic conductivity (often greater than 100 µS) is significant, as it may affect the osmoregulation of algae living in those waters.

The species recorded in each pH range are presented in Table 1, the numbers of species in Figure 49, and the percentages of different genera in Figure 50.

Percentages of desmid genera occurring in different pH ranges in % is presented in Table 2.

Desmid species richness in the Gorce Mts was highest at water pH 5.5–7.4. This is in line with findings from

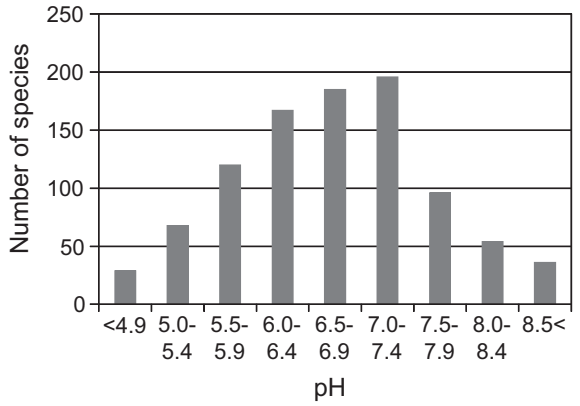

Figure 49. Number of desmid species in different pH ranges.

other authors indicating that most desmid species prefer moderately acidic water (Brook 1981; Gerrath 1993). A large variety of species was recorded from water with pH 7.0–7.4. These periodically acidic and periodically alkaline habitats are the most common types of aquatic habitats in the Gorce Mts. Few species were found at water pH 5.0–5.4; there are few such habitats in the Gorce Mts.

The desmid habitats in the Gorce Mts can be divided into four groups according to water pH.

Extremely acidic habitats with pH below 5.0, characterized by low numbers of species, low diversity of genera, a low share of *Cosmarium* (10.3% of species), and the occurrence of *Actinotaenium*, *Closterium*, *Euastrum*, *Hyalotheca*, *Micrasterias*, *Penium*, *Staurastrum* and *Staurodesmus*, and *Mesotaeniaceae* genera.

Relatively acidic to relatively alkaline habitats with pH 5.0–7.4, showing the greatest diversity of genera and species. The genus *Closterium* forms 15.0% to 17.3% of the species composition, *Cosmarium* forms 30.9–40.8%, *Euastrum* 6.7–11.8%, *Micrasterias* 1.5–4.4%, *Staurastrum* 14.8–16.2%, *Staurodesmus* 1.5–3.2%, *Mesotaeniaceae* genera 5.6–6.7%, and genera forming filamentous coenobia 0.8–2.5%.

Alkaline habitats with pH 7.5–8.4, showing a considerable decrease in the diversity of genera and species versus the previous group. *Closterium* forms 20.1–20.4% of the species composition, *Cosmarium* 51.5–57.4%, *Euastrum* 1.9–4.1%, *Staurastrum* 9.3–10.3%, and *Mesotaeniaceae* genera 3.7–4.1%. There are no species of *Micrasterias*

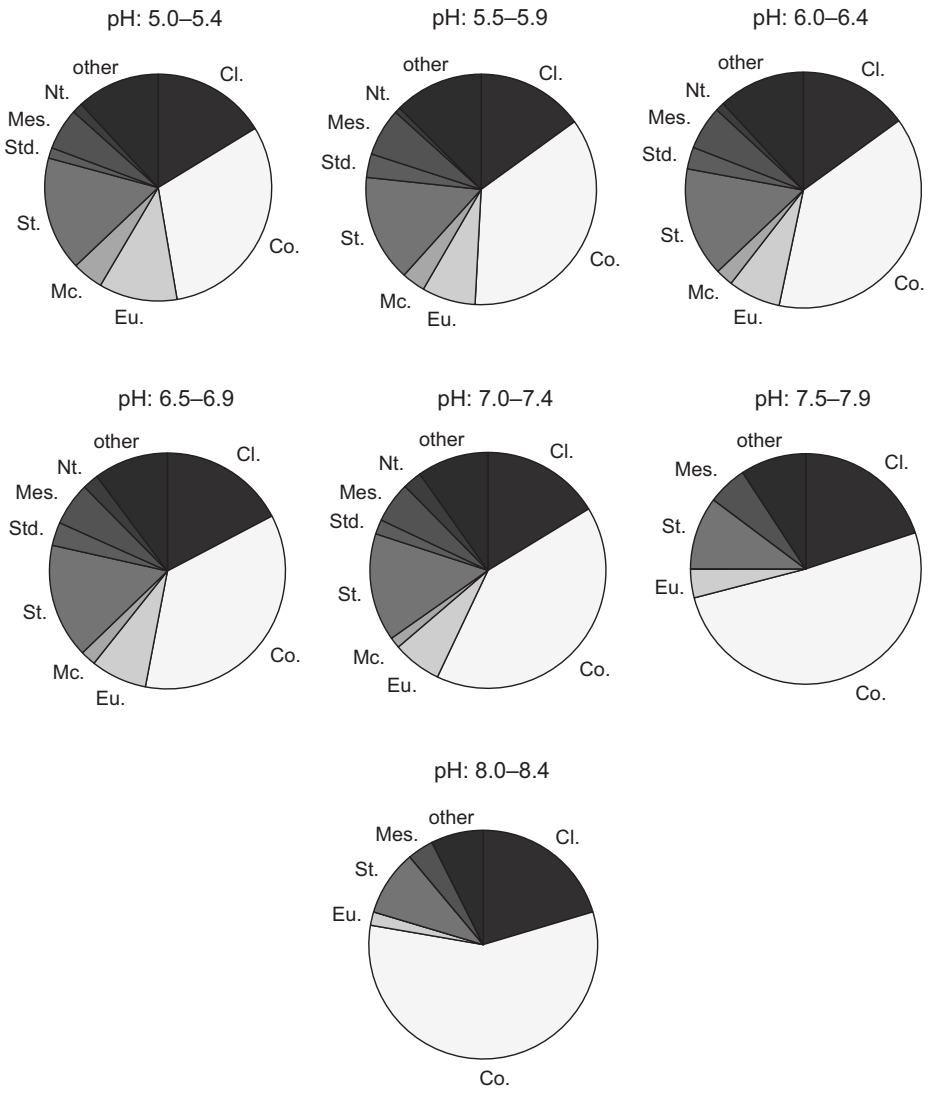

Figure 50. Percentage share of desmid species in different pH ranges. Cl. – *Closterium*, Co. – *Cosmarium*, Eu. – *Euastrum*, Mc. – *Micrasterias*, St. – *Staurastrum*, Std. – *Staurodesmus*, Mes. – species of *Mesotaeniaceae* family, Nt. – *Netrium*.

Table 1. List of desmid species occurring in different pH ranges.

Name of taxa \ pH range	< 4.4	4.5–4.9	5.0–5.4	5.5–5.9	6.0–6.4	6.5–6.9	7.0–7.4	7.5–7.9	8.0–8.4	8.5<
Actinotaenium borgeanum	–	–	–	–	–	1	1	–	–	–
Actinotaenium cruciferum	–	–	–	–	1	1	–	–	–	–
Actinotaenium cucurbita	–	1	1	1	1	1	1	1	1	1
Actinotaenium cucurbitinum	–	–	–	1	1	1	1	1	1	1
Actinotaenium curtum	–	–	–	–	–	–	1	–	–	–
Actinotaenium didymocarpum	–	–	–	–	1	1	1	–	–	–
Actinotaenium diplosporum	–	–	1	1	1	1	1	1	–	–
Actinotaenium gelidum	1	1	1	1	–	–	–	–	–	–
Actinotaenium perminutum	–	1	1	1	1	1	1	–	–	–
Actinotaenium silvae-nigrae	–	–	–	1	1	1	1	1	–	–
Actinotaenium spinospermum	–	–	–	1	1	1	1	–	–	–
Actinotaenium turgidum	–	–	–	1	1	1	1	–	–	–
Closterium abruptum	–	–	1	1	1	1	1	1	–	–
Closterium acerosum	–	–	1	1	1	1	1	1	1	1
Closterium acutum	–	–	–	–	1	1	1	–	–	–
Closterium baillyanum	–	–	–	1	1	–	–	–	–	–
Closterium calosporum	–	–	–	–	1	1	–	–	–	–
Closterium closterioides	–	–	–	1	1	1	1	–	–	–
Closterium cornu	–	–	–	–	–	–	1	1	1	–
Closterium costatum	–	1	1	1	1	1	1	–	–	–
Closterium cynthia	–	–	–	–	1	1	1	–	–	–
Closterium dianae	–	–	–	–	1	1	1	–	–	–
Closterium ehrenbergii	–	–	–	–	–	1	1	1	1	1
Closterium exile	–	–	–	1	–	–	–	–	–	–
Closterium idiosporum	–	–	–	–	–	1	1	1	–	–
Closterium intermedium	–	–	1	1	1	1	1	1	–	–
Closterium jenneri	–	–	–	–	–	1	–	–	–	–
Closterium juncidum	–	–	–	1	1	1	1	1	–	–
Closterium kuetzingii	–	–	–	–	1	1	1	1	–	–
Closterium lineatum	–	–	–	–	–	1	1	–	–	–
Closterium littorale	–	1	1	1	1	1	1	1	1	–
Closterium lunula	–	1	1	1	1	1	1	1	–	–
Closterium macilentum	–	–	–	1	–	–	–	–	–	–
Closterium moniliferum	–	–	–	–	–	1	1	1	1	1
Closterium navicula	–	–	1	1	1	1	1	1	1	–
Closterium parvulum	–	–	1	1	1	1	1	1	1	1
Closterium praelongum	–	–	–	–	1	1	1	1	–	–
Closterium pritchardianum	–	–	–	–	–	1	1	1	–	–
Closterium pronum	–	–	–	–	–	–	1	–	–	–
Closterium pseudolunula	–	–	–	–	–	1	1	1	1	1
Closterium pusillum	–	–	–	1	1	1	–	–	–	–
Closterium pygmaeum	–	–	–	–	1	1	1	–	–	–
Closterium rostratum	–	–	1	1	1	1	1	1	1	–
Closterium strigosum	–	–	–	1	1	1	1	1	1	1
Closterium striolatum	–	–	1	1	1	1	1	–	–	–
Closterium sublaterale	–	–	–	–	–	1	1	1	1	1
Closterium tumidulum	–	–	1	1	1	1	1	–	–	–
Closterium tumidum	–	–	–	–	1	1	1	1	–	–
Closterium turgidum	–	–	–	–	–	–	1	–	–	–
Closterium venus	–	–	–	–	1	1	1	–	–	–
Cosmarium alpestre	–	–	–	–	1	–	–	–	–	–
Cosmarium anceps	–	–	–	1	1	1	1	1	1	–
Cosmarium angulosum	–	–	–	–	–	–	1	–	–	–
Cosmarium annulatum	–	–	–	–	–	–	1	–	–	–
Cosmarium arctoum	–	–	–	–	–	1	–	–	–	–
Cosmarium asphaerosporum	–	1	–	–	–	–	–	–	–	–
Cosmarium bioculatum	–	–	–	–	–	–	–	1	–	–
Cosmarium biretum	–	–	–	–	–	–	1	1	–	–
Cosmarium blyttii	–	–	–	1	1	1	1	–	–	–
Cosmarium boeckii	–	–	–	1	1	1	1	–	–	–
Cosmarium botrytis	–	–	–	1	1	1	1	1	1	1
Cosmarium caelatum	–	–	1	1	1	1	1	1	–	–

Table 1. Continued

Name of taxa \ pH range	< 4.4	4.5–4.9	5.0–5.4	5.5–5.9	6.0–6.4	6.5–6.9	7.0–7.4	7.5–7.9	8.0–8.4	8.5<
Cosmarium connatum	–	–	–	1	1	1	1	–	–	–
Cosmarium conspersum	–	–	–	–	–	–	1	1	–	–
Cosmarium contractum	–	–	–	1	1	1	1	–	–	–
Cosmarium costatum	–	–	–	–	1	1	1	1	1	–
Cosmarium crenatum	–	–	–	–	–	–	1	1	1	1
Cosmarium crenulatum	–	–	–	–	–	–	1	–	–	–
Cosmarium cyclicum	–	–	1	1	1	1	1	–	–	–
Cosmarium cymatopleurum	–	–	–	–	–	–	1	1	–	–
Cosmarium davidsonii	–	–	1	1	1	1	1	1	–	–
Cosmarium debaryi	–	–	–	1	1	1	–	–	–	–
Cosmarium decedens	–	–	–	–	–	1	1	–	–	–
Cosmarium dentiferum	–	–	1	1	1	1	1	1	–	–
Cosmarium depressum	–	–	–	–	–	–	1	–	–	–
Cosmarium didymochondrum	–	–	–	–	–	1	1	1	1	1
Cosmarium difficile	–	–	–	1	1	1	1	–	–	–
Cosmarium dispersum	–	–	–	–	1	–	–	–	–	–
Cosmarium elegantissimum	–	–	–	–	1	1	1	1	–	–
Cosmarium exiguum	–	–	–	–	–	–	1	–	–	–
Cosmarium formosulum	–	–	1	1	1	1	1	1	1	–
Cosmarium galeritum	–	–	–	1	1	1	1	1	1	1
Cosmarium garrolense	–	–	–	–	–	1	1	–	–	–
Cosmarium gonioides	–	–	–	–	–	–	1	–	–	–
Cosmarium granatum	–	–	–	–	1	1	1	1	1	–
Cosmarium hammeri	–	–	–	–	–	–	1	–	–	–
Cosmarium holmiense var. *holmiense*	–	–	–	–	1	1	1	–	–	–
Cosmarium holmiense var. *integrum*	–	–	–	–	1	1	1	1	–	–
Cosmarium hornavanense	–	–	–	1	1	1	1	1	1	1
Cosmarium humile	–	–	–	–	1	1	1	–	–	–
Cosmarium impressulum	–	–	–	–	1	1	1	1	1	1
Cosmarium jenisejense	–	–	–	1	1	–	–	–	–	–
Cosmarium laeve	–	–	1	1	1	1	1	1	1	1
Cosmarium limnophilum	–	–	1	1	1	1	1	–	–	–
Cosmarium majae	–	–	–	–	–	1	1	–	–	–
Cosmarium margaritatum	–	–	1	1	1	1	1	–	–	–
Cosmarium margaritiferum	–	–	1	1	1	1	1	1	–	–
Cosmarium meneghinii	–	–	–	–	1	–	–	–	–	1
Cosmarium microsphinctum	–	–	–	–	–	–	1	–	–	–
Cosmarium nasutum	–	–	–	–	1	1	1	1	–	–
Cosmarium nitidulum	–	–	–	–	1	1	1	1	1	–
Cosmarium notabile	–	–	1	1	1	1	1	1	1	1
Cosmarium novae-semliae	–	–	–	–	1	1	1	–	–	–
Cosmarium obliquum	–	–	–	–	–	1	–	–	–	–
Cosmarium obtusatum	–	–	1	1	1	1	1	1	1	1
Cosmarium ochthodes	–	–	–	1	1	1	1	1	1	–
Cosmarium ornatum	–	–	–	1	1	1	1	–	–	–
Cosmarium pachydermum	–	–	1	1	1	1	1	1	–	–
Cosmarium paragranatoides	–	–	–	1	1	1	1	–	–	–
Cosmarium parvulum	–	–	–	–	–	–	–	1	1	1
Cosmarium pericymatium	–	–	–	–	–	–	–	1	1	1
Cosmarium pokornyanum	–	–	–	–	–	–	–	1	1	1
Cosmarium porteanum	–	–	–	–	1	1	1	1	–	–
Cosmarium praemorsum	–	–	–	–	1	1	1	1	1	–
Cosmarium pseudoexiguum	–	–	–	–	–	–	–	1	–	–
Cosmarium pseudopyramidatum	–	–	–	–	1	1	1	1	–	–
Cosmarium pulcherrimum	–	–	–	–	1	–	–	–	–	–
Cosmarium pyramidatum	–	–	–	1	–	–	–	–	–	–
Cosmarium quadratum	–	–	1	1	1	1	1	1	1	1
Cosmarium quadratulum	–	–	–	–	–	–	1	–	–	–
Cosmarium quadrum	–	–	–	–	1	1	1	–	–	–
Cosmarium rectangulare	–	–	–	1	1	1	1	–	–	–
Cosmarium regnellii	–	1	1	1	1	1	1	1	1	–
Cosmarium reniforme	–	–	–	–	–	–	1	1	–	–

Table 1. Continued

Name of taxa \ pH range	< 4.4	4.5–4.9	5.0–5.4	5.5–5.9	6.0–6.4	6.5–6.9	7.0–7.4	7.5–7.9	8.0–8.4	8.5<
Cosmarium saxicola	–	–	–	–	–	1	–	–	–	–
Cosmarium sexangulare	–	–	–	–	–	–	–	–	–	1
Cosmarium sexnotatum	–	–	–	–	1	1	1	–	–	–
Cosmarium speciosum	–	–	1	1	1	1	1	1	1	–
Cosmarium sphagnicola	–	–	–	–	–	–	1	–	–	–
Cosmarium sphalerostichum	–	–	1	1	1	–	1	1	–	–
Cosmarium sportella	–	–	1	1	1	1	1	1	1	1
Cosmarium staurastroides	–	–	–	1	–	–	–	–	–	–
Cosmarium subarctoum	–	–	–	–	1	1	1	–	–	–
Cosmarium subbroomei	–	–	–	–	1	1	1	1	1	1
Cosmarium subcostatum	–	–	–	1	1	1	1	1	1	1
Cosmarium subcrenatum	–	–	1	1	1	1	1	1	1	1
Cosmarium subcucumis	–	–	1	1	1	1	1	1	1	1
Cosmarium subgranatum	–	–	–	–	–	1	1	1	–	–
Cosmarium subnotabile	–	–	–	–	1	–	–	–	–	–
Cosmarium subprotumidum	–	–	–	–	–	–	1	–	–	–
Cosmarium subquadratum	–	–	–	–	–	1	–	–	–	–
Cosmarium subspeciosum	–	1	1	1	1	1	1	1	1	1
Cosmarium subtumidum	–	–	–	–	1	–	1	–	–	–
Cosmarium tatricum	–	–	–	–	1	–	1	–	–	–
Cosmarium tetragonum	–	–	1	1	1	1	1	1	1	–
Cosmarium tetraophthalmum	–	–	–	1	1	1	1	1	1	1
Cosmarium thwaitesii	–	–	–	–	–	–	1	–	–	–
Cosmarium tinctum	–	–	–	1	1	1	1	1	–	–
Cosmarium turpinii	–	–	–	–	–	1	1	–	–	–
Cosmarium venustum	–	–	–	–	–	1	–	–	–	–
Cosmarium vexatum	–	–	–	1	1	1	1	1	1	1
Cylindrocystis brebissonii	1	1	1	1	1	1	1	1	–	–
Cylindrocystis crassa	–	–	–	–	1	1	1	–	–	–
Desmidium grevillei	–	–	–	–	–	1	1	–	–	–
Desmidium swartzii	–	–	–	–	1	1	1	–	–	–
Euastrum ansatum	–	–	1	1	1	1	1	–	–	–
Euastrum bidentatum	–	1	1	1	1	1	1	–	–	–
Euastrum binale	–	1	1	1	1	1	1	–	–	–
Euastrum crassicolle	–	–	–	–	1	–	1	–	–	–
Euastrum denticulatum	–	–	–	–	1	1	1	1	1	–
Euastrum didelta	–	–	1	1	1	1	–	–	–	–
Euastrum dissimile	–	1	–	–	–	–	1	–	–	–
Euastrum dubium	–	–	–	1	1	1	1	–	–	–
Euastrum elegans	–	–	–	–	–	1	–	–	–	–
Euastrum erosum	–	–	–	–	1	1	1	–	–	–
Euastrum gayanum	–	–	–	–	–	1	1	–	–	–
Euastrum humerosum	–	1	1	1	1	1	1	1	–	–
Euastrum insigne	1	–	–	–	–	–	–	–	–	–
Euastrum montanum	–	–	1	1	1	–	–	–	–	–
Euastrum oblongum	–	1	1	1	1	1	1	1	–	–
Euastrum pulchellum	–	–	–	–	–	1	1	–	–	–
Euastrum subalpinum	–	–	1	1	1	1	–	–	–	–
Euastrum verrucosum	–	–	–	–	–	1	1	1	–	–
Gonatozygon brebissonii	–	–	–	1	1	1	1	1	–	–
Gonatozygon monotaenium	–	–	–	–	1	1	1	1	1	–
Haplotaenium rectum	–	–	–	1	1	1	1	–	–	–
Hyalotheca dissiliens	–	1	1	1	1	1	1	–	–	–
Mesotaenium degreyi	–	1	1	1	1	1	1	–	–	–
Mesotaenium endlicherianum	–	–	–	–	–	1	–	–	–	–
Mesotaenium macrococcum	–	–	–	–	1	1	1	–	–	–
Micrasterias americana	–	–	1	1	1	1	–	–	–	–
Micrasterias dickiei	–	–	1	1	1	1	1	–	–	–
Micrasterias papillifera	–	–	–	1	1	1	1	–	–	–
Micrasterias rotata	–	–	1	1	1	1	1	–	–	–
Micrasterias truncata	–	1	1	1	1	1	1	–	–	–
Netrium digitus	–	1	1	1	1	1	1	1	1	–
Netrium oblongum	–	–	–	–	1	1	1	–	–	–

Table 1. Continued

Name of taxa \ pH range	< 4.4	4.5–4.9	5.0–5.4	5.5–5.9	6.0–6.4	6.5–6.9	7.0–7.4	7.5–7.9	8.0–8.4	8.5<
Penium cylindrus	–	–	–	1	1	1	1	–	–	–
Penium margaritaceum	–	–	1	1	1	1	1	–	–	–
Penium spirostriolatum	–	–	1	1	1	1	1	1	–	–
Planotaenium interruptum	–	–	–	1	1	1	1	–	–	–
Pleutotaenium crenulatum	–	–	1	1	1	1	1	1	1	1
Pleutotaenium ehrenbergii	–	–	–	–	1	–	–	–	–	–
Pleutotaenium trabecula	–	–	–	–	1	1	1	1	1	–
Roya obtusa	–	–	–	1	1	1	1	–	–	–
Spirotaenia condensata	–	–	–	1	–	–	–	–	–	–
Spirotaenia obscura	–	–	–	–	–	–	1	–	–	–
Spondylosium pulchellum	–	–	–	–	–	1	1	–	–	–
Staurastrum aculeatum	–	–	–	–	1	1	1	–	–	–
Staurastrum acutum	–	–	–	1	1	1	1	–	–	–
Staurastrum alternans	–	–	1	1	1	1	1	–	–	–
Staurastrum arcuatum	–	–	–	–	1	–	–	–	–	–
Staurastrum avicula	–	–	–	–	–	1	1	–	–	–
Staurastrum bieneanum	–	–	–	1	1	1	1	–	–	–
Staurastrum botrophilum	–	–	–	–	–	–	1	–	–	–
Staurastrum capitulum	–	1	1	1	1	–	–	–	–	–
Staurastrum controversum	–	–	–	–	–	1	1	–	–	–
Staurastrum dispar	–	–	–	–	1	–	–	–	–	–
Staurastrum furcatum	–	–	–	–	–	1	1	–	–	–
Staurastrum gladiosum	–	1	1	1	1	1	1	–	–	–
Staurastrum hexacerum	–	–	–	–	–	–	1	1	1	1
Staurastrum hirsutum	–	1	1	1	1	1	1	–	–	–
Staurastrum inflexum	–	–	–	–	1	1	1	–	–	–
Staurastrum lapponicum	–	–	–	–	–	1	–	–	–	–
Staurastrum lunatum	–	–	–	–	–	1	1	–	–	–
Staurastrum margaritaceum	1	1	1	1	1	1	1	1	–	–
Staurastrum merianii	–	–	–	–	–	–	1	1	1	1
Staurastrum muricatum	–	–	–	–	–	–	–	–	–	–
Staurastrum muticum	–	1	1	1	1	1	1	–	–	–
Staurastrum orbiculare	–	–	1	1	1	1	1	1	–	–
Staurastrum oxyacanthum	–	–	–	1	1	1	1	–	–	–
Staurastrum pileolatum	–	1	1	1	–	–	–	–	–	–
Staurastrum pilosum	–	1	1	1	1	1	1	–	–	–
Staurastrum polymorphum	–	–	–	–	–	1	1	–	–	–
Staurastrum polytrichum	–	–	–	–	1	1	1	1	–	–
Staurastrum proboscideum	–	–	–	1	1	1	1	–	–	–
Staurastrum punctulatum	–	–	–	1	1	1	1	1	1	1
Staurastrum pungens	–	–	–	–	1	–	–	–	–	–
Staurastrum pyramidatum	–	–	–	–	–	1	–	–	–	–
Staurastrum scabrum	–	–	–	–	–	–	1	1	–	–
Staurastrum sexcostatum	–	–	–	1	1	1	1	1	1	–
Staurastrum spongiosum	–	–	–	1	1	1	–	–	–	–
Staurastrum subavicula	–	–	–	–	1	1	–	–	–	–
Staurastrum subbrebissonii	–	–	1	1	1	1	1	1	1	–
Staurastrum teliferum	–	–	1	1	1	1	1	–	–	–
Staurastrum tetracerum	–	–	–	–	–	1	1	–	–	–
Staurastrum turgescens	–	–	–	–	1	1	1	1	–	–
Staurodesmus controversus	–	–	–	1	1	1	–	–	–	–
Staurodesmus convergens	–	–	–	1	1	1	1	–	–	–
Staurodesmus cuspidatus	–	–	–	–	1	1	–	–	–	–
Staurodesmus extensus	–	1	–	–	–	–	–	–	–	–
Staurodesmus glaber	–	–	–	1	1	1	1	–	–	–
Staurodesmus patens	–	–	–	–	–	1	1	–	–	–
Teilingia granulata	–	–	–	–	–	–	1	–	–	–
Tetmemorus granulatus	–	–	1	1	1	1	1	1	–	–
Tetmemorus laevis	1	1	1	1	1	1	1	1	–	–
Xanthidium antilopaeum	–	–	–	1	1	1	1	–	–	–
Xanthidium cristatum	–	–	–	1	1	–	–	–	–	–
	5	28	68	120	167	185	196	97	54	36

Table 2. Percentages desmid genera occurring in different pH ranges in %.

Genera \ pH range	< 4.4	4.5–4.9	5.0–5.4	5.5–5.9	6.0–6.4	6.5–6.9	7.0–7.4	7.5–.9	8.0–8.4	8.5<
	percentages									
Closterium	Participation of representatives not statistically significant		16.2	15.0	15.0	17.3	16.3	20.1	20.4	19.4
Cosmarium			30.9	35.8	38.31	35.7	40.9	51.5	57.4	63.9
Euastrum			11.1	7.51	7.21	7.7	6.7	4.1	1.9	–
Micrasterias			4.4	3.3	2.4	2.1	1.5	10.3	9.3	–
Staurastrum			16.2	15.0	15	15.7	14.8	–	–	–
Staurodesmus			1.5	3.3	3.0	3.2	2.0	–	–	–
Mesotaeniaceae family	Participation of representatives not statistically significant		5.9	6.7	6.0	5.9	5.6	5.6	3.7	–
Genera forming ilamentous coenobia			1.5	0.8	1.2	2.2	2.6	–	–	–
Others genera			11.8	12.5	11.9	10.2	9.8	9.3	7.4	–
Number of taxa	29		68	120	167	185	196	96	54	36

or *Staurodesmus*, and no genera forming filamentous coenobia.

Extremely alkaline habitats with pH greater than 8.4. Like the extremely acidic habitats, they show low diversity of genera and species. Species of the genus *Closterium* form 19.4% of the species composition, and *Cosmarium* 63.9%. There are no representatives of *Euastrum*, *Micrasterias*, *Staurodesmus*, *Mesotaeniaceae* genera, or genera forming filamentous coenobia.

The share of *Closterium* and especially *Cosmarium* species increased with the increase of habitat pH (Fig. 51). A similar correlation has been reported for *Cosmarium* in the floras of Lithuania (Kostkeviciene et al. 2003) and Turkey (Sahin 2005).

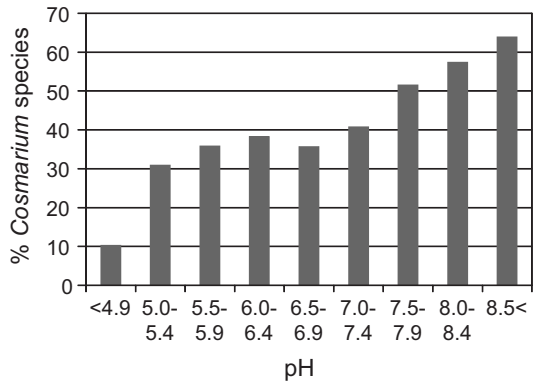

Figure 51. Percentage share of *Cosmarium* species among other desmid species in different pH ranges.

Many desmid species of the Gorce Mts occurred in broad ranges of pH. This is a phenomenon known for many species (Förster 1982). The habitat preference of an algal species can be determined using Starmach's method (1963, 1989), which takes abundance as an indicator of preference, based on the assumption that in its optimal conditions the quantitative share of a species increases. In many cases, this assumption is correct, especially for planktonic species, but the ability to occur en masse may not depend solely on habitat conditions. In the Gorce Mts, only 90 desmid species (36.4% of the Gorce desmid flora) were recorded at least once as the first dominant in a sample. Assuming that a species becomes the first dominant in its optimal habitat, this would mean that 63.6% of the desmid species do not have their optimal habitat in the Gorce Mts, or such species are so rare that it was not possible to find them in the course of this research. Many common species were represented mostly by only a few specimens in the samples, and were rare as dominants. Among algae, proliferative capacity can depend not only on habitat conditions, but also on species characteristics. There are species that employ breeding strategies similar to the r-selection and K-selection strategies of vascular plants. Desmids generally belong to the second group (Reynolds 1983).

In this study the criterion for determining the preferred pH range was the occurrence of the sampled species in habitats of given pH ranges. When possible, frequency of occurrence as the first dominant (Fig. 52f) in samples from habitats of the different pH ranges (Fig. 52) was taken as supporting information. To reduce information noise, the analysis was based only on samples in which at least 50 desmid cells were found on three consecutive microscope slides (20 × 20 mm coverslip). The pH range preference was determined for 175 species. It was not possible for the others because the data were insufficient (many species were represented by only a single cell in one preparation).

The desmids in this analysis can be divided into five groups.

Acidophilic species sensitive to alkalization (A) – These include desmids occurring with the greatest

Figure 52a–f. Frequency of occurrence of desmid species (samples with more than 50 cells in the microscope preparation) in different pH ranges. a – acidophilic species sensitive to alkalization; b – acidophilic species resistant to alkalization; c – alkalophilic species sensitive to acidification; d – alkalophilic species resistant to acidification; e – species of indeterminate preference; f – frequency of occurrence as first dominant species in different pH ranges.

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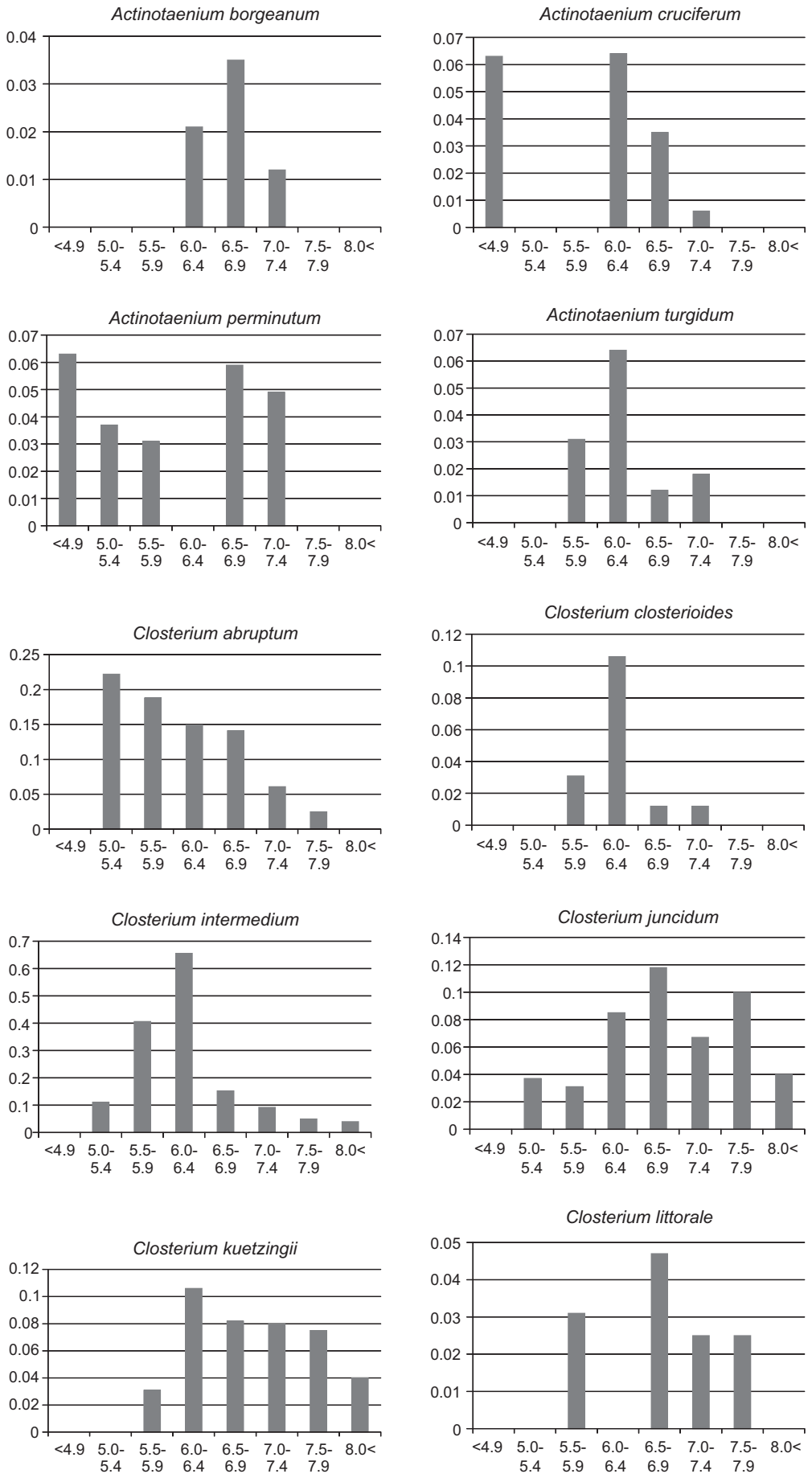

Figure 52a. Frequency of occurrence of desmid species (samples with more than 50 cells in the microscope preparation) in different pH ranges. Acidophilic species sensitive to alkalization.

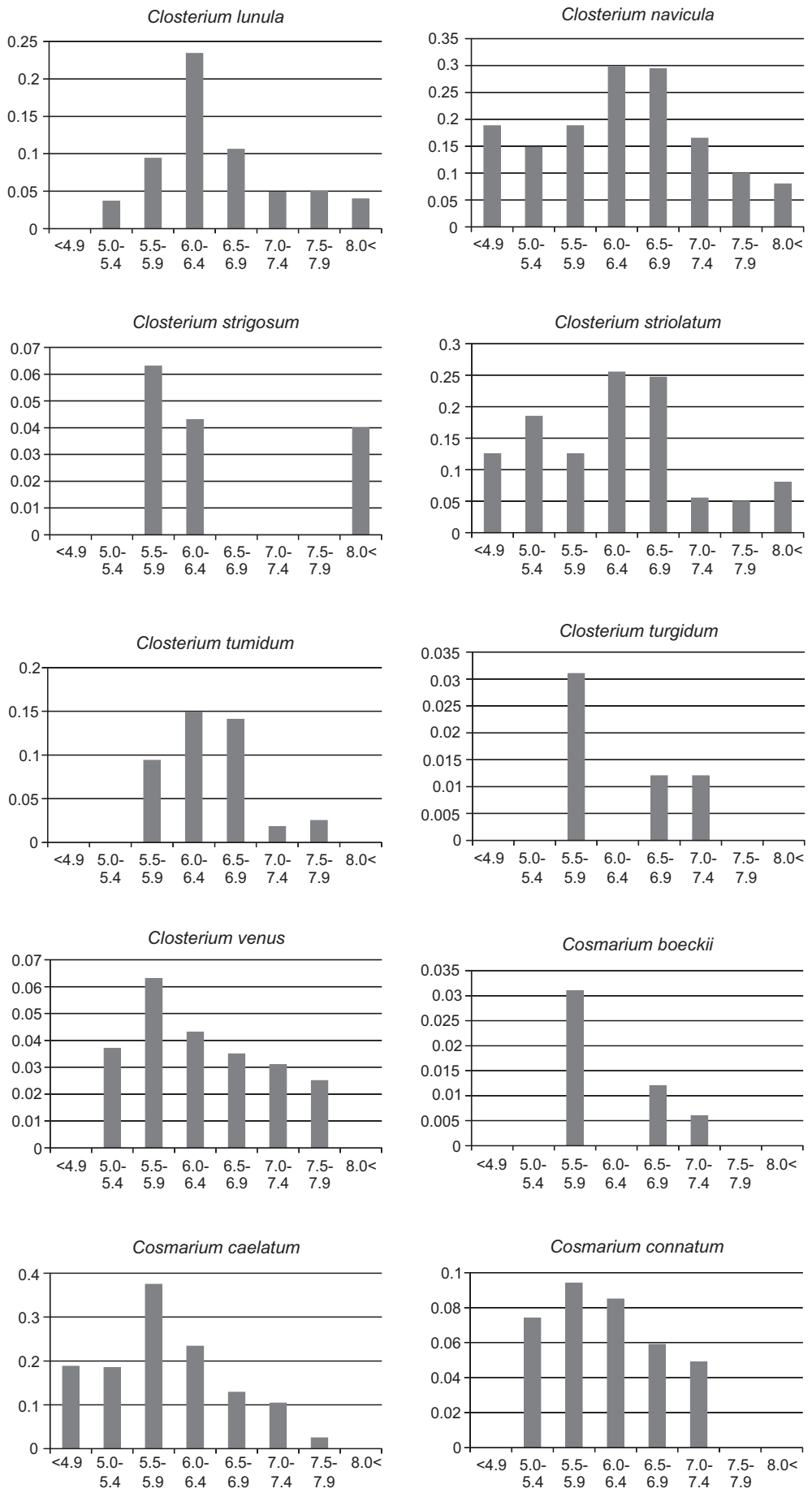

Figure 52a. Continued

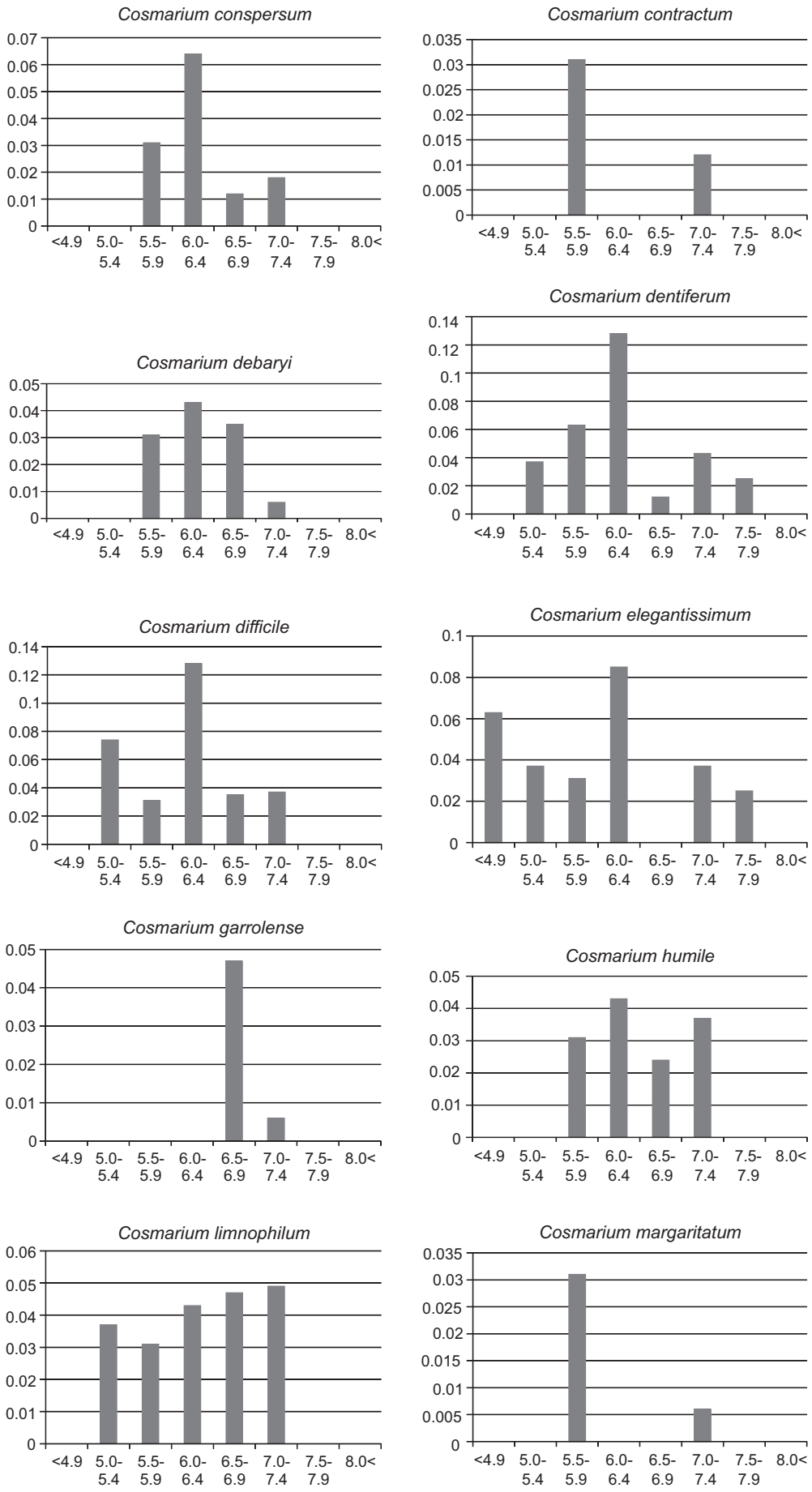

Figure 52a. Continued

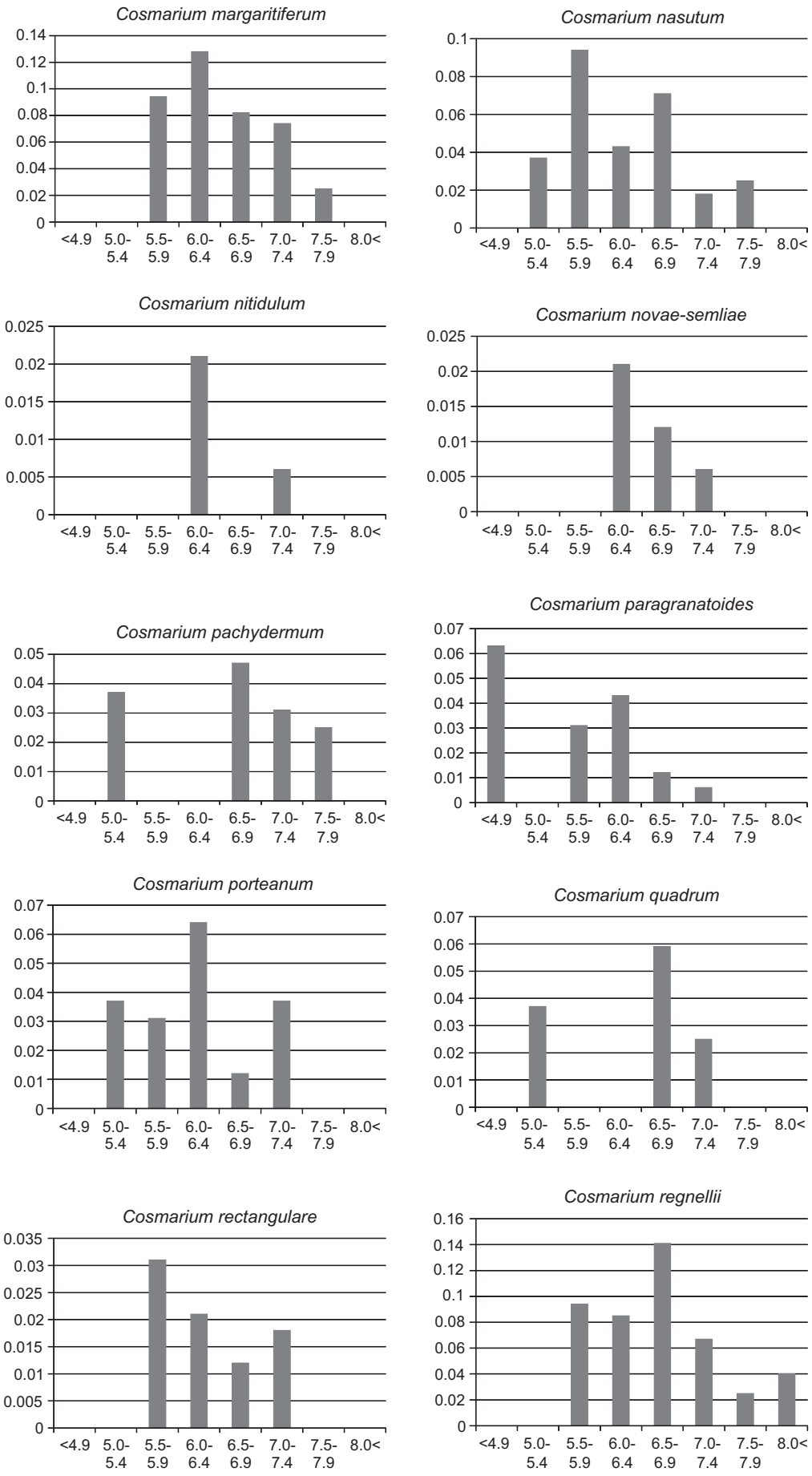

Figure 52a. Continued

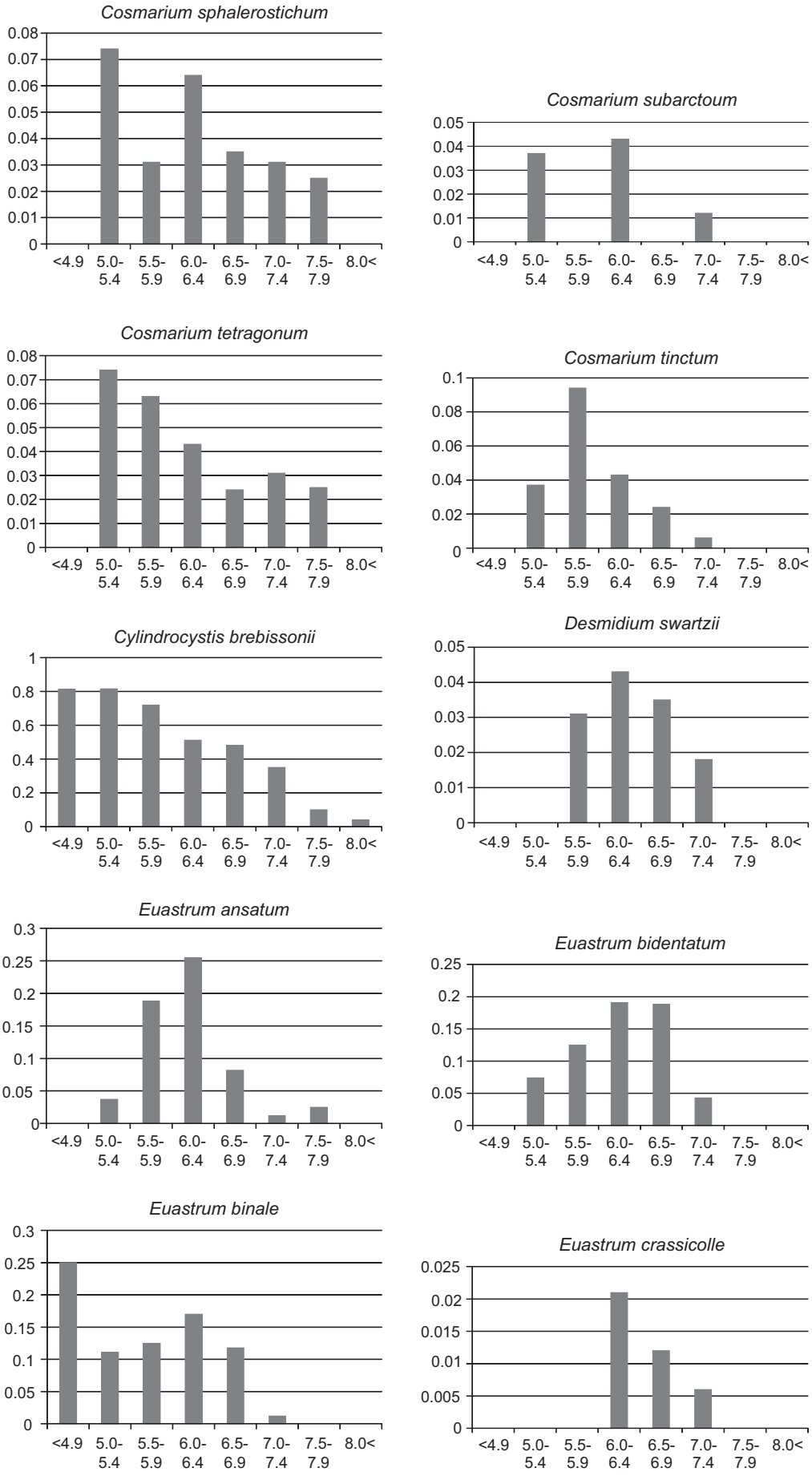

Figure 52a. Continued

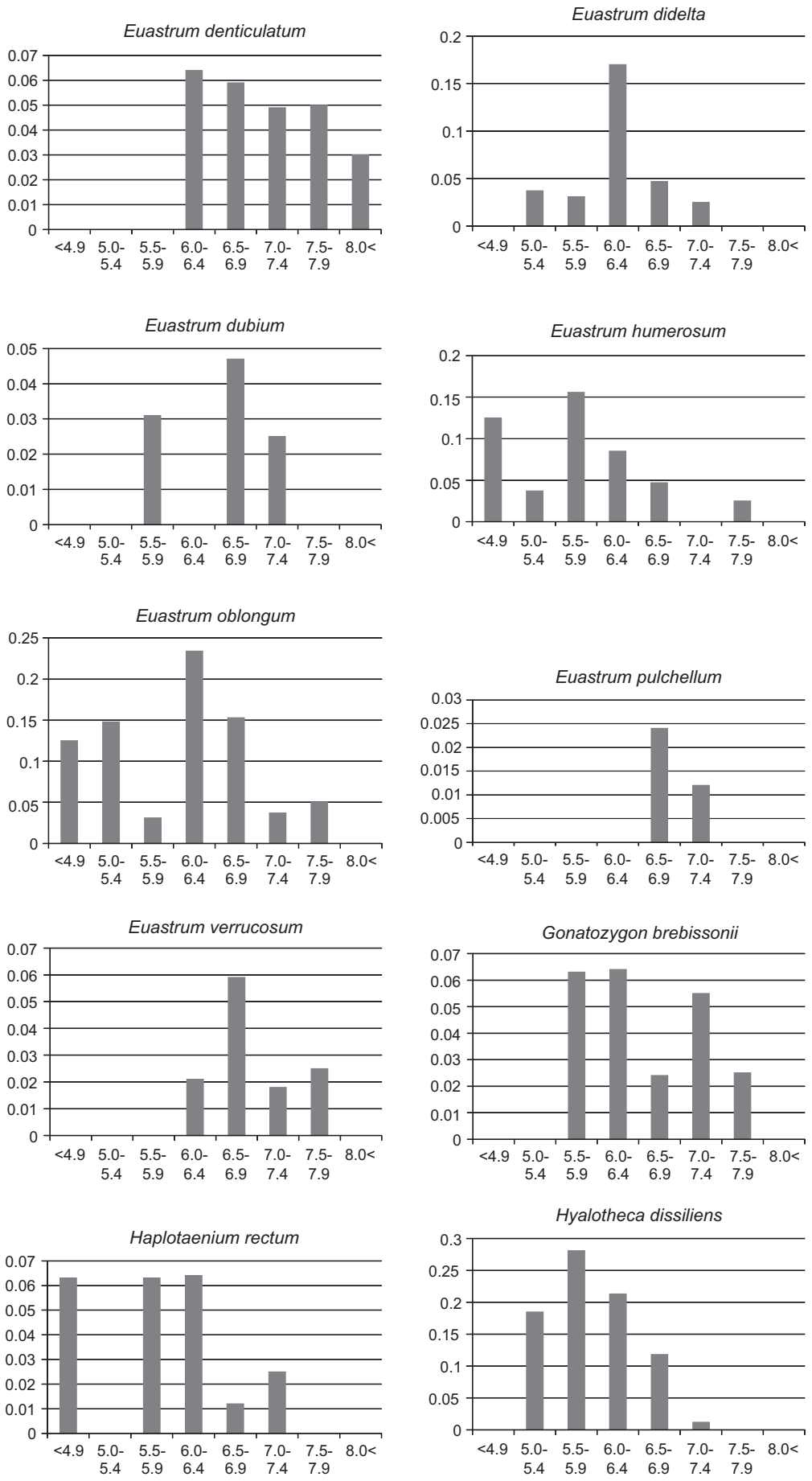

Figure 52a. Continued

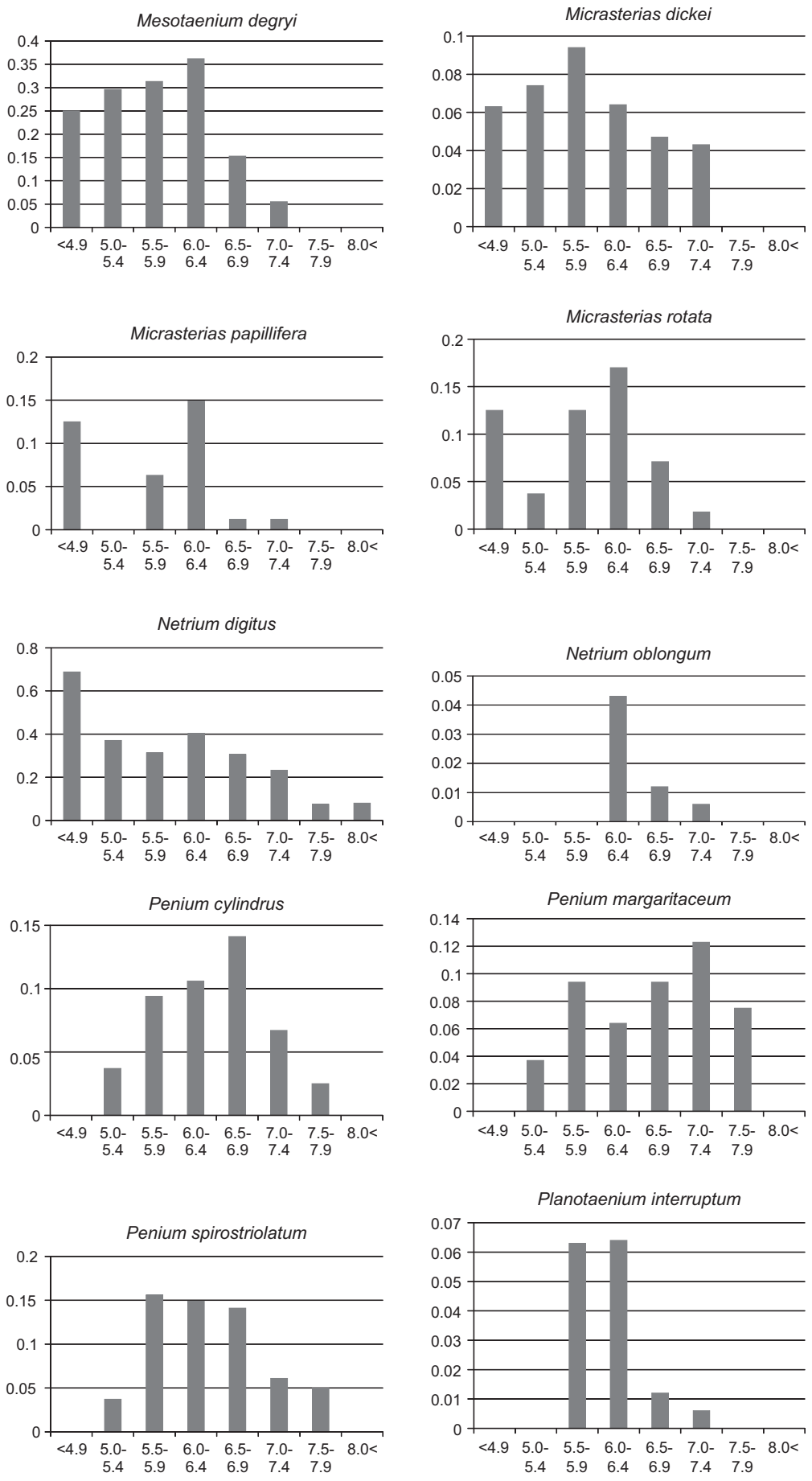

Figure 52a. Continued

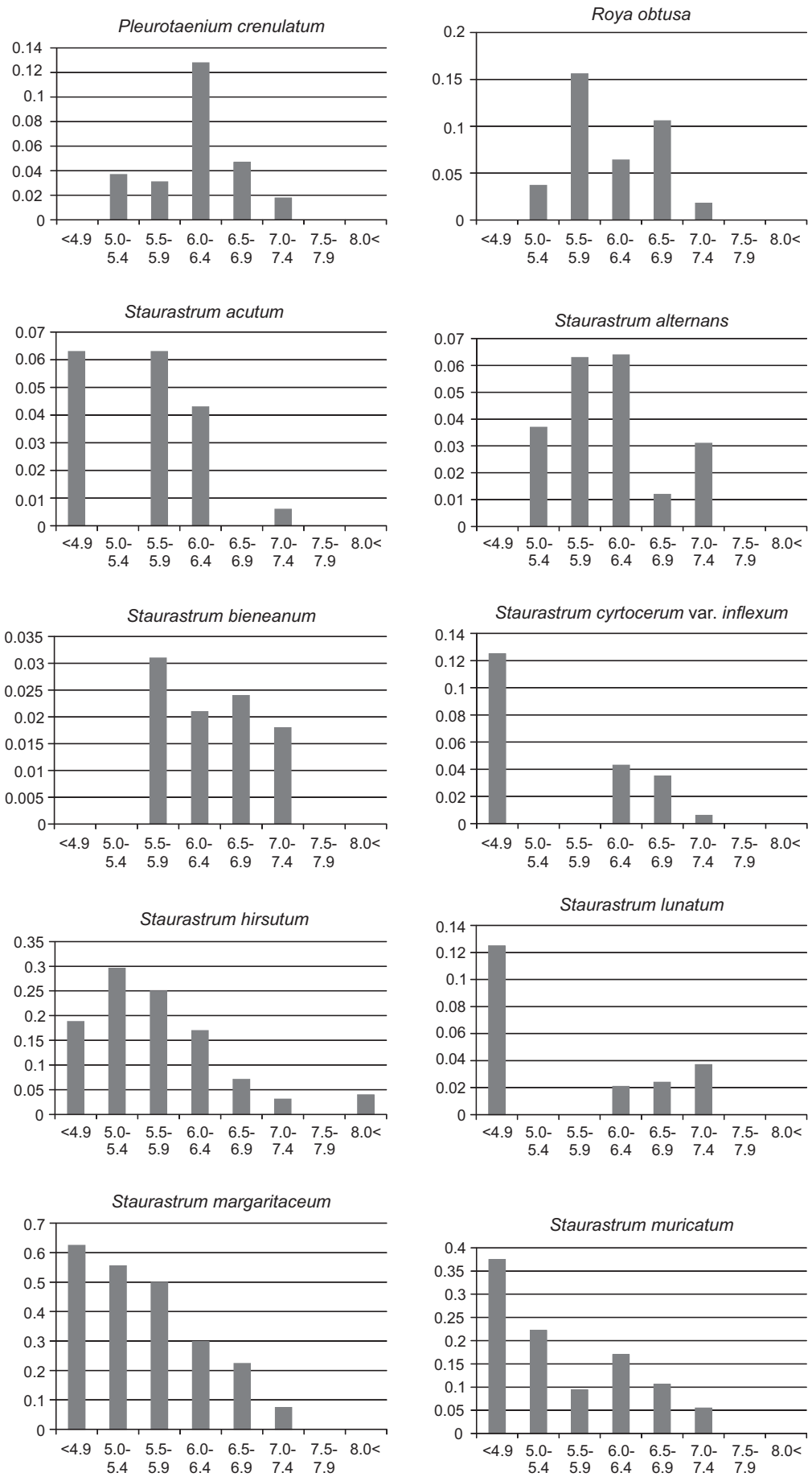

Figure 52a. Continued

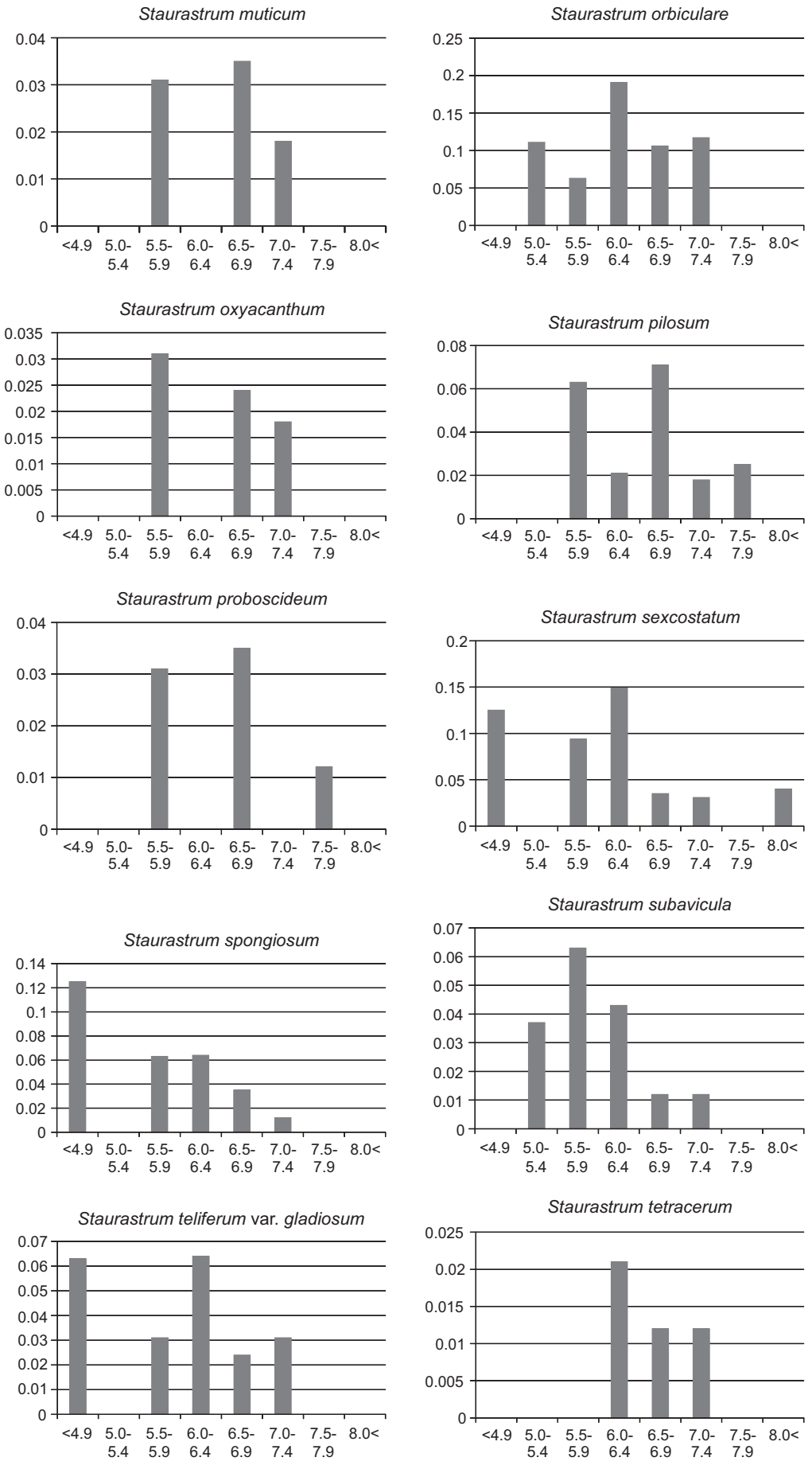

Figure 52a. Continued

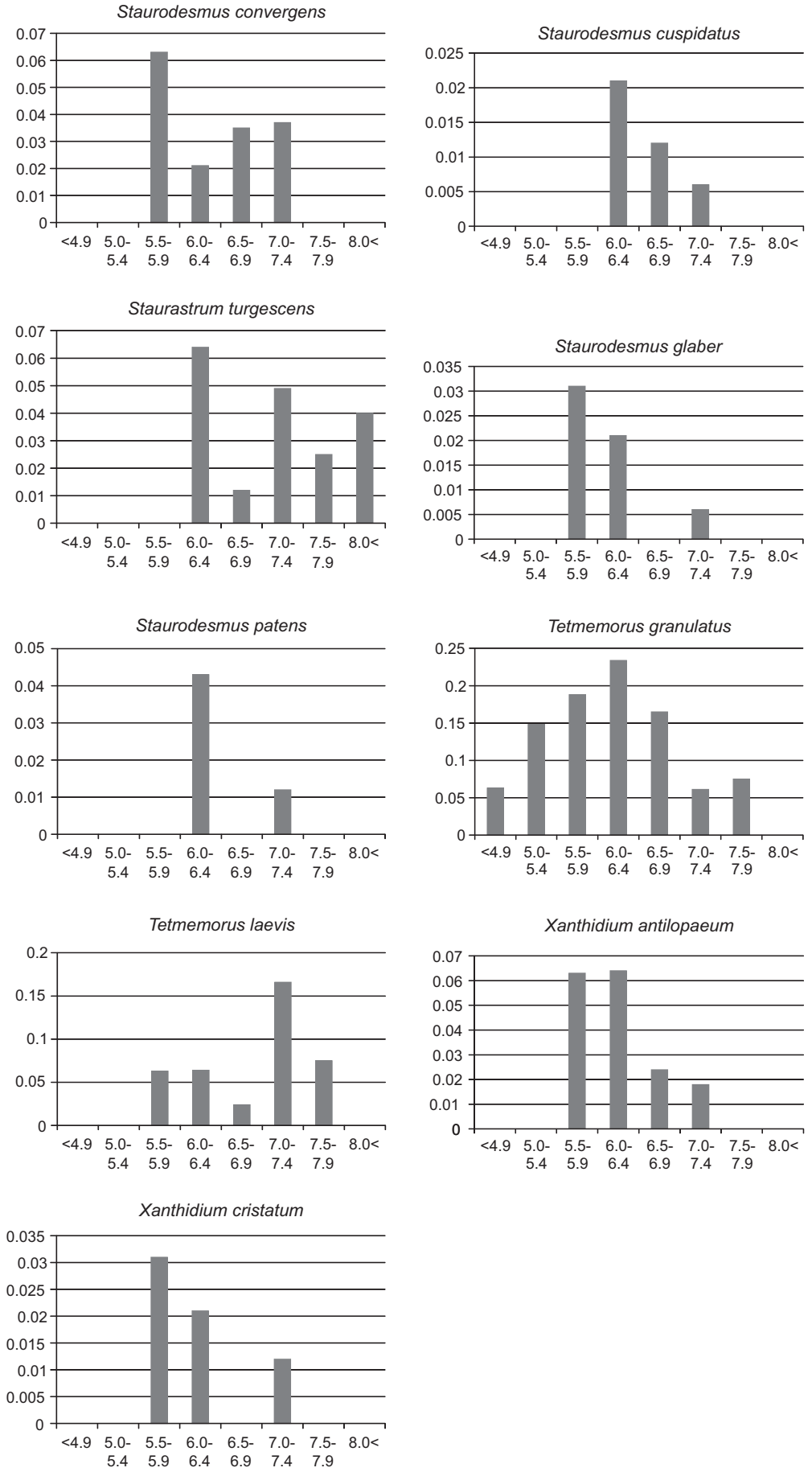

Figure 52a. Continued

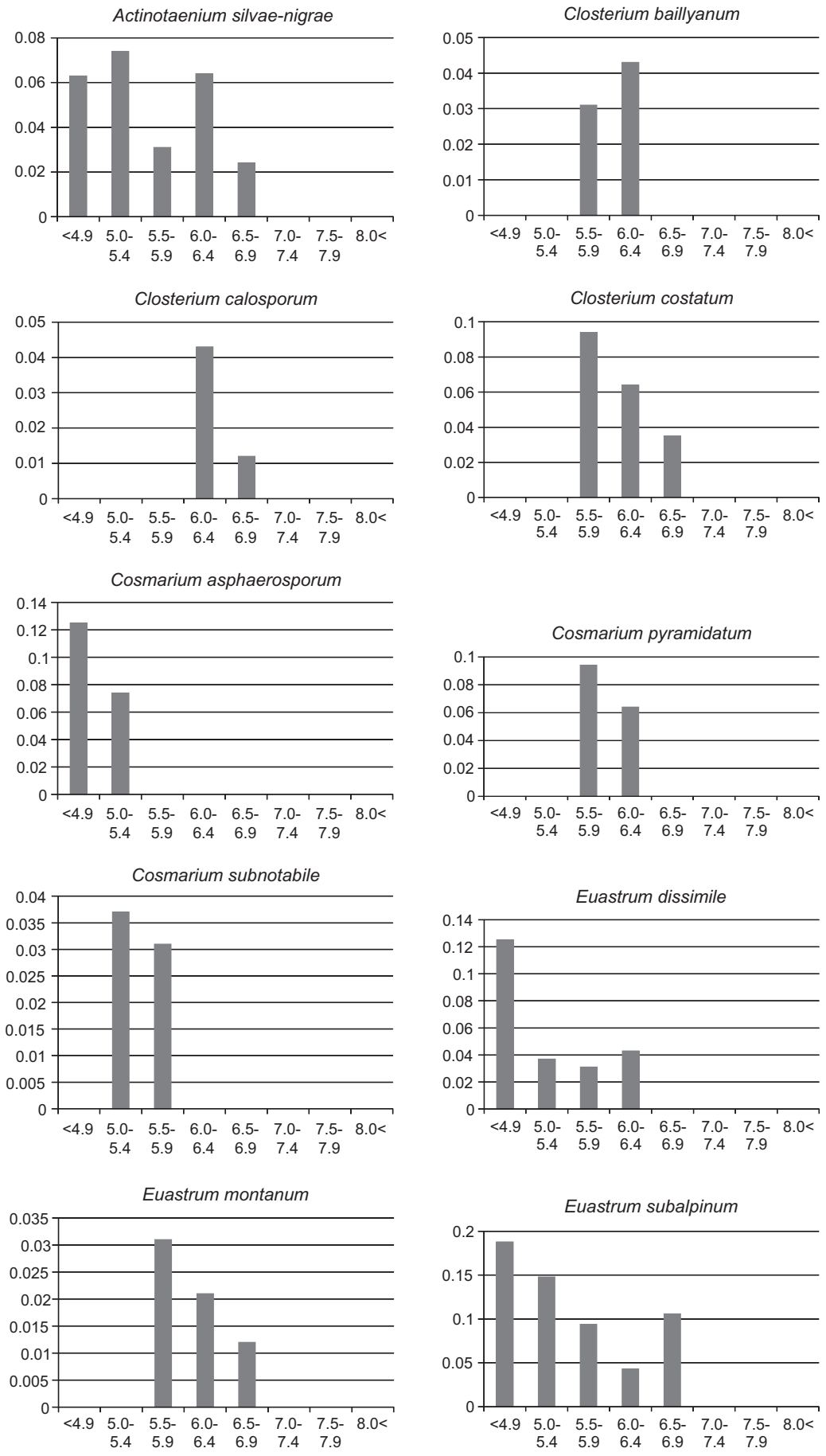

Figure 52b. Frequency of occurrence of desmid species (samples with more than 50 cells in the microscope preparation) in different pH ranges. Acidophilic species resistant to alkalization.

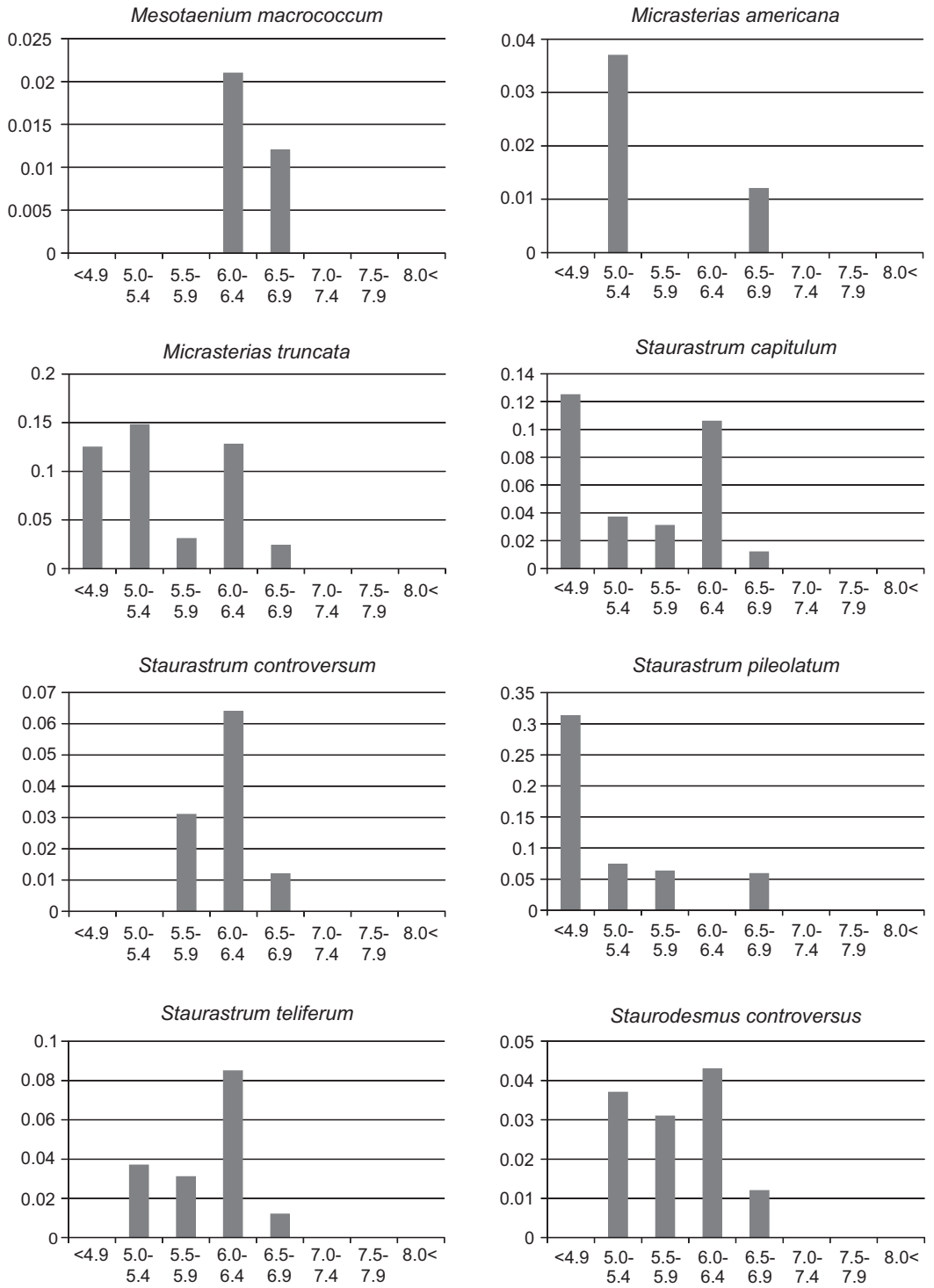

Figure 52b. Continued

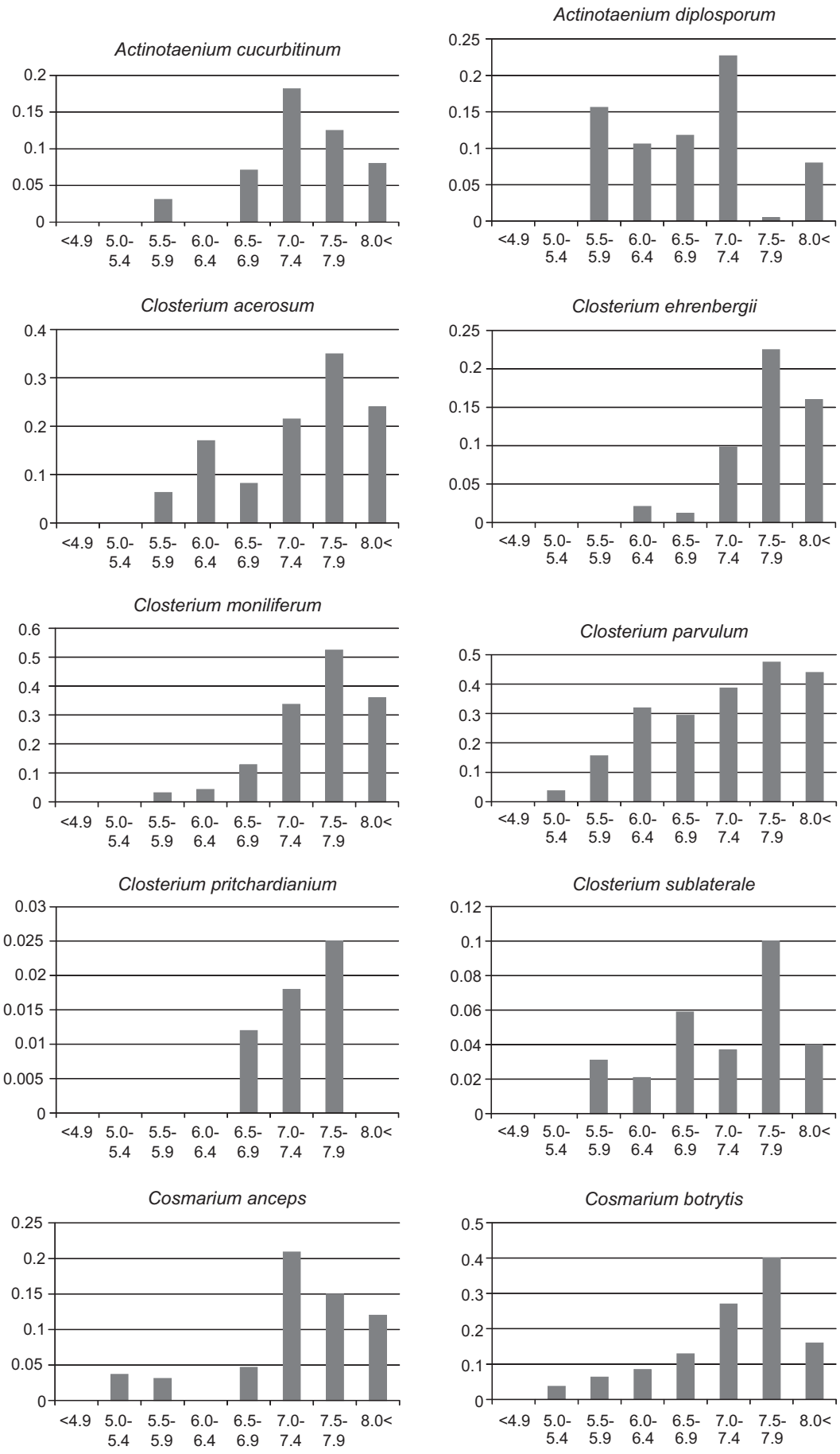

Figure 52c. Frequency of occurrence of desmid species (samples with more than 50 cells in the microscope preparation) in different pH ranges. Alkalophilic species sensitive to acidification.

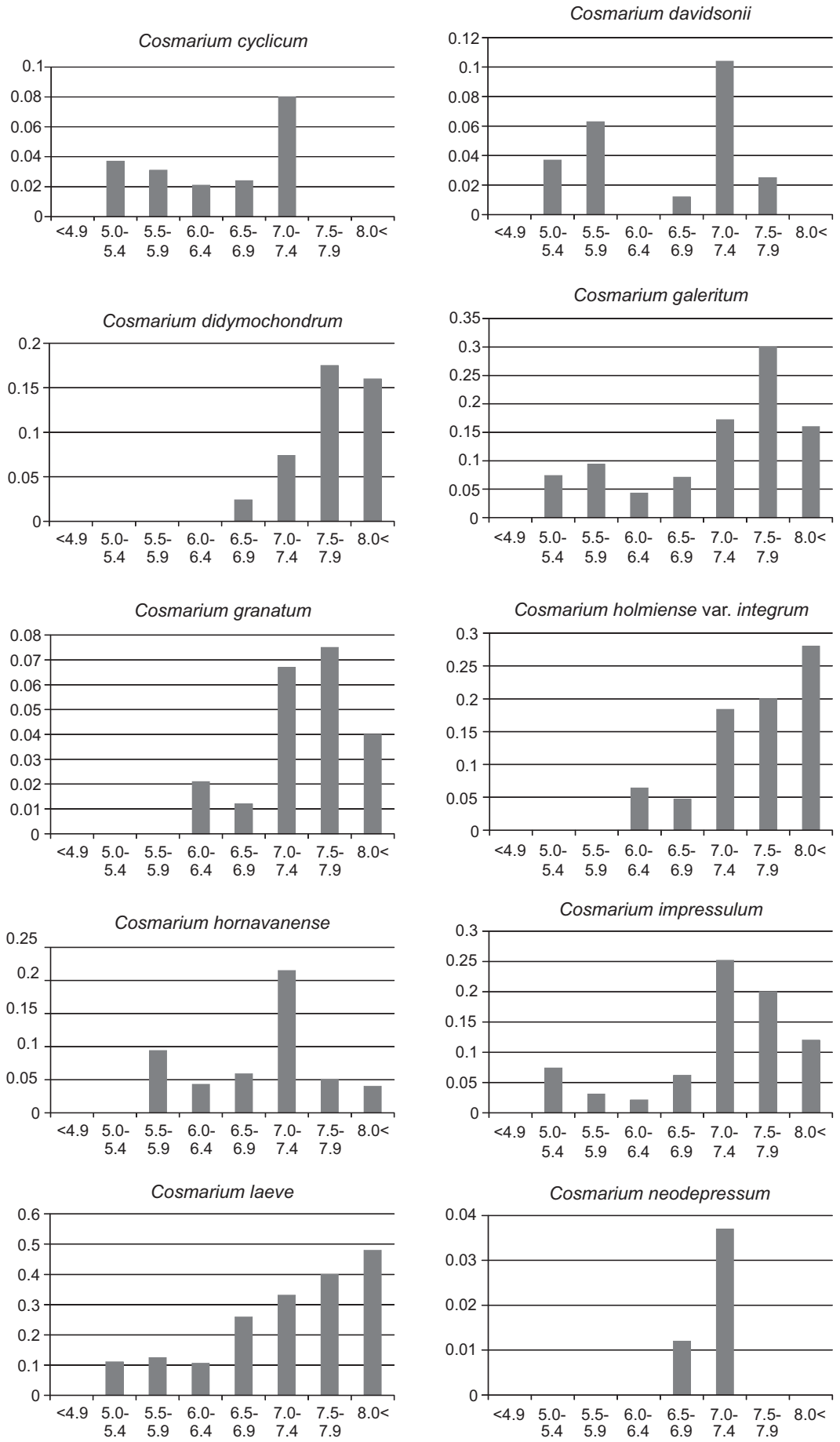

Figure 52c. Continued

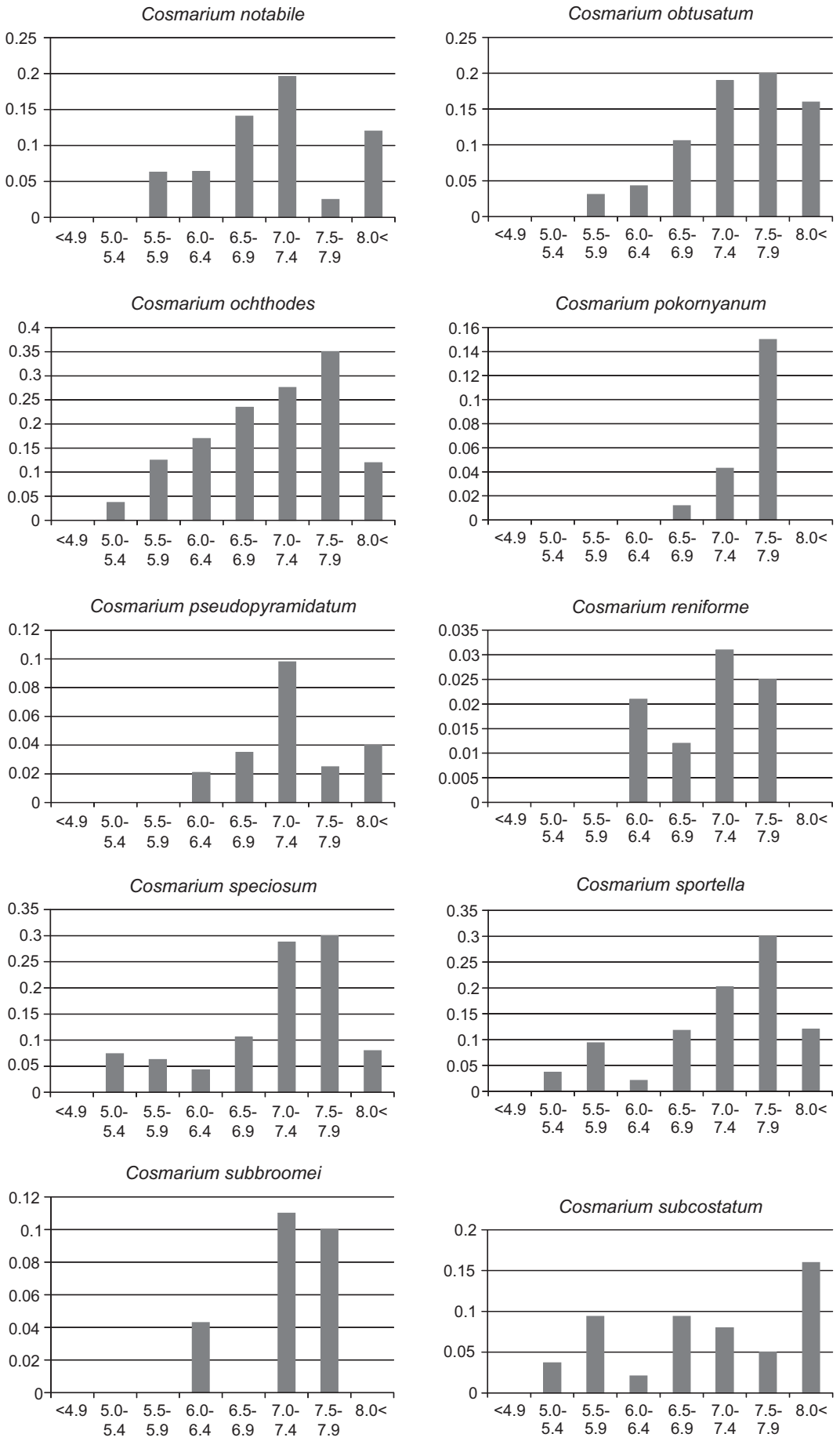

Figure 52c. Continued

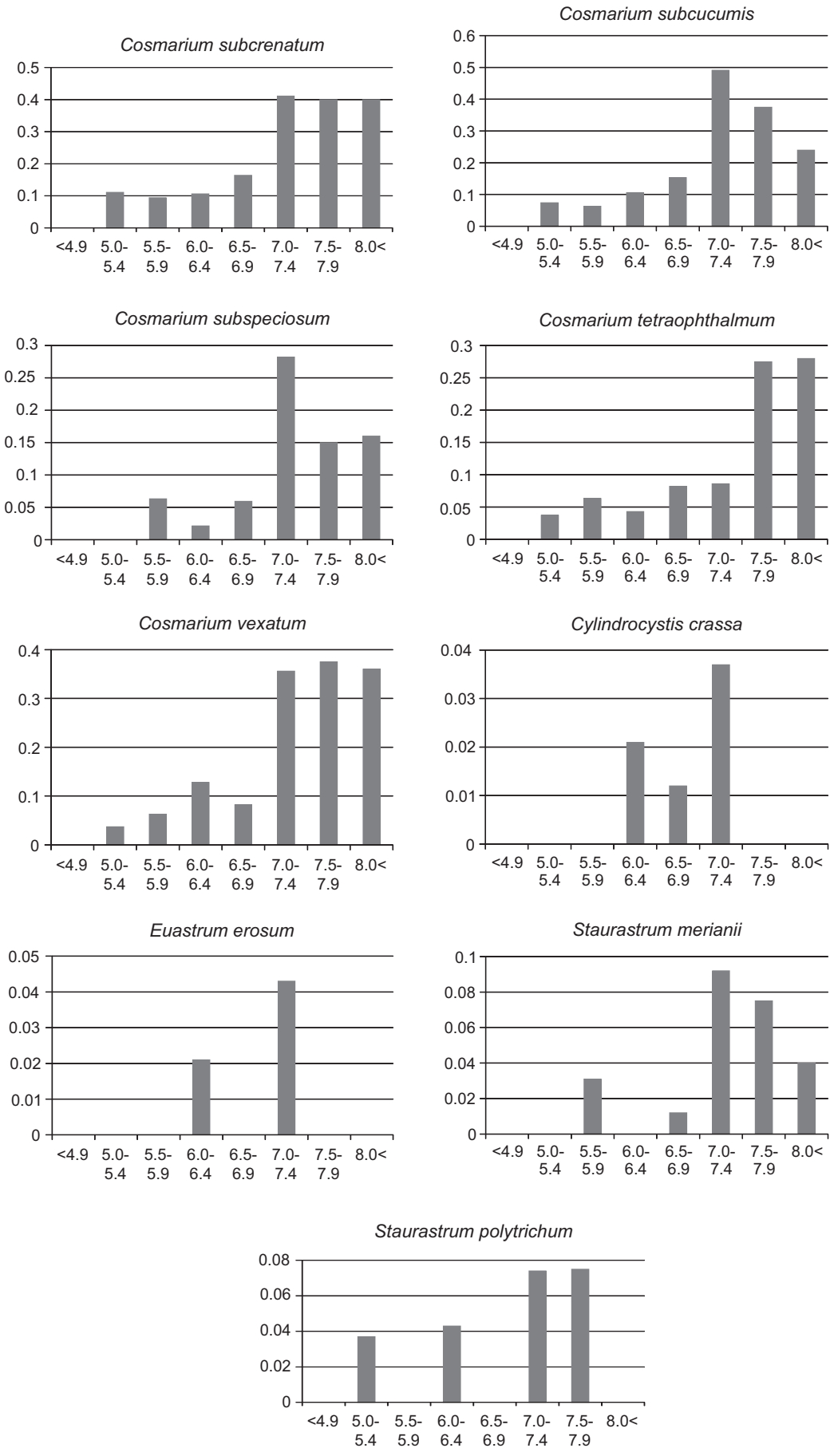

Figure 52c. Continued

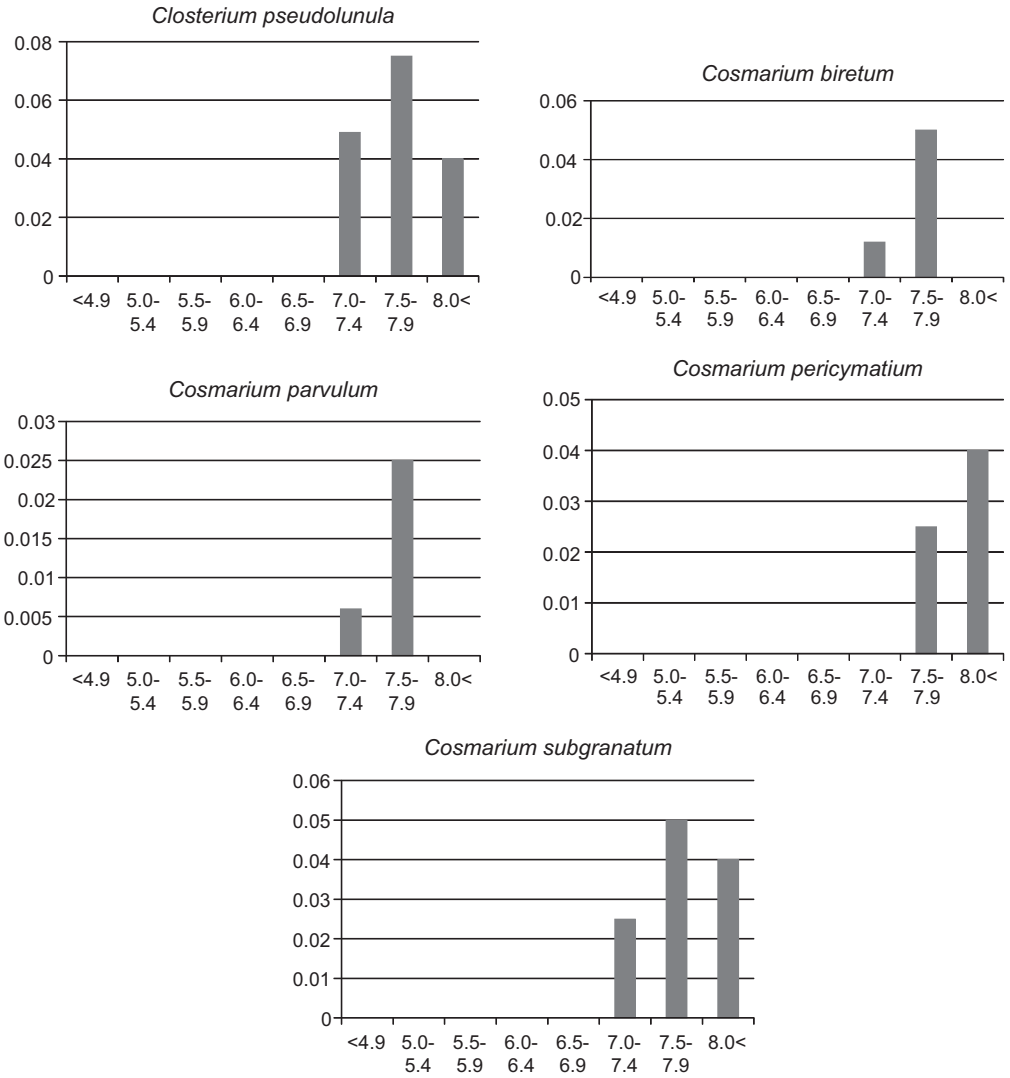

Figure 52d. Frequency of occurrence of desmid species (samples with more than 50 cells in the microscope preparation) in different pH ranges. Alkalophilic species resistant to acidification.

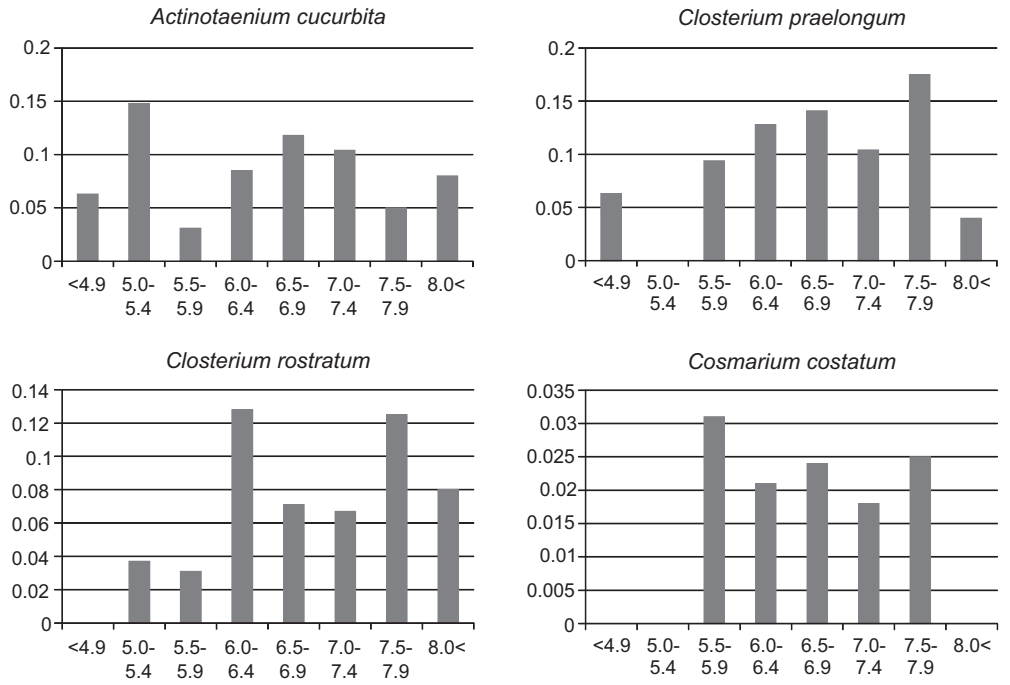

Figure 52e. Frequency of occurrence of desmid species (samples with more than 50 cells in the microscope preparation) in different pH ranges. Species of indeterminate preference.

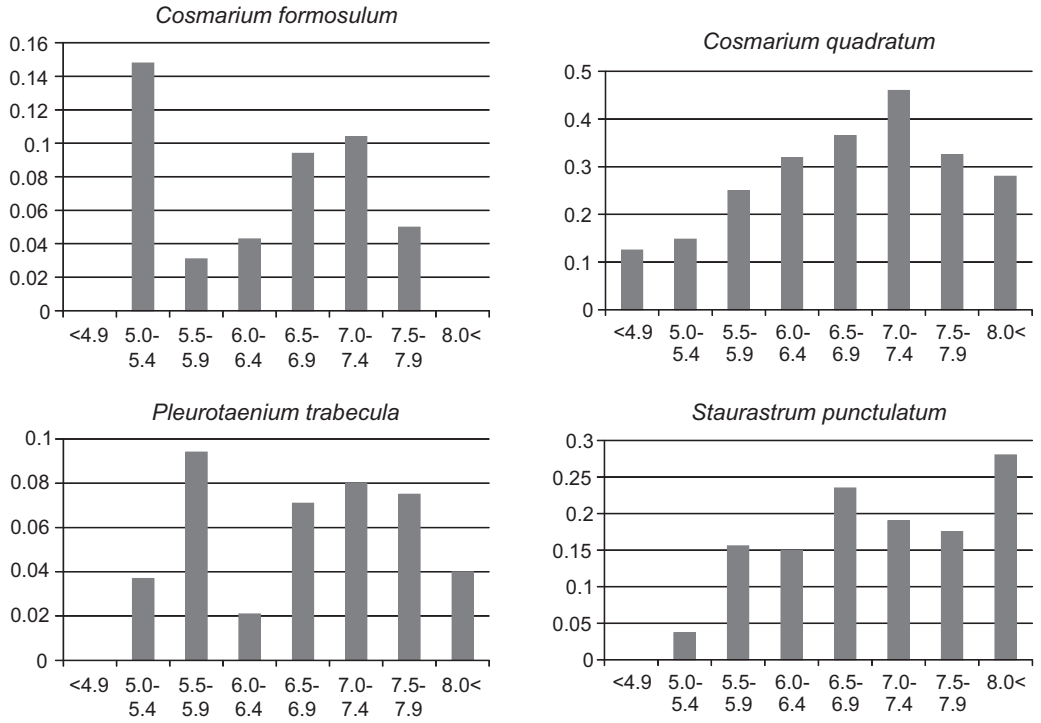

Figure 52e. Continued

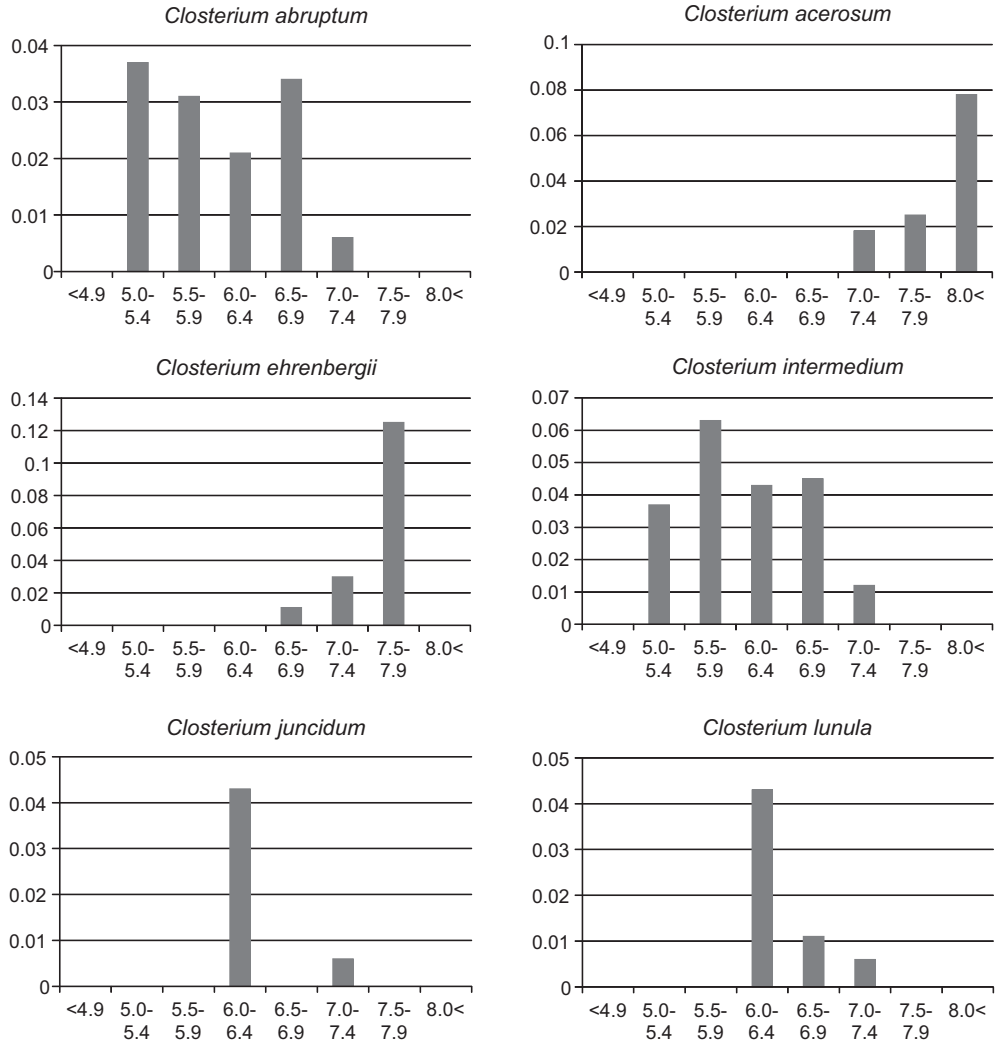

Figure 52f. Frequency of occurrence of desmid species (samples with more than 50 cells in the microscope preparation) in different pH ranges. Frequency of occurrence as first dominant species in different pH ranges.

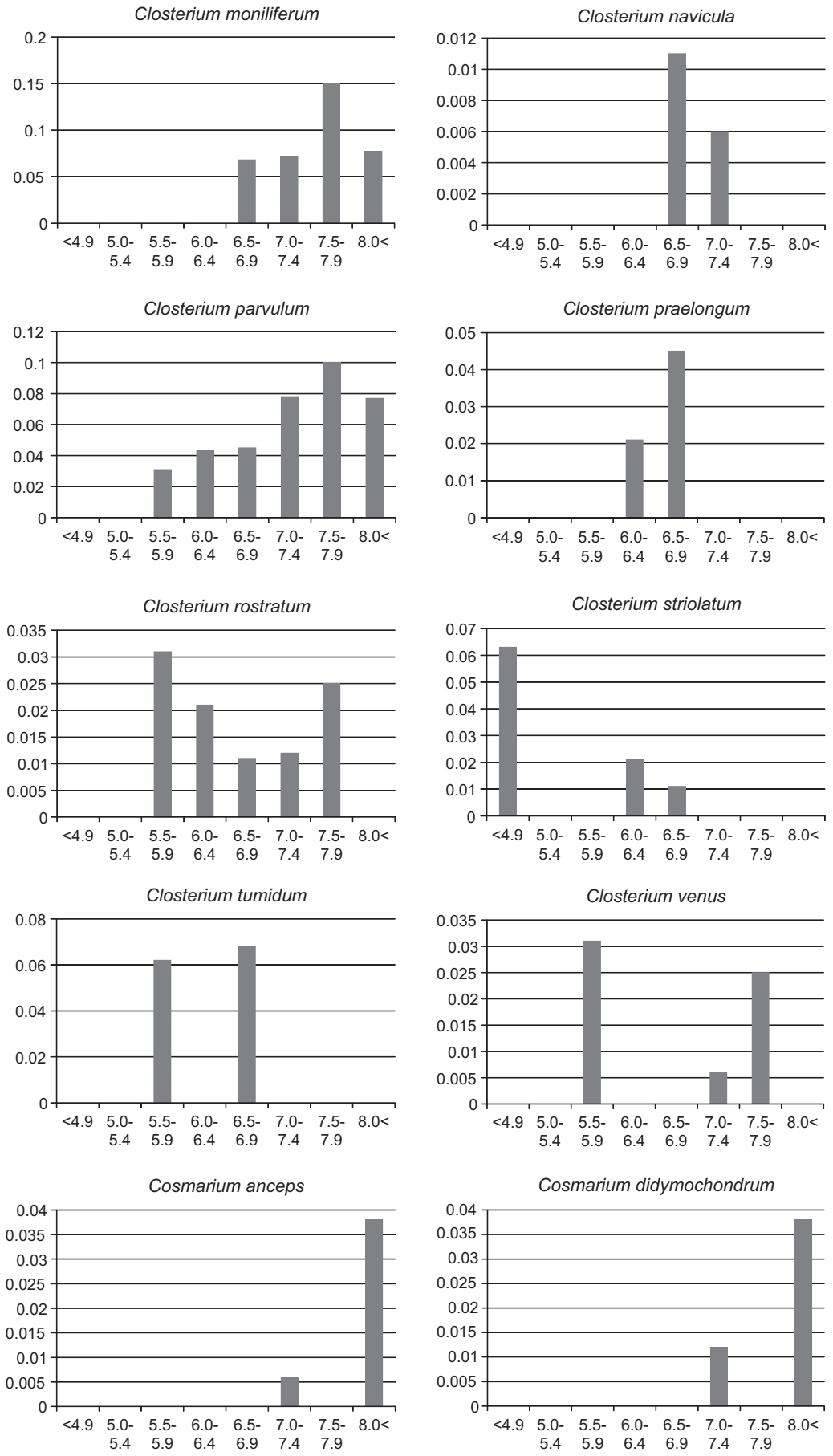

Figure 52f. Frequency of occurrence of desmid species (samples with more than 50 cells in the microscope preparation) in different pH ranges. Frequency of occurrence as first dominant species in different pH ranges.

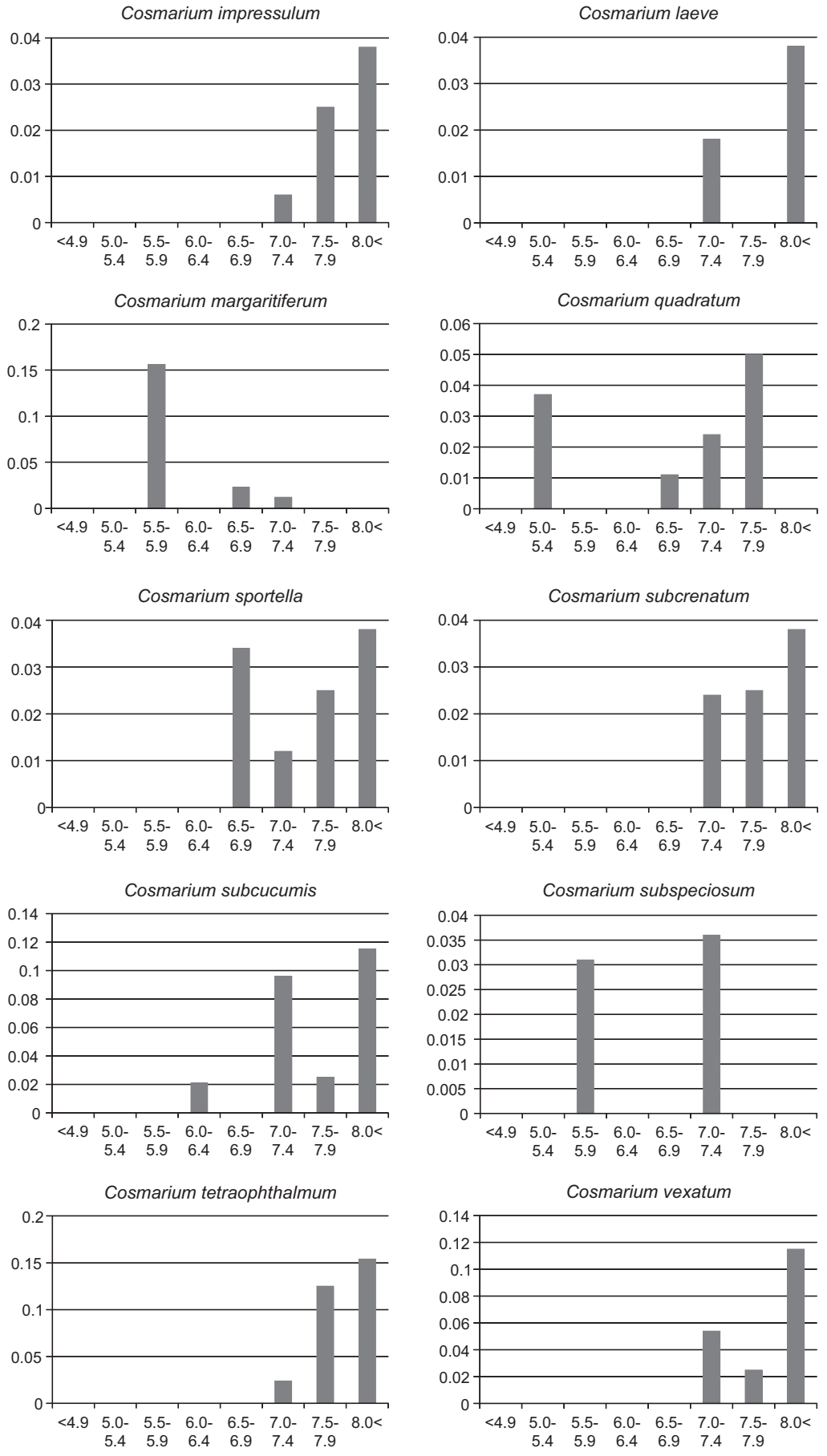

Figure 52f. Continued

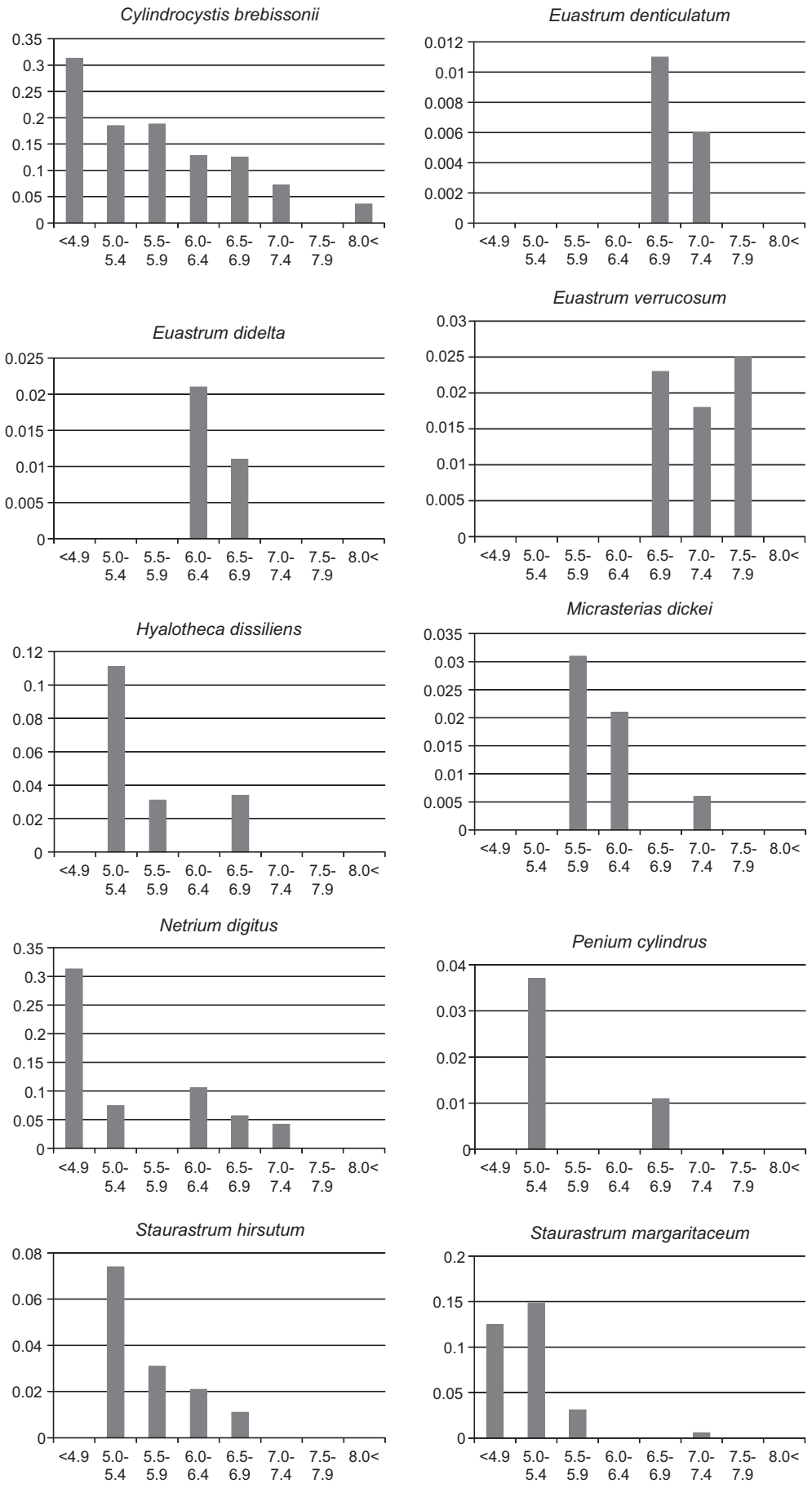

Figure 52f. Continued

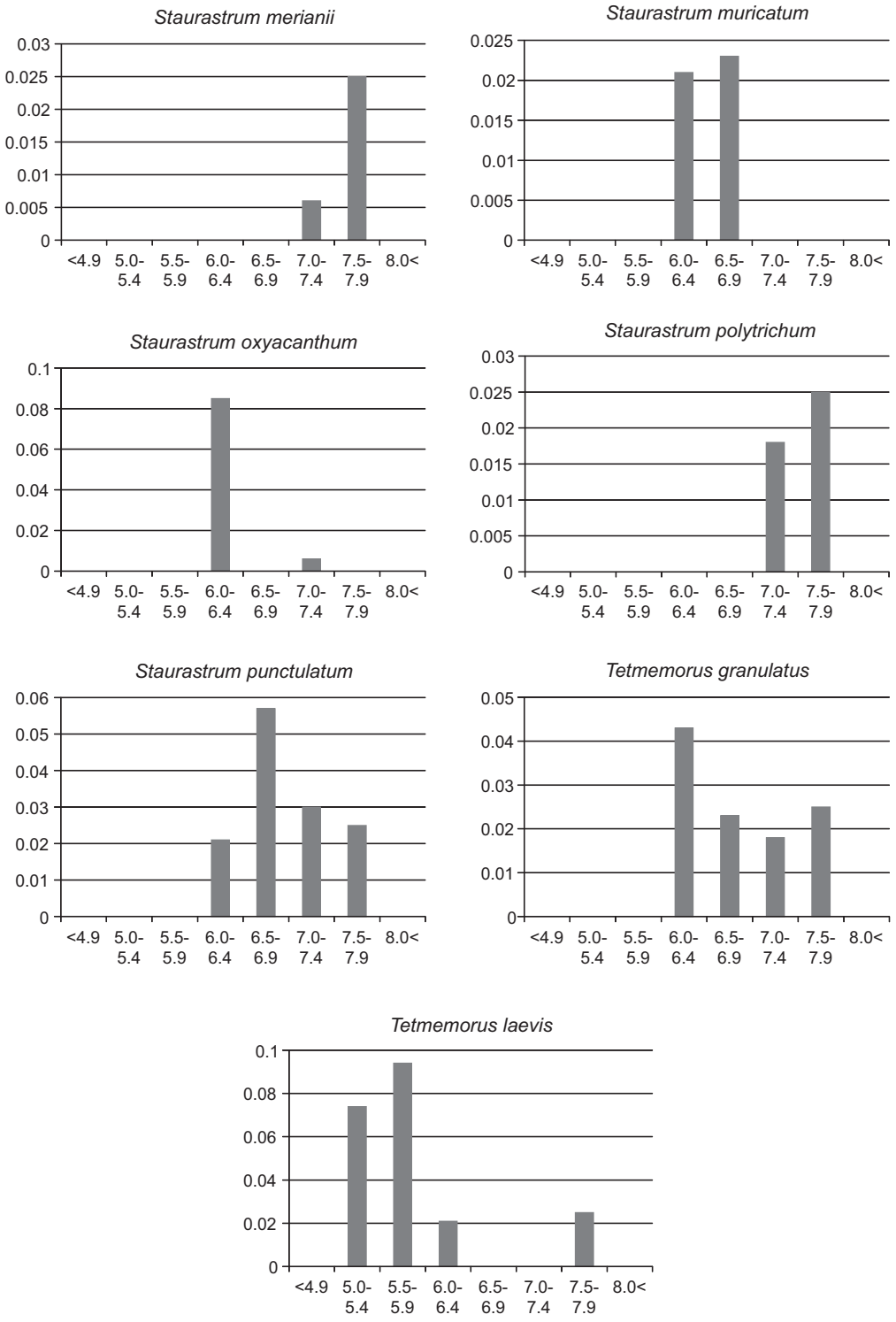

Figure 52f. Continued

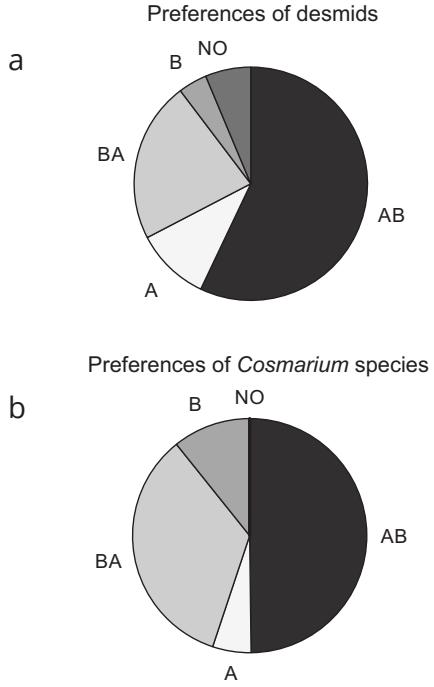

Figure 53. Percentage shares of desmids species (a) and *Cosmarium* species (b) with different pH preferences. AB – acidophilic species resistant to alkalization; A – acidophilic species sensitive to alkalization; BA – alkalophilic species sensitive to acidification; B – alkalophilic species resistant to acidification; NO – species of indeterminate preference.

frequency in acidic waters and avoiding alkaline waters (Fig. 52a).

Acidophilic species resistant to alkalization (AB) – These include species having their highest occurrence in acidic waters, which may also live in alkaline waters. Some of them clearly prefer strongly acidic habitats with pH below 5, but most of them show a preference for moderately acidic waters. These species differ in their tolerance of habitat alkalization. Most of them do not occur at pH 7.0–7.4, and some tolerate more alkaline habitats (Fig. 52b).

Alkalophilic species sensitive to acidification (B) – These include taxa that occur in alkaline habitats and avoid acidic ones (Fig. 52c).

Alkalophilic species resistant to acidification (BA) – These include species preferring alkaline habitats, but occurring even in moderately acidic waters. Most of them reach maximum occurrence at pH 7.0–7.4, and a few occur in more alkaline habitats (Fig. 52d).

Species of indeterminate preference (I) – These species, though occurring abundantly, did not show a strong preference for acidic or for alkaline habitats (Fig. 52e). The reasons for the lack of preference are not clear.

Acidophilic desmids resistant to alkalization formed the largest group (Fig. 53a); it includes 100 species (~57%), of which 38 (21.7%) tolerate habitats with pH above 7.4. Other evidence suggests that this group of species is numerous not only in the Gorce Mts. In Hungary, a number of species described as acidophilic, such as *Penium margaritaceum* (Féher 2003), were found in alkaline habitats. The second most numerous category, with 39 species identified (22.3%), was the group of alkalophilic desmids resistant to acidification. The other

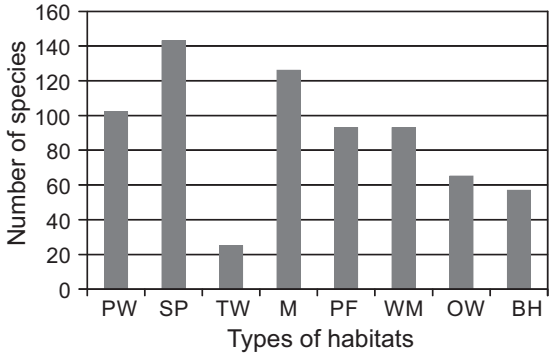

Figure 54. Number of desmid species in different natural and seminatural habitats. PW – polyhumic water bodies, SP – *Sphagnum* puddles, TW – temporary water bodies, M – habitats related to marshes, PF – puddles on the fens, WM – wet mosses from *Bryidae* class on marshes, OW – old wells, BH – brook habitats.

groups were much less numerous. Acidophilic desmids sensitive to alkalization were represented by 18 species (10.3%), alkalophilic species sensitive to acidification by 7 species (~4%), and taxa of indeterminate preference by 11 species (6.3%). Species associated with acidic habitats (A, AB) constituted 67.3%, and species associated with alkaline habitats (B, BA) 26.3%. Such findings are consistent with results from other phycologists suggesting that desmids generally prefer acidic waters (Brook 1981; Gerrath 1993). Representatives of the genus *Cosmarium* (Fig. 53b) behaved in a completely different way: 28 species were acidophilic and resistant to alkalization (39.4%), 27 species were alkalophilic and resistant to acidification (~27%), 3 species were acidophilic and sensitive to alkalization (4.2%), and 6 species were alkalophilic and sensitive to acidification: (8.4%). Species that prefer acidic habitats constituted 43.6% of the total number, and those preferring alkaline habitats accounted for 46.5%.

The factors determining the preferences of each species are probably complex; varying pH range is not the only factor that differentiates their habitats.

Occurrence of desmids in different types of habitats

In the Gorce Mts, desmids were found in various natural habitats: polyhumic waterbodies (102 species), *Sphagnum* puddles (143), habitats associated with streams (57), temporary waterbodies (25) and marshes (126). They were also found in anthropogenic habitats, which are characterized in the chapter that discusses the influence of humans on the desmid flora of the Gorce Mts. Table 3 presents the occurrence of species in different types of natural and semi-natural habitats of the Gorce Mts, Figure 54 gives the number of desmid species in the most important types of habitats there, Figure 55 shows the shares of genera in the most important habitat types, and Figure 56 covers frequency of desmid species occurrence in different habitats.

Polyhumic waterbodies

This type of habitat is known for its abundance of desmids (Brook 1981; Gerrath 1993). There are three polyhumic

Table 3. List of desmid species occurring in different natural and seminatural habitats: PW – polyhumic water bodies, SP – *Sphagnum* puddles, PM – puddles on marshes, WM – wet mosses from *Bryidae* class on marshes, OW – old wells, BH – habitats related to mountain streams (species recorded from only one locality are bolded).

Name of taxa	PW	SP	PM	WM	OW	BH
Actinotaenium borgeanum	–	1	–	1	–	–
Actinotaenium cruciferum	–	1	1	1	–	–
Actinotaenium cucurbita	1	1	1	1	–	1
Actinotaenium cucurbitinum	–	–	1	1	1	1
Actinotaenium diplosporum	–	1	1	1	1	–
Actinotaenium didymocarpum	–	1	1	–	–	–
Actinotaenium gelidum	1	–	1	–	–	–
Actinotaenium perminutum	–	1	1	1	–	–
Actinotaenium silvae-nigrae	–	1	–	1	–	–
Actinotaenium spinospermum	–	1	–	1	–	–
Actinotaenium turgidum	1	1	–	–	–	–
Closterium abruptum	1	1	1	–	1	1
Closterium acerosum	–	–	1	1	1	1
Closterium acutum	1	1	–	–	–	–
Closterium baillyanum	1	1	–	–	–	–
Closterium calosporum	–	1	–	–	–	–
Closterium closterioides	–	1	–	–	–	–
Closterium costatum	1	1	–	–	1	–
Closterium cynthia	–	1	–	1	–	–
Closterium dianae	1	1	1	1	–	–
Closterium ehrenbergii	1	–	1	1	1	1
Closterium exile	–	1	–	–	–	–
Closterium idiosporum	–	–	1	–	–	–
Closterium intermedium	1	1	1	1	1	1
Closterium juncidum	1	1	1	1	1	1
Closterium kuetzingii	1	–	1	–	1	1
Closterium lineatum	–	–	–	–	1	–
Closterium littorale	–	1	1	1	1	1
Closterium lunula	1	1	1	–	1	–
Closterium moniliferum	1	–	1	1	1	1
Closterium navicula	1	1	1	1	1	1
Closterium parvulum	1	1	1	1	1	1
Closterium praelongum	1	1	1	1	1	1
Closterium pritchardianum	–	–	1	1	–	1
Closterium pronum	1	–	–	–	–	–
Closterium pseudolunula	–	–	1	1	–	1
Closterium pusillum	–	1	1	–	–	–
Closterium pygmaeum	–	–	1	1	–	–
Closterium rostratum	–	1	1	1	1	1
Closterium strigosum	–	1	–	1	–	–
Closterium striolatum	1	1	–	–	1	1
Closterium sublaterale	–	–	1	1	1	–
Closterium tumidulum	–	1	–	1	–	–
Closterium tumidum	–	1	1	–	1	1
Closterium turgidum	1	–	–	–	–	–
Closterium venus	1	1	–	–	–	–
Cosmarium alpestre	–	1	–	–	–	–
Cosmarium anceps	–	1	–	1	1	1
Cosmarium angulosum	–	1	–	–	1	–
Cosmarium annulatum	–	–	–	1	–	–
Cosmarium asphaerosporum	–	1	–	–	–	–
Cosmarium biretum	–	–	–	1	–	–
Cosmarium blyttii	–	1	1	–	–	–
Cosmarium boeckii	1	1	–	–	–	–
Cosmarium botrytis	–	1	1	1	1	1
Cosmarium caelatum	1	1	1	1	1	–
Cosmarium connatum	1	1	–	–	–	–
Cosmarium conspersum	1	–	1	–	–	–
Cosmarium contractum	–	1	–	–	1	–
Cosmarium costatum	–	–	1	1	1	–
Cosmarium crenatum	–	–	–	1	–	1
Cosmarium crenulatum	–	–	–	–	–	1
Cosmarium cyclicum	–	1	1	1	1	–
Cosmarium cymatopleurum	–	–	–	–	1	–
Cosmarium davidsonii	–	–	1	1	1	1
Cosmarium debaryi	1	1	–	–	–	–
Cosmarium decedens	–	–	–	–	1	–
Cosmarium dentiferum	–	1	1	–	1	–
Cosmarium depressum	1	–	–	–	–	–
Cosmarium didymochondrum	–	–	1	1	1	1
Cosmarium difficile	–	1	1	–	–	–
Cosmarium dispersum	–	1	–	–	–	–
Cosmarium elegantissimum	–	1	1	1	1	–
Cosmarium exiguum	–	–	–	1	–	–
Cosmarium formosulum	1	1	1	1	1	1
Cosmarium galeritum	–	1	1	1	1	1
Cosmarium garrolense	–	–	–	1	–	–
Cosmarium gonioides	–	1	–	–	–	–
Cosmarium granatum	–	–	1	1	1	1
Cosmarium hammeri	–	–	–	1	–	–
Cosmarium holmiense var. *holmiense*	–	–	–	1	–	–
Cosmarium holmiense var. *integrum*	–	–	1	1	1	1
Cosmarium hornavanense	–	1	1	1	1	–
Cosmarium humile	1	1	–	–	–	–
Cosmarium impressulum	–	1	1	1	1	1
Cosmarium jenisejense	–	1	–	–	–	–
Cosmarium laeve	1	1	1	1	1	1
Cosmarium limnophilum	1	1	–	–	–	–
Cosmarium majae	1	–	–	–	–	–
Cosmarium margaritatum	1	1	–	–	–	–
Cosmarium margaritiferum	1	1	–	–	1	–
Cosmarium meneghinii	1	–	–	–	–	–
Cosmarium nasutum	–	1	1	1	1	–
Cosmarium nitidulum	–	–	1	–	–	–
Cosmarium notabile	–	1	–	1	1	1
Cosmarium novae-semliae	–	–	1	–	–	–
Cosmarium obliquum	–	–	1	1	–	–
Cosmarium obtusatum	1	1	1	1	1	1
Cosmarium ochthodes	–	1	1	1	1	1
Cosmarium ornatum	–	1	–	–	–	–
Cosmarium pachydermum	–	1	–	1	1	–
Cosmarium paragranatoides	1	1	–	–	–	–
Cosmarium parvulum	–	–	–	–	–	1
Cosmarium pericymatium	–	–	–	–	–	1
Cosmarium pokornyanum	–	–	1	1	1	1
Cosmarium porteanum	1	1	–	–	–	–
Cosmarium praemorsum	–	1	–	–	–	–
Cosmarium pseudopyramidatum	–	1	1	1	1	–
Cosmarium pulcherrimum	–	–	–	–	1	–
Cosmarium pyramidatum	–	1	–	–	–	–
Cosmarium quadratum	1	1	1	1	1	1
Cosmarium quadratulum	–	–	–	1	–	–

Table 3. Continued

Name of taxa	PW	SP	PM	WM	OW	BH
Cosmarium quadrum	1	1	–	–	–	–
Cosmarium rectangulare	1	1	–	–	–	–
Cosmarium regnellii	1	1	1	1	1	–
Cosmarium reniforme	1	–	–	–	1	–
Cosmarium sexnotatum	–	–	–	1	–	–
Cosmarium speciosum	–	1	1	1	1	1
Cosmarium sphagnicola	1	–	–	–	–	–
Cosmarium sphalerostichum	–	1	1	1	1	–
Cosmarium sportella	–	1	1	1	1	1
Cosmarium staurastroides	–	1	–	–	–	–
Cosmarium subarctoum	–	1	1	–	–	–
Cosmarium subbroomei	–	1	1	1	–	–
Cosmarium subcostatum	–	–	–	1	1	1
Cosmarium subcrenatum	–	–	1	1	1	1
Cosmarium subcucumis	–	–	1	1	1	1
Cosmarium subgranatum	–	–	1	1	1	1
Cosmarium subnotabile	–	1	–	–	–	1
Cosmarium subquadratum	–	–	–	1	–	–
Cosmarium subspeciosum	–	–	1	1	1	1
Cosmarium tatricum	–	–	–	1	–	–
Cosmarium tetragonum	–	–	–	1	1	–
Cosmarium tetraophthalmum	1	1	1	1	1	1
Cosmarium thwaitesii	–	–	–	1	–	–
Cosmarium tinctum	–	–	1	1	–	–
Cosmarium venustum	–	1	–	–	–	–
Cosmarium vexatum	–	1	1	1	1	1
Cylindrocystis brebissonii	1	1	1	1	1	1
Cylindrocystis crassa	–	1	1	1	1	–
Desmidium grevillei	1	–	–	–	–	–
Desmidium swartzii	1	1	–	–	–	–
Euastrum ansatum	1	1	–	–	–	–
Euastrum bidentatum	1	1	1	–	1	–
Euastrum binale	1	1	–	1	–	–
Euastrum denticulatum	–	–	–	–	1	–
Euastrum didelta	1	1	–	–	–	–
Euastrum dissimile	–	1	–	–	–	–
Euastrum dubium	1	1	–	–	–	–
Euastrum gayanum	1	–	–	–	–	–
Euastrum humerosum	1	1	–	–	1	–
Euastrum insigne	–	1	–	–	–	–
Euastrum montanum	–	1	–	–	–	–
Euastrum oblongum	1	1	1	1	1	–
Euastrum pulchellum	1	–	–	–	–	–
Euastrum subalpinum	1	1	–	–	–	–
Euastrum verrucosum	–	1	1	–	1	–
Gonatozygon brebissonii	–	–	1	1	1	–
Haplotaenium rectum	1	1	–	–	–	–
Hyalotheca dissiliens	1	1	1	–	1	–
Mesotaenium degreyi	–	1	1	–	1	–
Micrasterias dickiei	1	1	–	–	–	–
Micrasterias papillifera	1	1	–	–	–	–
Micrasterias rotata	1	1	–	–	–	–
Micrasterias truncata	1	1	1	–	–	–
Netrium digitus	1	1	1	–	1	–
Penium cylindrus	1	1	1	1	–	1
Penium margaritaceum	1	–	1	1	1	1
Penium spirostriolatum	1	1	1	–	–	1
Planotaenium interruptum	–	1	–	–	–	–
Pleutotaenium crenulatum	1	1	–	–	–	–
Pleutotaenium ehrenbergii	–	1	–	–	–	–
Pleutotaenium trabecula	–	1	1	1	1	1
Roya obtusa	–	1	1	1	–	–
Spirotaenia obscura	–	–	–	1	–	–
Spondylosium pulchellum	1	–	–	–	–	–
Staurastrum aculeatum	1	1	–	–	–	–
Staurastrum acutum	1	1	–	–	–	–
Staurastrum alternans	1	1	–	–	–	–
Staurastrum arcuatum	–	1	–	–	–	–
Staurastrum avicula	1	–	–	–	–	–
Staurastrum bieneanum	1	1	–	–	–	–
Staurastrum botrophilum	–	–	–	1	–	–
Staurastrum capitulum	–	1	–	–	–	–
Staurastrum controversum	1	–	–	–	–	–
Staurastrum dispar	–	1	–	–	–	–
Staurastrum furcatum	1	–	–	–	–	–
Staurastrum gladiosum	1	1	–	–	–	–
Staurastrum hexacerum	–	–	–	–	1	–
Staurastrum hirsutum	–	1	–	–	1	–
Staurastrum inflexum	1	1	–	–	–	–
Staurastrum lunatum	1	–	–	–	–	–
Staurastrum margaritaceum	1	1	1	–	–	1
Staurastrum merianii	–	–	1	1	1	–
Staurastrum muricatum	1	1	–	–	–	–
Staurastrum muticum	1	1	–	–	–	–
Staurastrum orbiculare	1	1	–	1	–	–
Staurastrum oxyacanthum	1	1	–	–	–	–
Staurastrum pileolatum	–	1	–	–	–	–
Staurastrum pilosum	1	1	1	–	1	1
Staurastrum polymorphum	1	–	–	–	–	–
Staurastrum polytrichum	–	–	1	–	1	–
Staurastrum proboscideum	1	1	–	–	–	–
Staurastrum punctulatum	1	–	1	1	1	1
Staurastrum pungens	–	1	–	–	–	–
Staurastrum pyramidatum	–	–	1	–	–	–
Staurastrum scabrum	–	–	–	–	–	1
Staurastrum sexcostatum	1	–	1	–	–	–
Staurastrum spongiosum	–	1	–	–	–	–
Staurastrum subavicula	1	–	–	–	–	–
Staurastrum subbrebissonii	–	1	1	–	1	–
Staurastrum teliferum	1	1	–	–	–	–
Staurastrum tetracerum	1	–	–	–	–	–
Staurastrum turgescens	–	–	–	1	–	–
Staurodesmus convergens	1	1	–	–	–	–
Staurodesmus cuspidatus	1	1	–	–	–	–
Staurodesmus extensus	–	1	–	–	–	–
Staurodesmus glaber	1	–	–	–	–	–
Staurodesmus patens	1	–	–	–	–	–
Teilingia granulata	1	–	–	–	–	–
Tetmemorus granulatus	1	1	1	1	1	1
Tetmemorus laevis	1	1	1	1	1	–
Xanthidium antilopaeum	1	1	–	–	–	–
Xanthidium cristatum	1	1	–	–	–	–
	102	143	93	93	85	57

waterbodies in the Gorce area. They are characterized by intensive brown color and overgrowth of *Sphagnum* mosses on their edges. These are shallow reservoirs rarely exceeding one meter depth. Their depth varies greatly during the year, sometimes reaching only a few centimeters during drought.

Reservoir in Polana Tokarnia meadow (Jeziorne peatland) in the Lubań range. This is the species-richest locality in the Gorce Mts; 102 species were found here. Its pH ranged from 6.5 to 7.2, and ionic conductivity from 42 to 82 µS. Cyanophytes of the genera *Anabaena*, *Gomphosphaeria*, *Nostoc* and *Tolypothrix* occur abundantly in the plankton, sometimes forming blooms, along with numerous filamentous green algae of the genera *Spirogyra*, *Stigeoclonium* and *Zygnema*. This waterbody was recorded as the only station in the Gorce Mts for a number of species (e.g., *Closterium pronum*, *Cl. turgidum*, *Cosmarium depressum*, *Euastrum pulchellum*, *Staurastrum lunatum*).

Stawek Pucołowski pond. Fifty-nine species were found here. Water pH ranged from 5.5 to 7.0, and ionic conductivity from 10 to 31 µS. Chlorophytes of the genera *Pandorina*, *Spirogyra*, *Stigeoclonium* and *Zygnema* dominated the plankton. Green algae quite often form blooms of various species compositions, including desmids. Occasionally, a *Cystodinium* (*Dinophyta*) taxon occurred en masse. Desmids, for which Stawek Pucołowski pond is the only station in the Gorce Mts, include *Spondylosium pulchellum* and *Staurastrum controversum*.

Morskie Oko Lake at Kudłoń peak. Only 21 species were found here. Unlike other reservoirs, Morskie Oko Lake is surrounded by forest. The water is strongly acidic, with pH ranging from 4.3 to 5.4, and ionic conductivity ranged from 10 to 32 µS. The plankton contains numerous algae of *Merismopedia* (*Cyanophyta*) and *Trachelomonas* (*Euglenophyta*). *Netrium digitus* occasionally occurred very abundantly. No desmid species had Morskie Oko Lake as its only station in the Gorce Mts. Probably the small number of species found in Morskie Oko Lake is related to its low pH. It is not without significance that the reservoir is shaded by surrounding spruce forest. Low input of nutrients may be due to the location of Morskie Oko in the top part of Kudłoń peak among upper subalpine forest. Stawek Pucołowski pond and the reservoir in Polana Jeziorne meadow are in clearings where there is a greater insolation, which may augment the species richness of these waterbodies. Slightly acidic to slightly alkaline pH is another factor that increases the richness of desmids. The very high species richness of the reservoir in Polana Jeziorne meadow in the Lubań range may be related to the abundance of cyanobacteria, particularly *Nostocales*. Certain species of cyanobacteria have been found to secrete substances to the substrate that stimulate the growth of other algae (Sud'ina et al. 1978).

The shares of desmid genera living in polyhumic waterbodies are as follows: *Closterium* 17.5%, *Cosmarium* 24.3%, *Euastrum* 9.7%, *Micrasterias* 2.9%, *Staurastrum* 22.3%, *Staurodesmus* 4.9%, *Mesotaeniaceae* genera 1.9%, genera forming filamentous coenobia (*Desmidium*, *Hyalotheca*, *Spondylosium*, *Teilingia*) 4.9%, and others (*Actinotaenium*, *Haplotaenium*, *Penium*, *Pleurotaenium*, *Tetmemorus*, *Xanthidium*) 10.2% (Fig. 55). Most of the species found in polyhumic waterbodies are those often or very often recorded from Poland. This is a habitat with very high species diversity. Often more than 30 and sometimes even 40 species were found in a given sample. The Gorce Mts host a relatively high number of species that prefer polyhumic waterbodies, especially those belonging to *Euastrum* and *Micrasterias*.

Sphagnum puddles

Many authors note the preference of numerous desmid species for habitats related to *Sphagnum* mosses. This may be related to *Sphagnum*'s ability to acidify the habitat in which they grow (Halsey et al. 1997), which is generally preferred by most desmid species (Fisher & Wilcox 1996).

Sphagnum puddles are formed in depressions between tufts of *Sphagnum*. They are usually shallow, with depth rarely exceeding 20 cm. They are usually temporary and often dry out during drought. Their water is brown. These are acidic habitats with pH in the range of 3.7–6.8. These puddles are formed in areas of local *Sphagnum* expansion, or on Schwingmoors of the polyhumic waterbody in Polana Jeziorne meadow in the Lubań range. In the Gorce Mts, this is a rare type of habitat, which occurs in the vicinity of Turbacz peak, Kiczora peak, Jaworzyna Kamieniecka peak, Przełęcz Borek pass, Przełęcz Wierch Młynne pass, Kiczora Kamieniecka, and at Lubań peak. Sphagnum puddles in Gorce Mts occurs only in the upper and lower montane zone. *Sphagnum* puddles are often colonized by filamentous green algae of the genera *Microspora*, *Spirogyra* and *Zygnema*, as well as algae of *Trachelomonas*, *Euglena* (*Euglenophyta*) and *Synura* (*Heteroconthophyta*).

The species diversity of *Sphagnum* puddles varies greatly. Puddles on peat Schwingmoors have the greatest species richness. About 20 species were observed in samples with pH at 4.9; more than 50 species were often found in a single sample when pH was above 6. In comparison, there were rarely more than 10 species (up to 12) in single samples from *Sphagnum* puddles on sites of local *Sphagnum* expansion with pH at around 5, and at pH above 6 there were rarely more than 20 species (up to 23). This phenomenon can be explained by the higher availability of water in habitats associated with Schwingmoors than in areas of *Sphagnum* expansion. A very important factor influencing the species diversity of *Sphagnum* puddles is pH, both in habitats associated with Schwingmoors and in local *Sphagnum* expansions. Species diversity decreases significantly with the decrease of pH. Species that clearly prefer a high concentration of hydrogen ions occurring at pH close to 4 are *Cylindrocystis brebissonii*, *Mesotaenium degreyi*, *Netrium digitus*, *Staurastrum hirsutum*, *St. muricatum* and *St. margaritaceum*. The last one was the only species found at pH 3.7. *Cylindrocystis brebissonii* occurred very abundantly in extremely acidic conditions, sometimes creating monospecific communities.

The shares of individual desmid genera living in *Sphagnum* puddles are as follows: *Closterium* 16%, *Cosmarium* 36%, *Euastrum* 8.3%, *Micrasterias* 2.1%, *Staurastrum* 15.3%, *Staurodesmus* 2.8%, *Mesotaeniaceae* genera 4.2%, genera forming filamentous coenobia (*Desmidium*, *Hyalotheca*) 1.4%, and others (*Actinotaenium*, *Haplotaenium*, *Penium*, *Pleurotaenium*, *Tetmemorus*) 13.9% (Fig. 55). Many rare and interesting species were found in this habitat (e.g., *Closterium exile*, *Euastrum montanum*, *Eu. subalpinum*, *Staurastrum capitulum*, *St. pileolatum*).

Marshes related to helocrenic springs

Helocrenic springs are a common habitat of algae in the Gorce Mts. These are springs of low productivity found in depressions of the terrain, creating local swampy areas. In the Gorce area, they often occur in the Turbacz range. Habitats for many desmid species are supplied by helocrenic spring-associated plant communities with high shares of bryophytes of the genera *Hypnum*, *Mnium*, *Plagiothetium* and *Rhytidiadelphus*, of the *Bryidae* class (Kozak 2007). In samples from streams located in forests, only single species of common in Gorce desmidii were found, and no desmidia species associated with the shaded environment were recorded in them. This is likely the result of unfavorable light conditions. Marshes are the main habitat for desmids related to helocrenic springs. They occur mainly in clearings of the lower and upper montane zone. They are characterized by a high share of bryophytes and the occurrence of vascular plant species, such as *Caltha palustris*, *Epipactis palustris*, *Eriophorum angustifolium* and *Valeriana simplicifolia*, and numerous *Carex* species. These communities usually persist as a result of human activity (grazing, mowing). In most cases, these are alkaline habitats, with pH as high as 8.9; ionic conductivity usually exceeds 100 µS, but is lower in puddles on marshes. Acidification, if it occurs, happens only after periods of heavy rainfall or in situations of oxygen deficiency (low oxidation-reduction potential, sometimes with negative values), mainly in old wells. Marshes dominated by acidic conditions were found only on Świnkówka meadow and Ustępne meadow. Depending on the productivity of the spring, the marshes are evaporative or outflow. Although both types of marshes occur in the Gorce area, they do not seem to increase desmid species richness. This is probably because water deficit exerts strong pressure during dry years in evaporative marshes (e.g., in 2003), and in outflow marshes the algae are intensively washed-out during years of heavy rainfall (e.g., in 2001). In marshes, the dominant algae are *Bacillariophyta*. Filamentous green algae of the genera *Mougeotia*, *Spirogyra* and *Zygnema* are often found. *Cyanophyta*, *Chlorophyta*, *Dinophyta*, *Euglenophyta* and *Heterocontophyta* are rarely found. The number of desmid species found in a single sample rarely exceeded 10, exceptionally reaching 24 species.

In the marsh habitats of the Gorce Mts, desmids were recorded in puddles between tufts of leafy mosses (93 species), on wet mosses (93) and in old wells (85). The puddles in marshes are rarely more than 20 cm deep and are temporary. Moss tufts are also vulnerable to dessication, especially in dry years. Old wells dry out to an extreme extent and are shaded by the surrounding vegetation. In this type of habitat, there are also frequent blooms of filamentous green algae, which, in addition to shading, contribute to the decrease of oxygen content in the water. The shares of desmid genera living in marsh habitats are as follows:

– puddles in marshes – *Closterium* 22.6%, *Cosmarium* 43%, *Euastrum* 3.2%, *Micrasterias* 1.1%, *Staurastrum* 8.6%, *Mesotaeniaceae* genera 6.5%, genera forming filamentous coenobia (*Hyalotheca*) 1.1%, others (*Actinotaenium*, *Penium*, *Pleurotaenium*, *Tetmemorus*) 13.9%;

– wet mosses of the *Bryidae* class – *Closterium* 19.4%, *Cosmarium* 53.8%, *Euastrum* 2.2%, *Staurastrum* 5.4%, *Mesotaeniaceae* genera 5.4% others (*Actinotaenium*, *Penium*, *Pleurotaenium*, *Tetmemorus*) 14%;

– old wells – Cl*osterium* 21.2%, *Cosmarium* 50.6%, *Euastrum* 5.9%, *Staurastrum* 8.2%, *Mesotaeniaceae* genera 5.9%, genera forming filamentous coenobia (*Hyalotheca*) 1.2%, and others (*Actinotaenium*, *Penium*, *Pleurotaenium*, *Tetmemorus*) 7.1% (Fig. 56c).

These habitats are very similar in floristic composition, due in large part to their proximity to each other. Algae can easily move through water from mosses to puddles or wells, and in the opposite direction via zoochory. There are many species that prefer alkaline marshes, especially those of the genera *Closterium* and *Cosmarium*. A number of rare and interesting taxa such as *Closterium pygmaeum*, *Cosmarium hammeri*, *Co. tatricum* and *Staurastrum merianii* were identified in these habitats.

Streams

The Gorce area is covered by a uniform network of streams. This is a very common type of habitat in both the Lubań and Turbacz ranges. The streams are generally alkaline (pH 7.4–8.6). A significant increase of pH was noted in drought periods. Ionic conductivity generally exceeded 100 µS and sometimes 300 µS. In lotic habitats, only 2 desmid species were found: *Closterium acerosum* and *Closterium littorale*. They occurred on *Cladophora glomerata* thalli. Other species were found in lenitic habitats, such as old branches of streams, puddles among rocks near rivers or streams, or in oxbow lakes in the foothills and lower montane zone. These habitats were dominated by *Bacillariophyta*. Filamentous green algae of the genera *Cladophora*, *Mougeotia*, *Spirogyra* and *Ulothrix* occurred frequently. These are habitats poor in desmid species. More than 10 species were never found in a single sample.

The shares of individual desmid genera living in habitats associated with streams are as follows: *Closterium* 25.6%, *Cosmarium* 60.5%, *Staurastrum* 4.7%, and others (*Actinotaenium*, *Pleurotaenium*, *Tetmemorus*) 9.3% (Fig. 55). Only a few species showed a preference for habitats associated with streams. Most taxa recorded from these habitats are common algae and have a broad ecological spectrum. *Cosmarium pericymatium* is a rare species associated with streams.

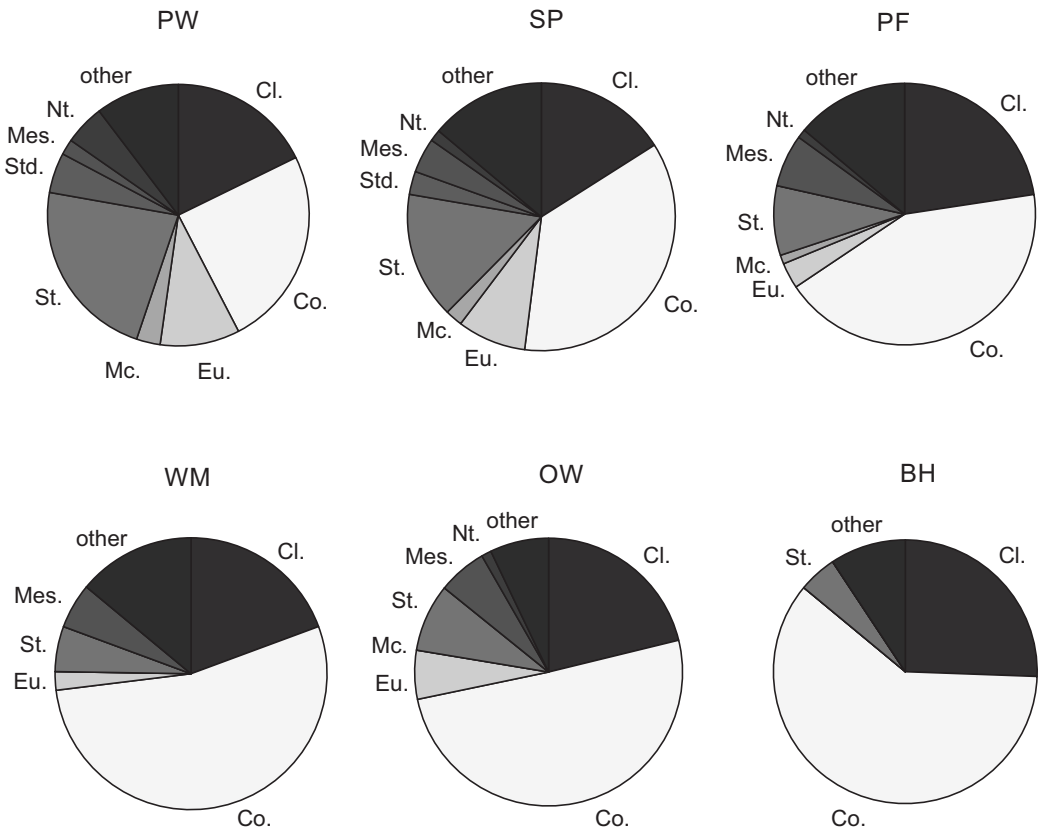

Figure 55. Percentage share of genera in different natural and seminatural types of habitats. PW – polyhumic water bodies, SP – *Sphagnum* puddles, PF – puddles on the fens, WM – wet mosses from *Bryidae* class on marshes, OW – old wells, BH – brook habitats, Cl. – *Closterium*, Co. – *Cosmarium*, Eu. – *Euastrum*, Mc. – *Micrasterias*, St. – *Staurastrum*, Std. – *Staurodesmus*, Mes. – species of *Mesotaeniaceae* family, Nt. – *Netrium*.

Temporary waterbodies

In the lower montane zone of the Gorce Mts, there are two ephemeral waterbodies located near each other: Jeziorko Zawadowskie (lake) and Jeziorko Iwankowskie (periodic lake) near the village of Ochotnica Górna. In both ponds, the water level is maintained for only a few weeks during the growing season, reaching a depth of about 2 m only after very heavy rains. During the spring, the ponds are usually about a meter deep. The color of water is usually not brown. Filamentous green algae of the genera *Mougeotia*, *Spirogyra* and *Zygnema* often occur abundantly there, and species of *Bacillariophyta* are broadly represented.

Jeziorko Zawadowskie pond. Its water shows pH 6.1–8.6 and ionic conductivity 132–238 µS. During the dry season its bottom is muddy, with numerous puddles, and is covered by *Equisetum limosum*. Fifteen desmid species were found there: *Closterium acerosum*, *Cl. moniliferum*, *Cl. parvulum*, *Cosmarium bioculatum*, *Co. formosulum*, *Co. hornavanense*, *Co. impressulum*, *Co. margaritiferum*, *Co. obtusatum*, *Co. ochthodes*, *Co. vexatum*, *Hyalotheca dissiliens*, *Pleurotaenium trabecula*, *Staurastrum proboscideum* and *St. punctulatum*.

Jeziorko Iwankowskie pond. Its water shows pH 6.1–8.2 and ionic conductivity 42–215 µS. During the dry season the pond dries completely and its bottom is overgrown with grass. Sixteen desmid species were found there: *Actinotaenium cucurbita*, *Cosmarium anceps*, *Co. biretum*, *Co. crenatum*, *Co. cyclicum*, *Co. holmiense* var. *integrum*, *Co. impressulum*, *Co. notabile*, *Co. ochthodes*, *Co. porteanum*, *Co. reniforme*, *Co. speciosum*, *Co. subcrenatum*, *Cylindrocystis brebissonii*, *Gonatozygon monotaenium* and *Staurastrum punctulatum*.

Twenty-nine species were found in these ponds. The differences in species composition probably are due to the difference in water supply during the dry season. *Cosmarium* species comprise about 75% of the floristic list in Jeziorko Iwankowskie, but only ~53% in Jeziorko Zawadowskie. The species composition of the two ponds is very similar to that of the marsh habitats.

Figure 56a–e. Frequency of desmid species occurrence (samples with more than 50 cells in the microscope preparation) in different habitats. a) habitats related to *Sphagnum* mosses; polyhumic water bodies (PW) and *Sphagnum* puddles (SP); b) habitats related to roads; puddles on mountain roads (PR), wet soil on roads (WSR), puddles on paths (PP); c) habitats related to marshes; wet mosses from *Bryidae* class (WM), puddles on marshes (PM), old wells (OW); d) habitats related to mountain streams (BH); e) species with wide habitat spectrum

Continued on pages 124–140

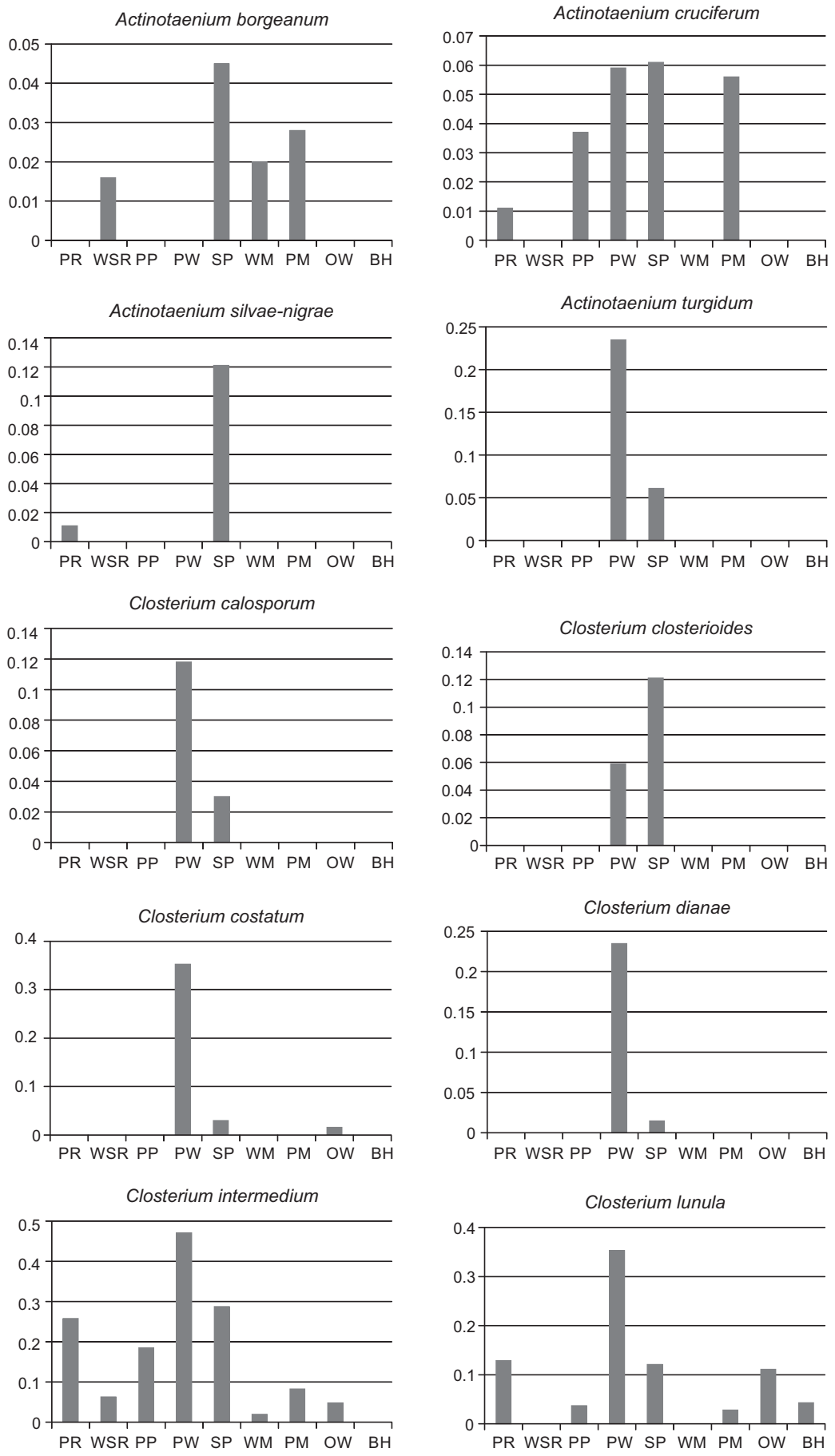

Figure 56a. Frequency of desmid species occurrence (samples with more than 50 cells in the microscope preparation) in different habitats. Habitats related to *Sphagnum* mosses; polyhumic water bodies (PW) and *Sphagnum* puddles (SP).

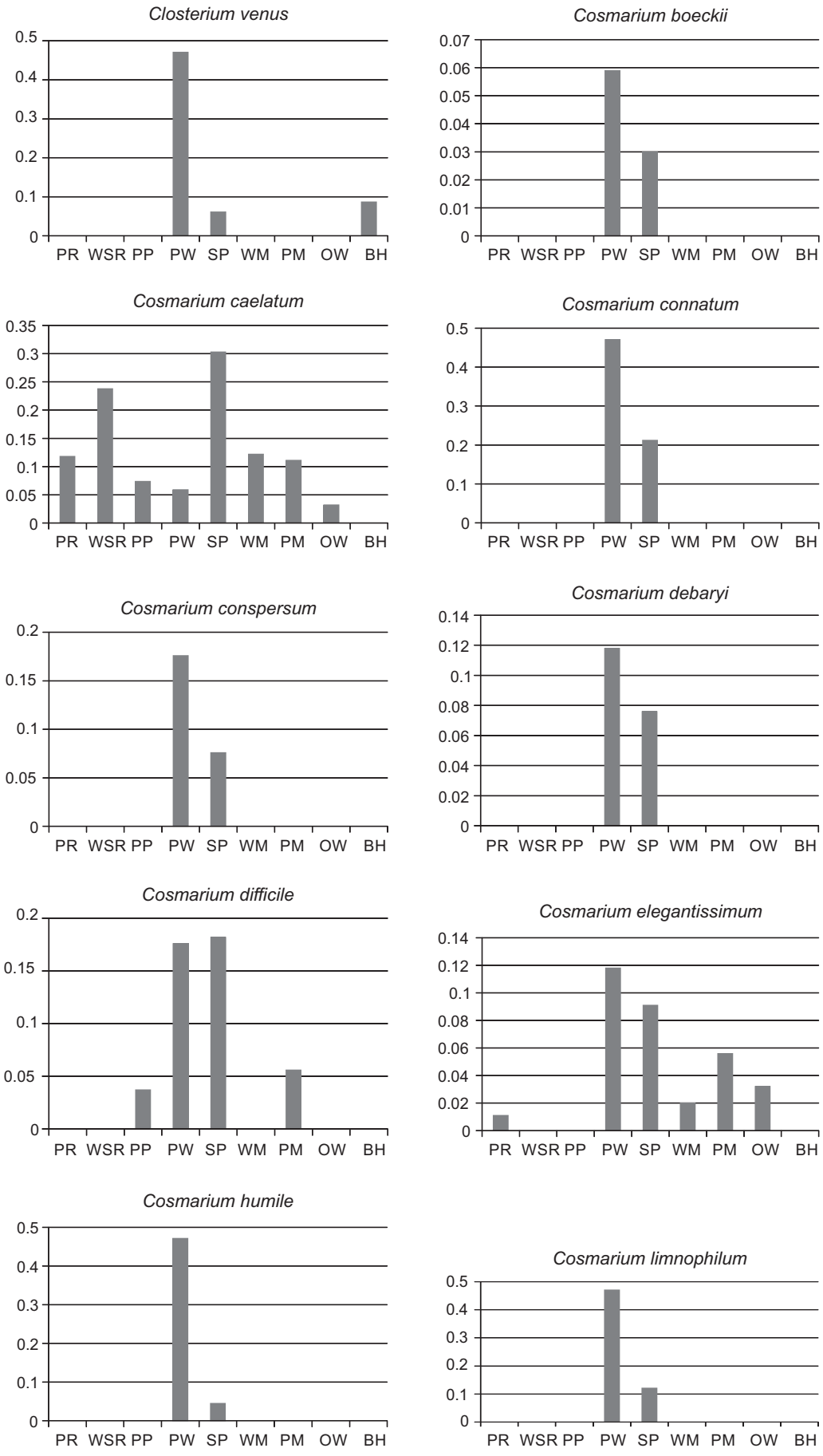

Figure 56a. Continued

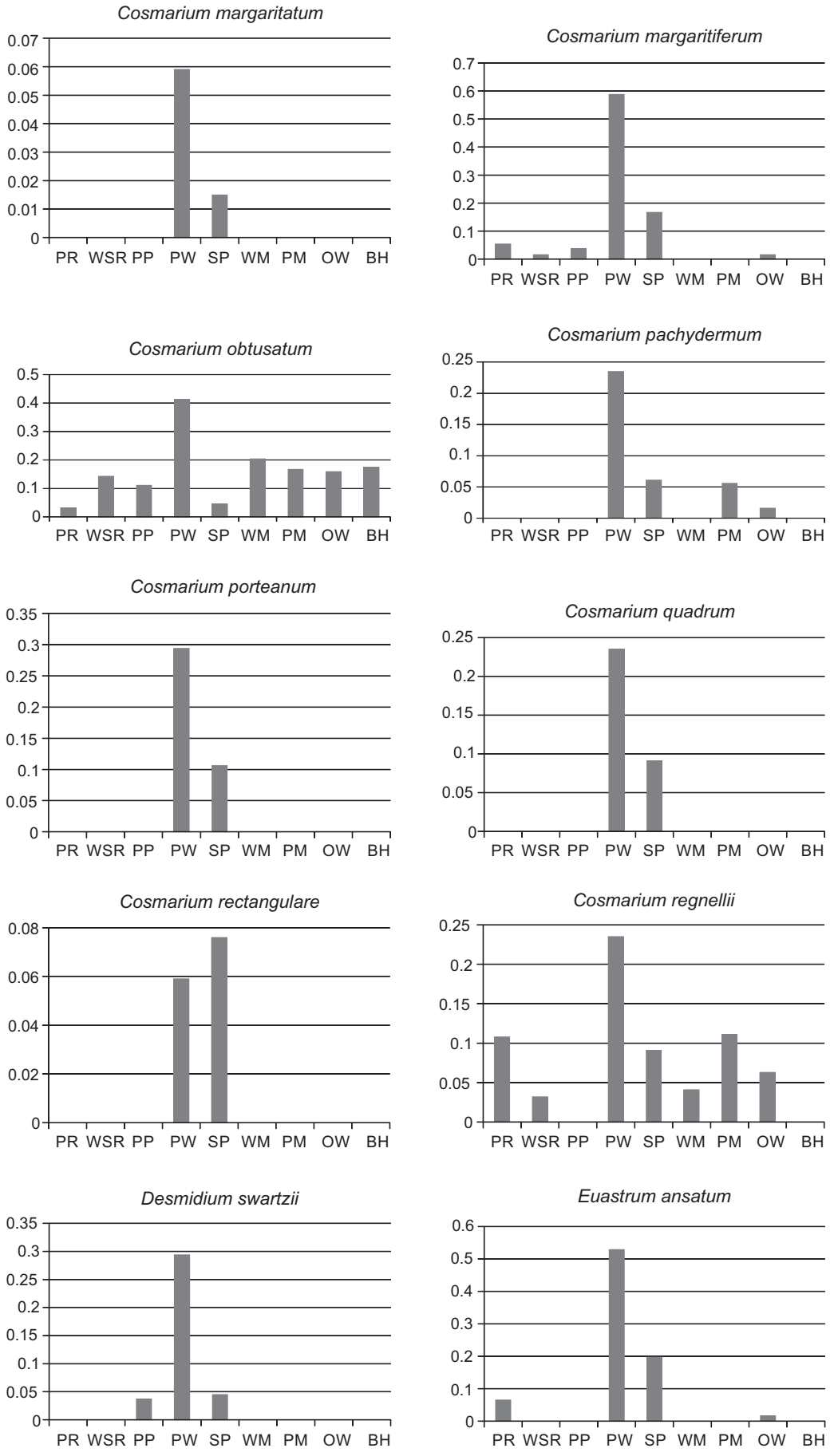

Figure 56a. Continued

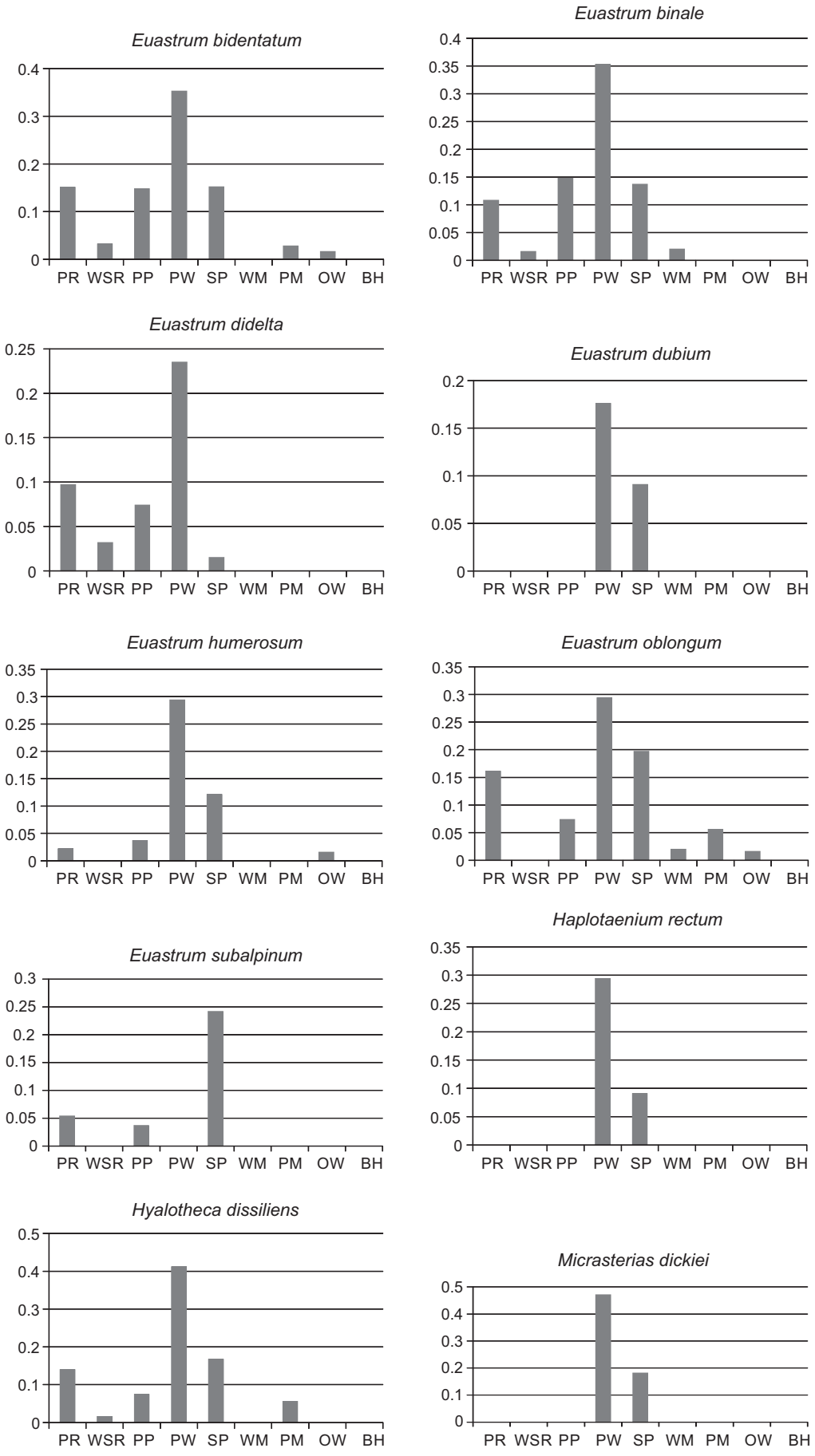

Figure 56a. Continued

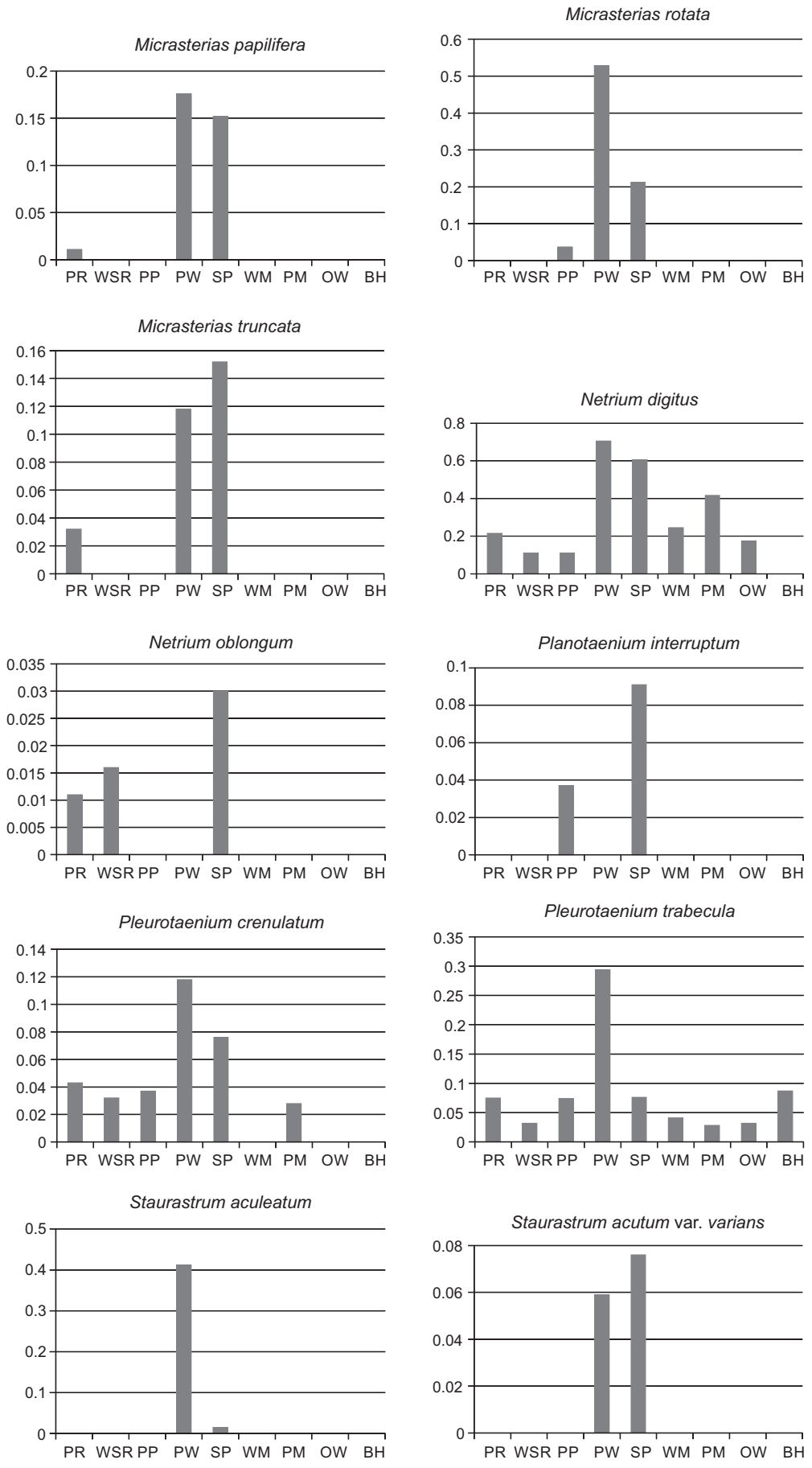

Figure 56a. Continued

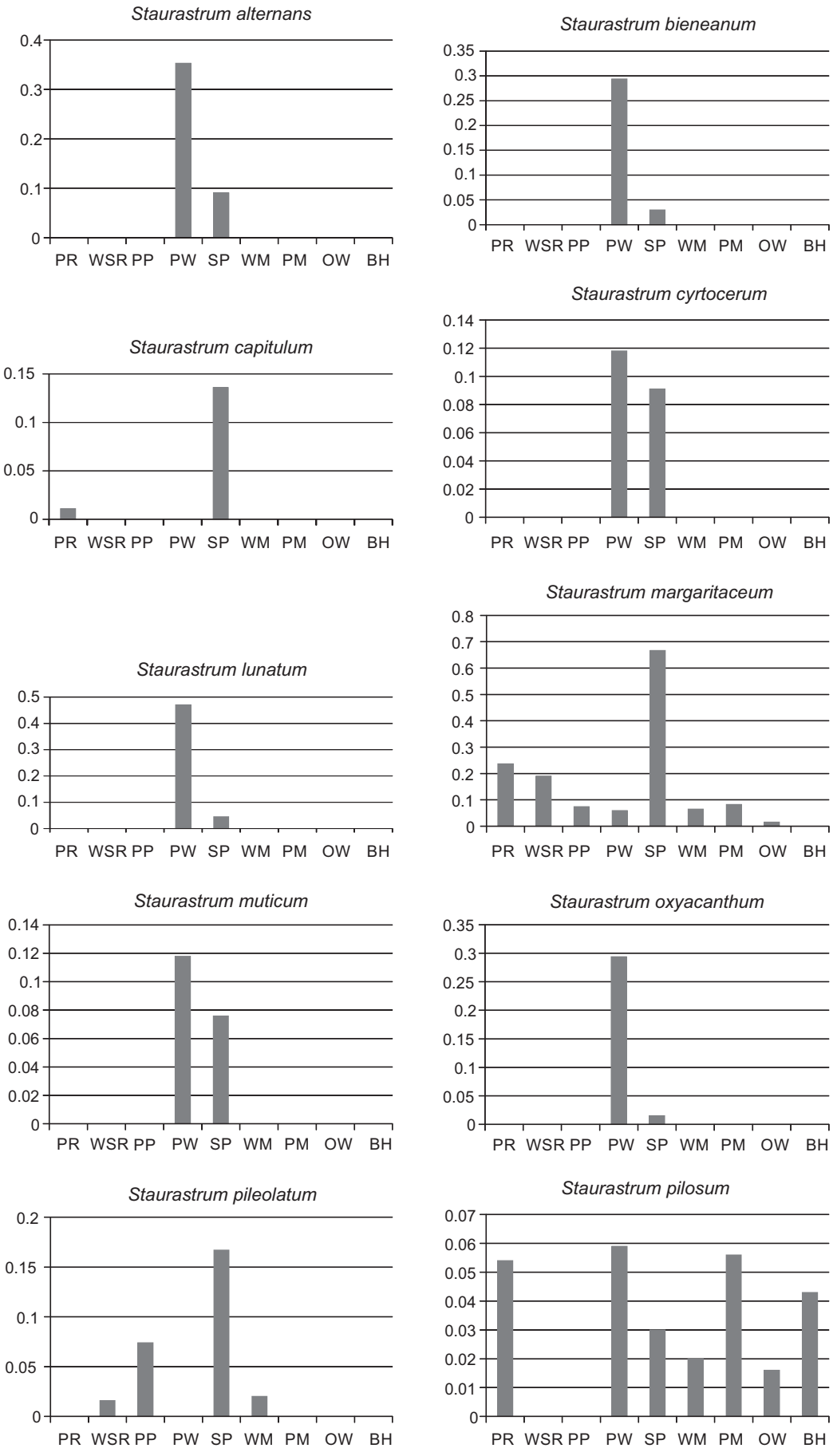

Figure 56a. Continued

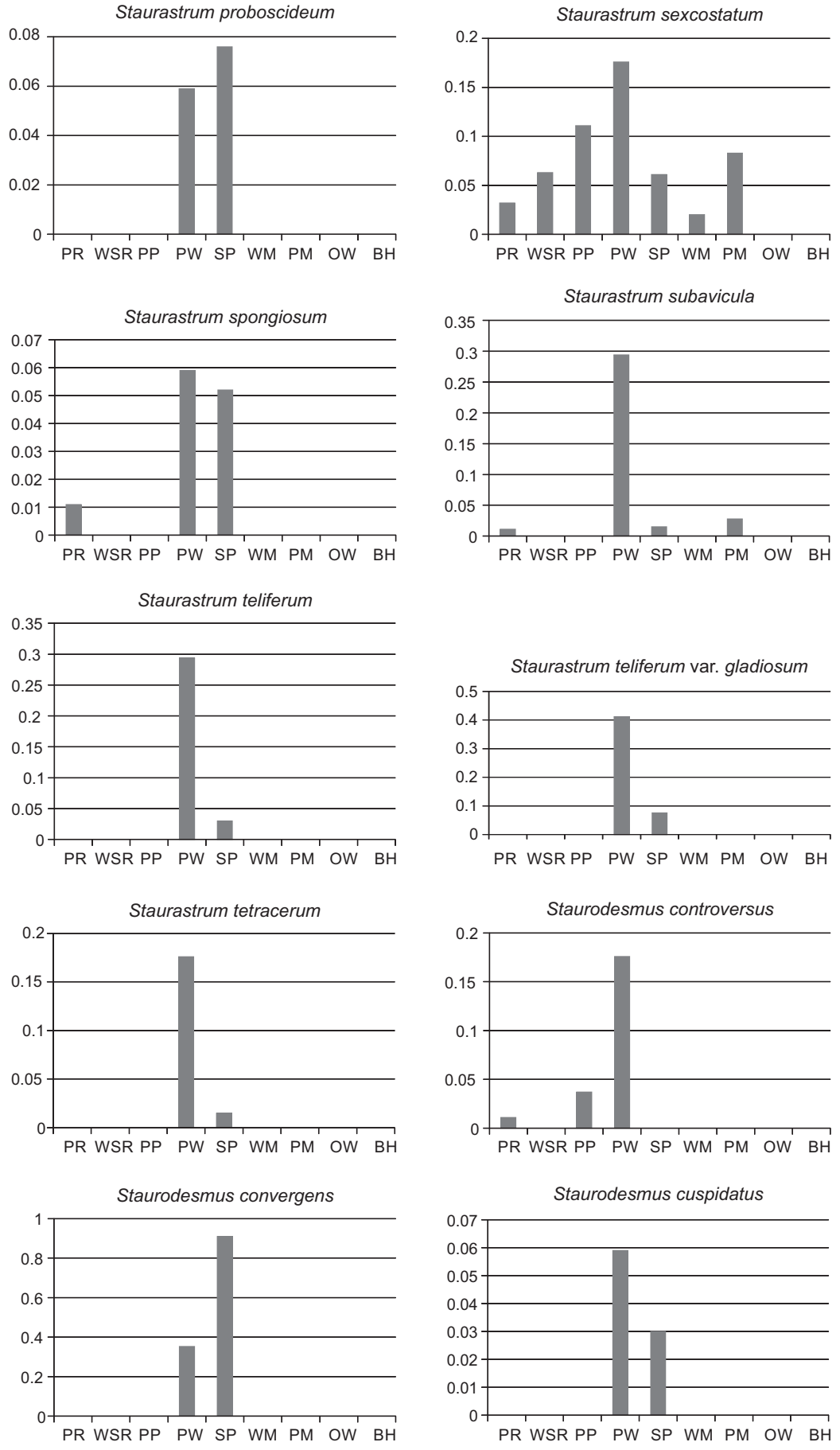

Figure 56a. Continued

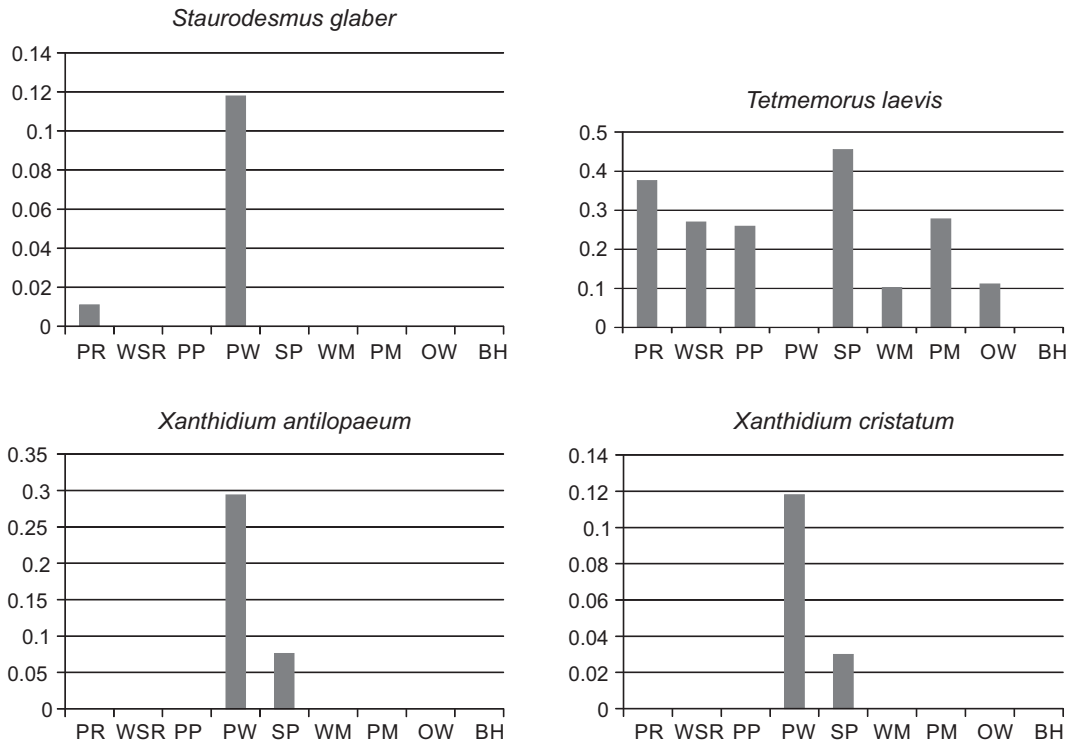

Figure 56a. Continued

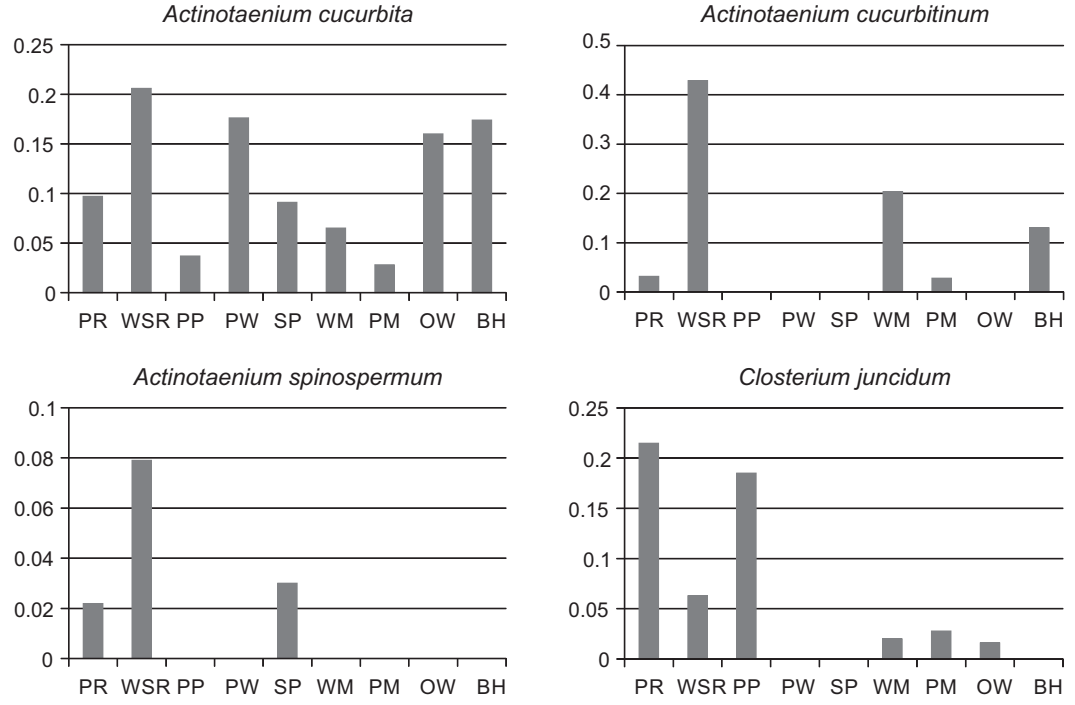

Figure 56b. Frequency of desmid species occurrence (samples with more than 50 cells in the microscope preparation) in different habitats. Habitats related to roads; puddles on roads (PR), wet soil (WSR), puddles on paths (PP).

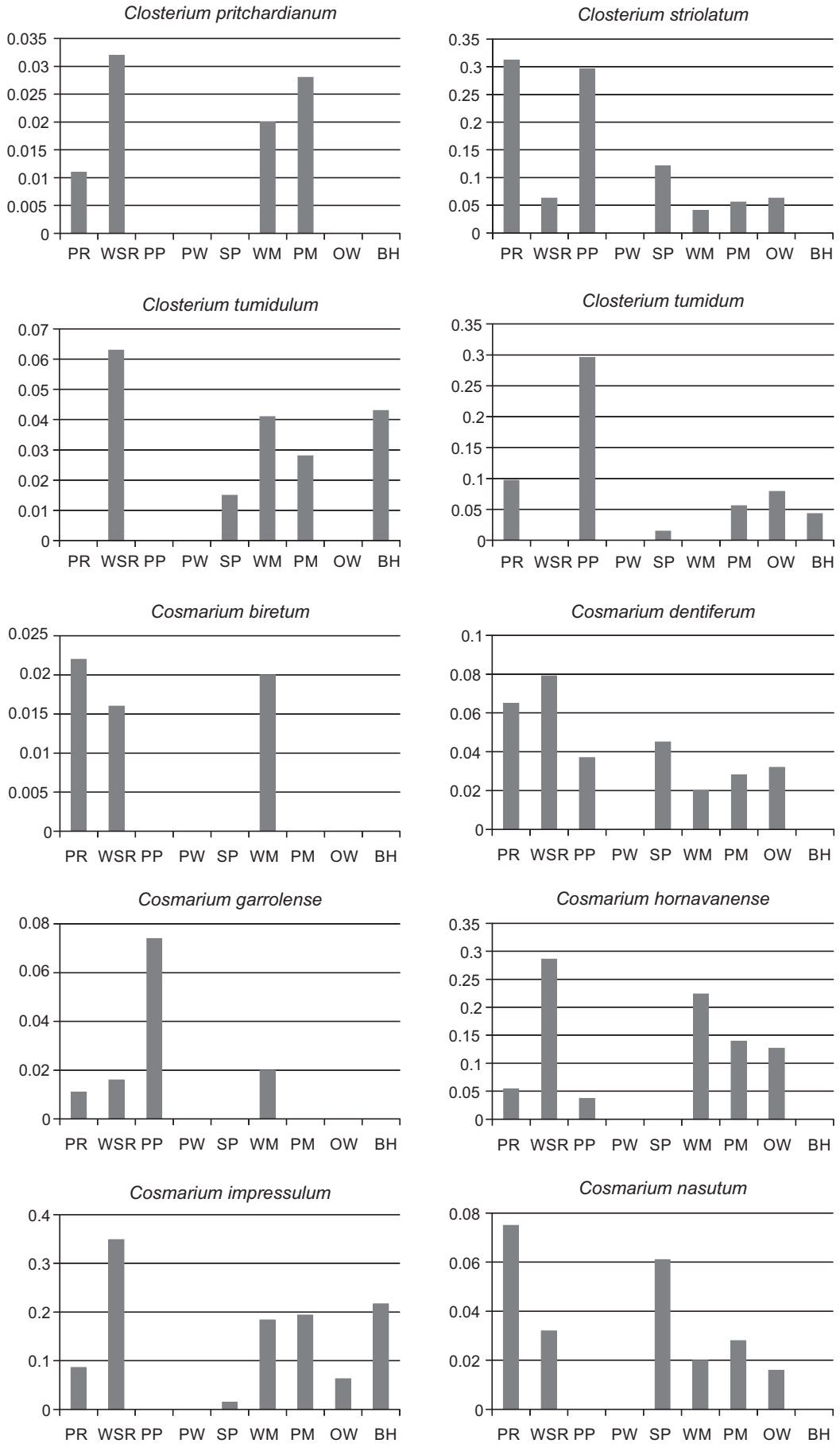

Figure 56b. Continued

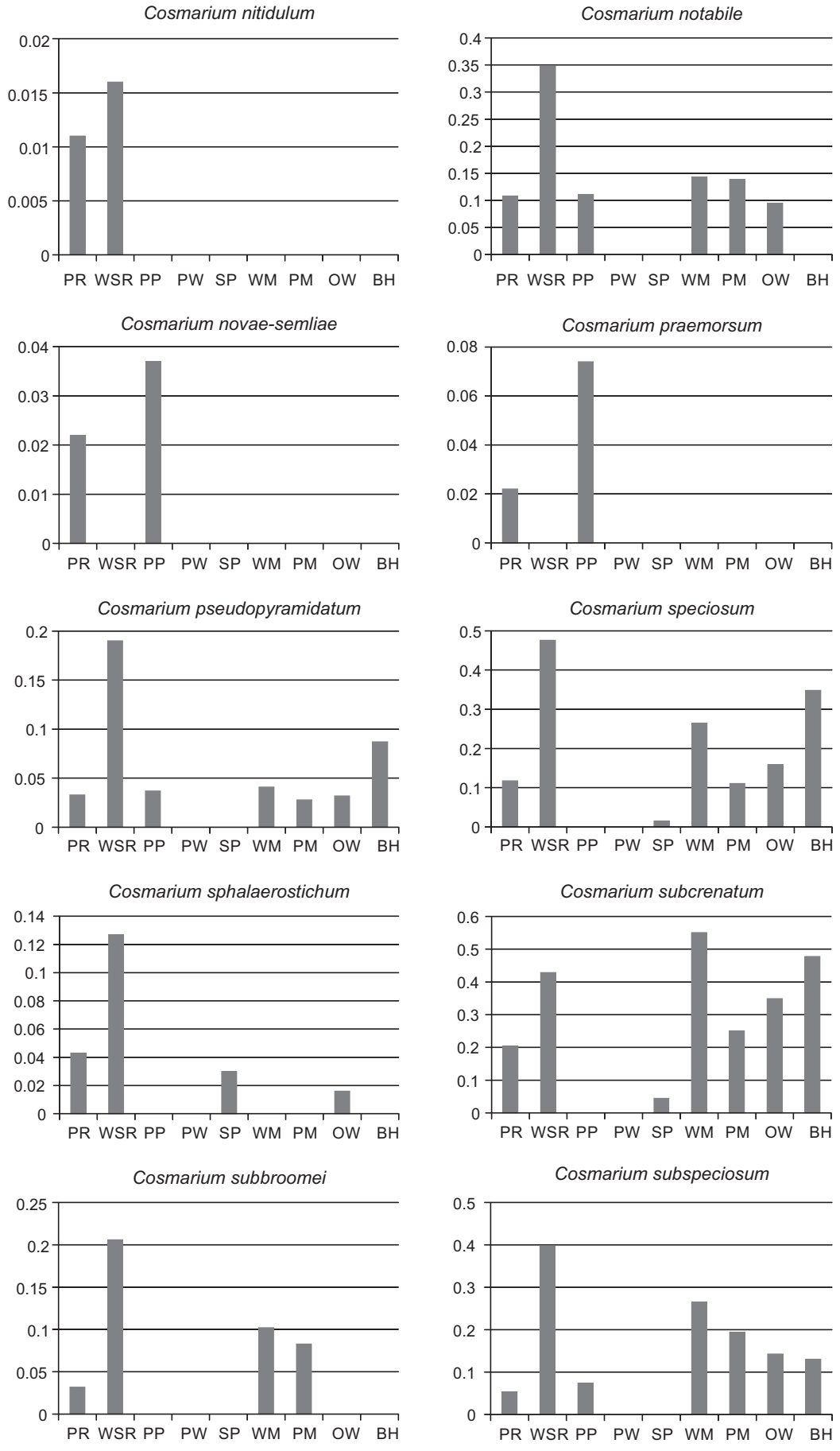

Figure 56b. Continued

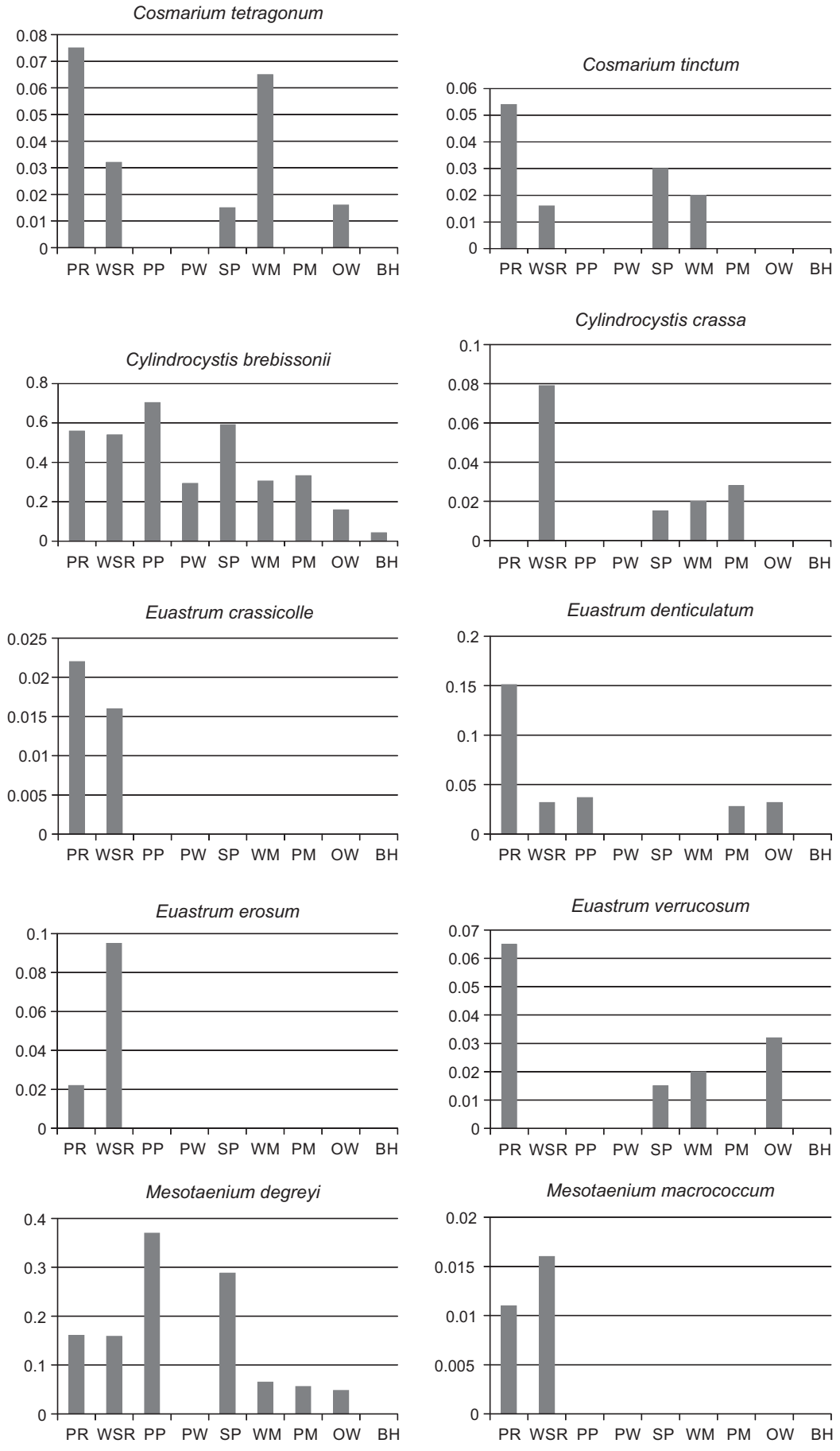

Figure 56b. Continued

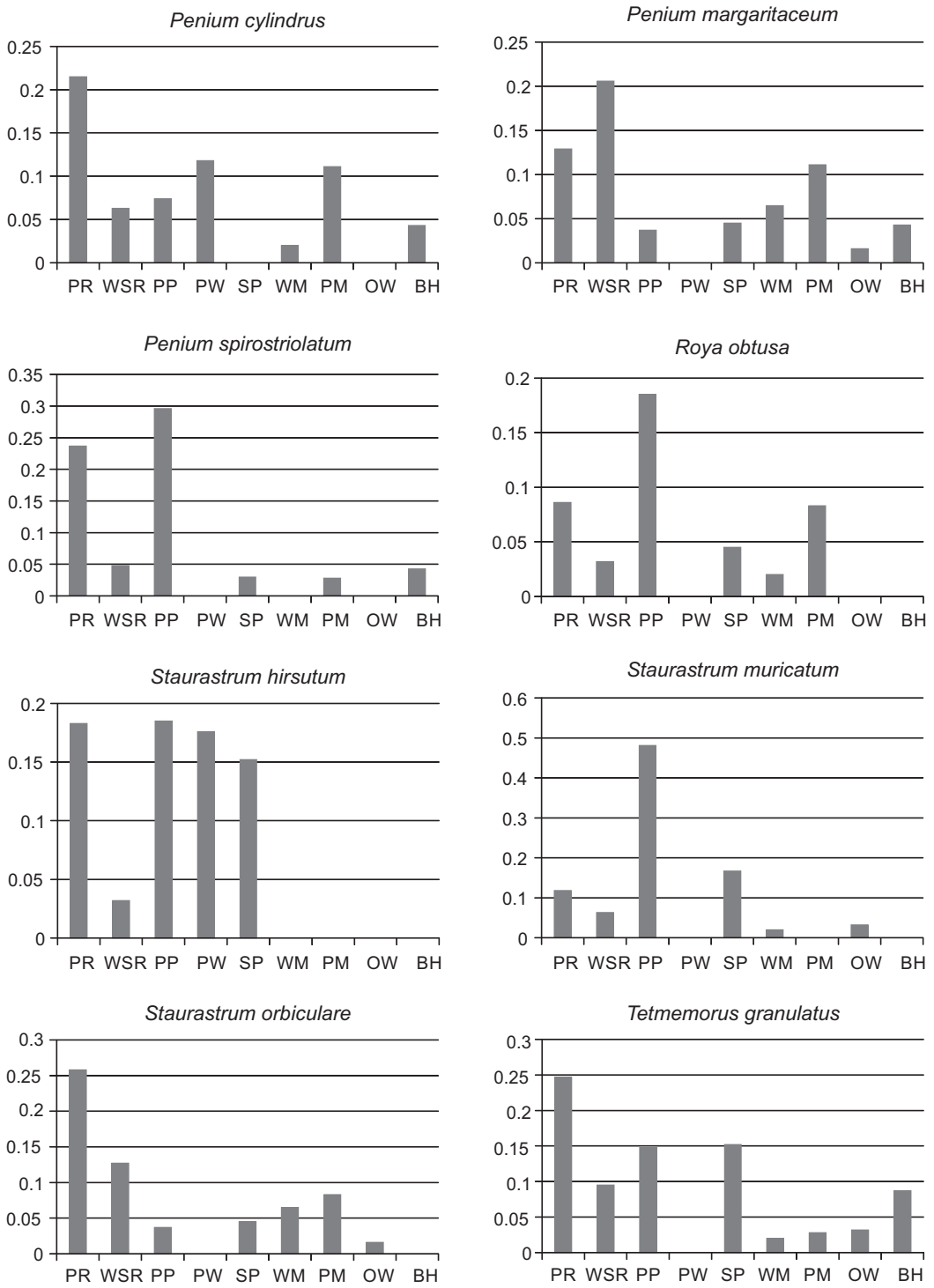

Figure 56b. Continued

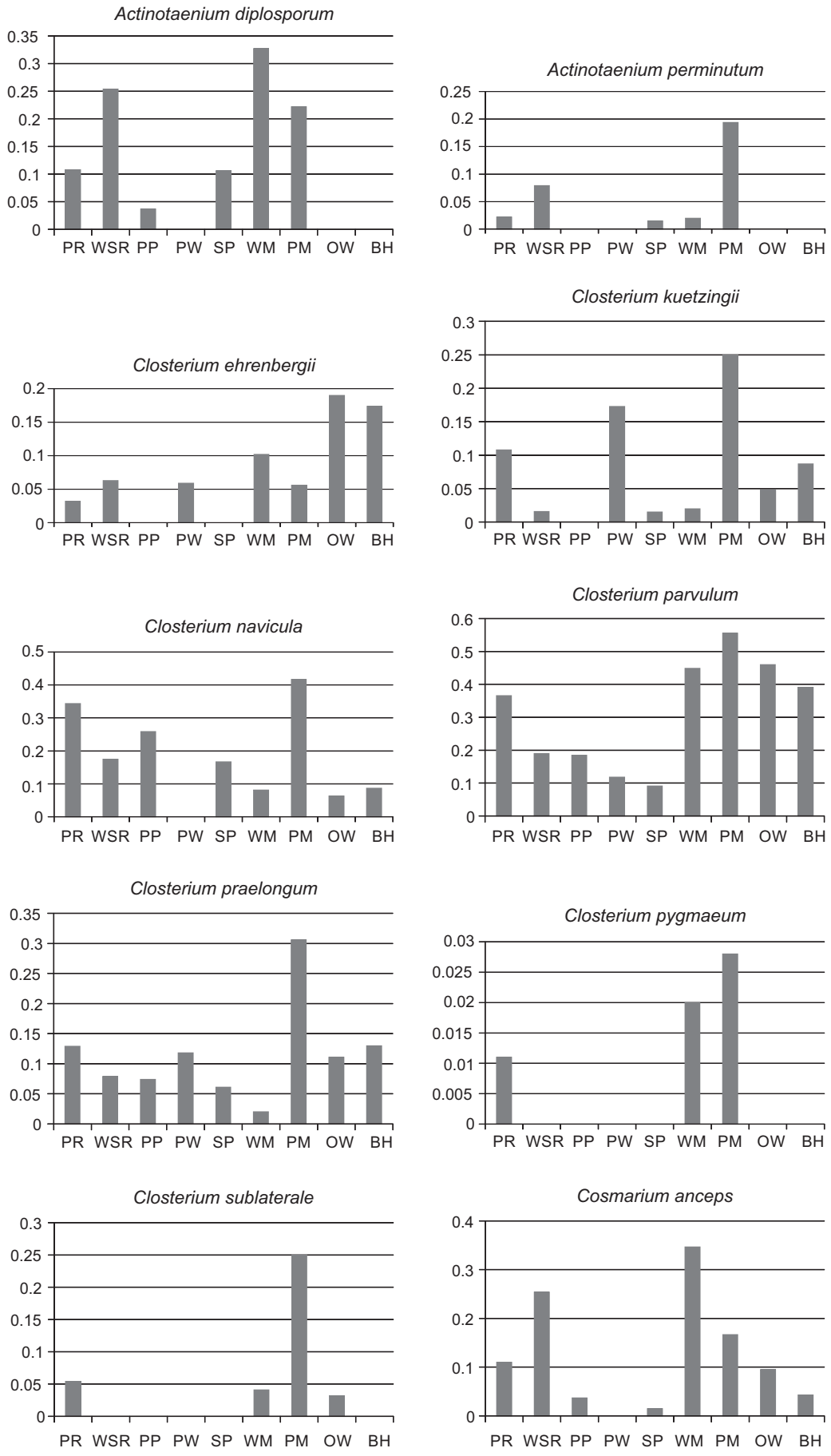

Figure 56c. Frequency of desmid species occurrence (samples with more than 50 cells in the microscope preparation) in different habitats. Habitats related to marshes; wet mosses from *Bryidae* class (WM), puddles on marshes (PM), old wells (OW).

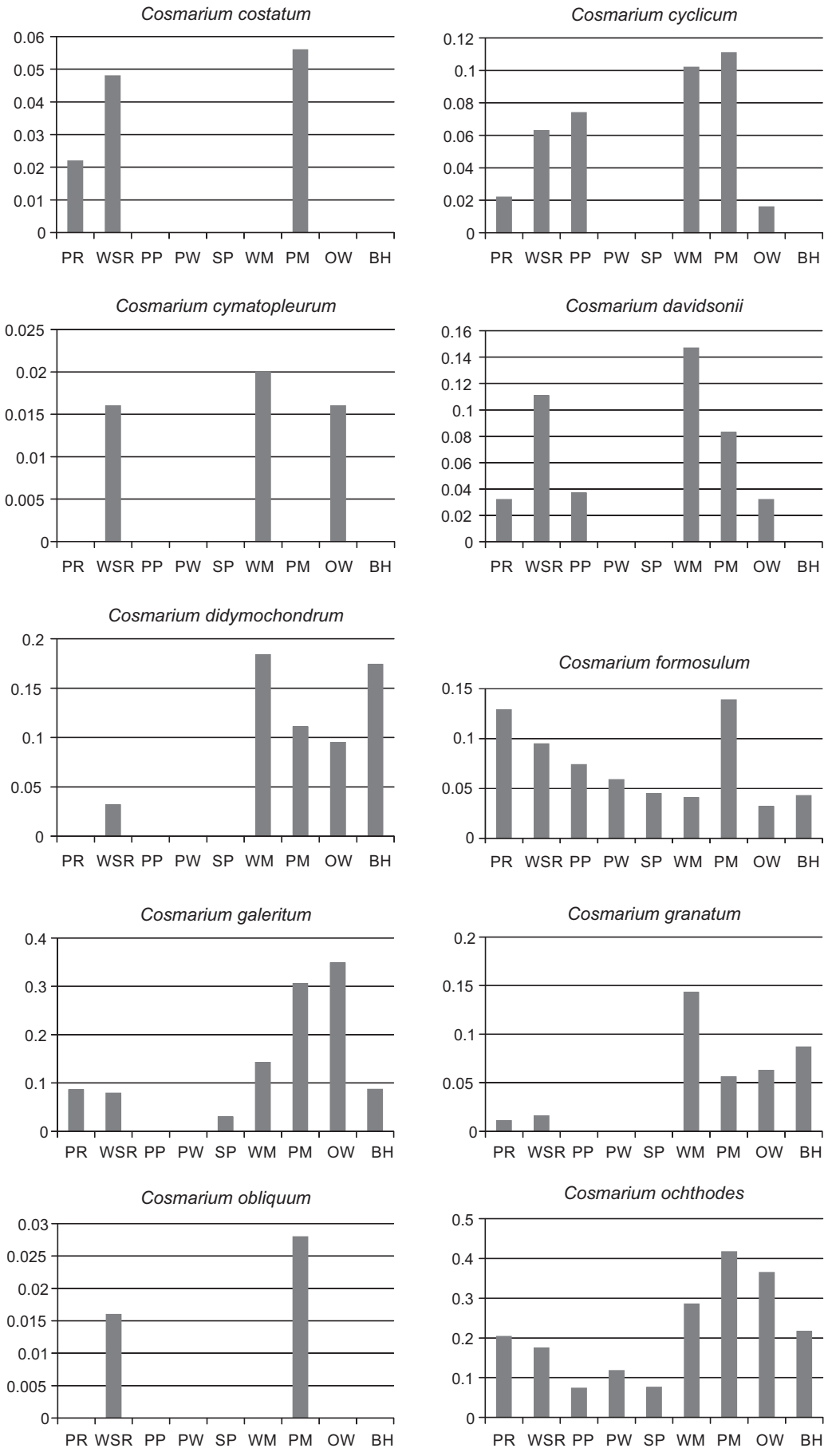

Figure 56c. Continued

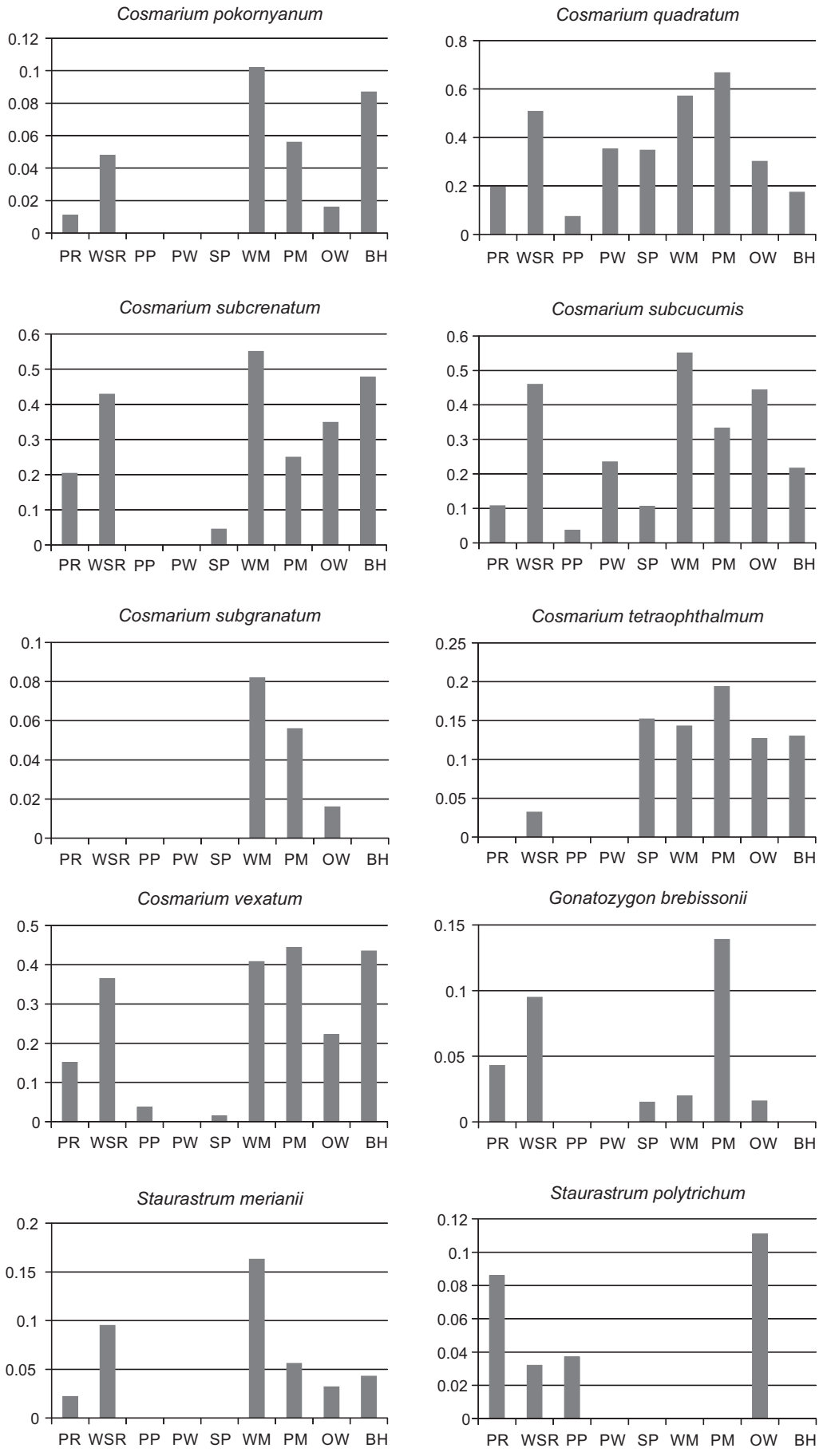

Figure 56c. Continued

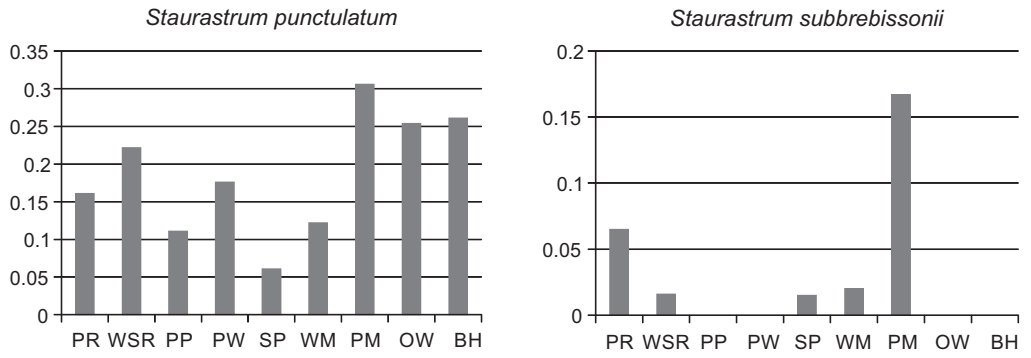

Figure 56c. Continued

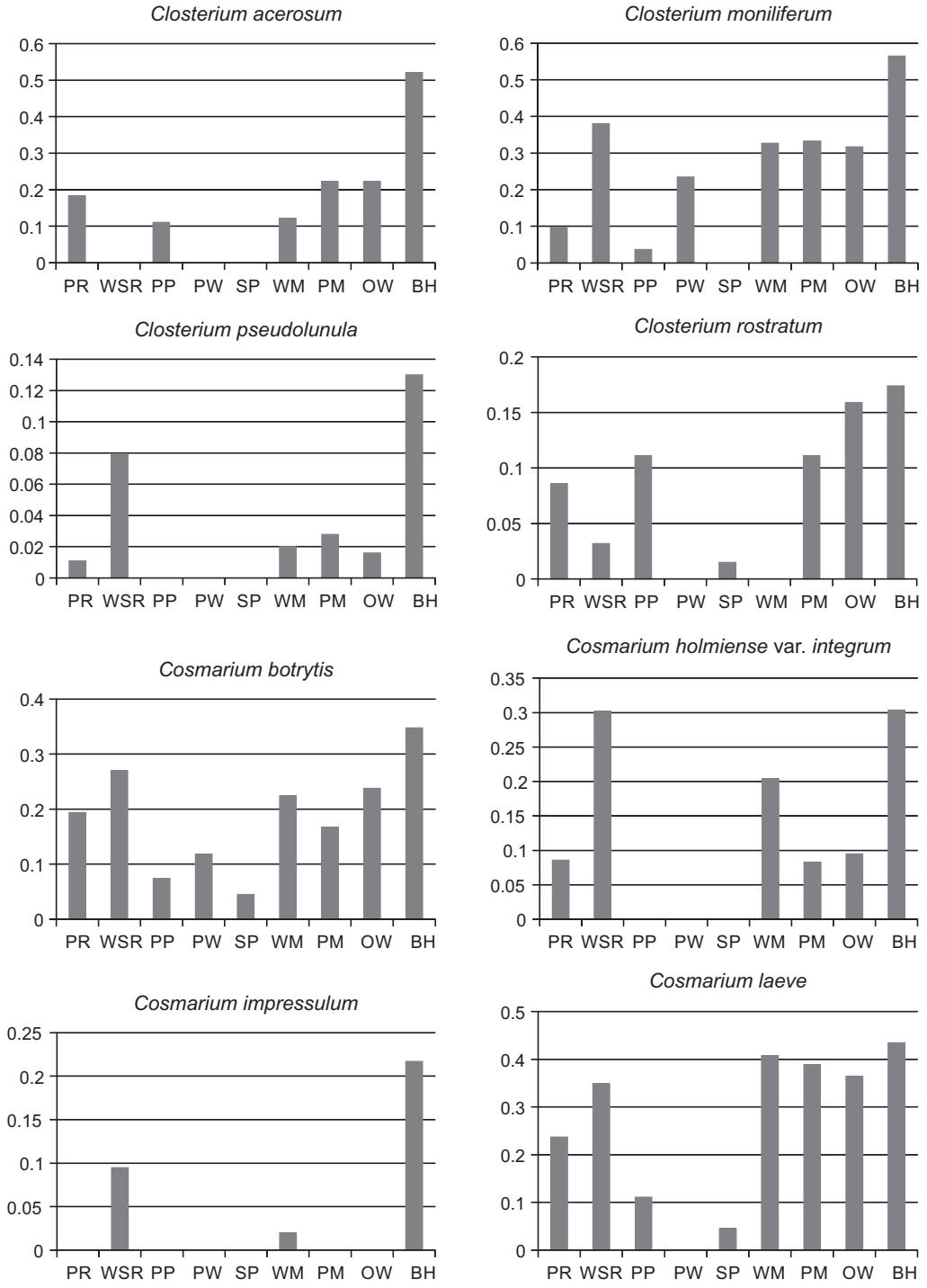

Figure 56d. Frequency of desmid species occurrence (samples with more than 50 cells in the microscope preparation) in different habitats. Habitats related to mountain streams (BH).

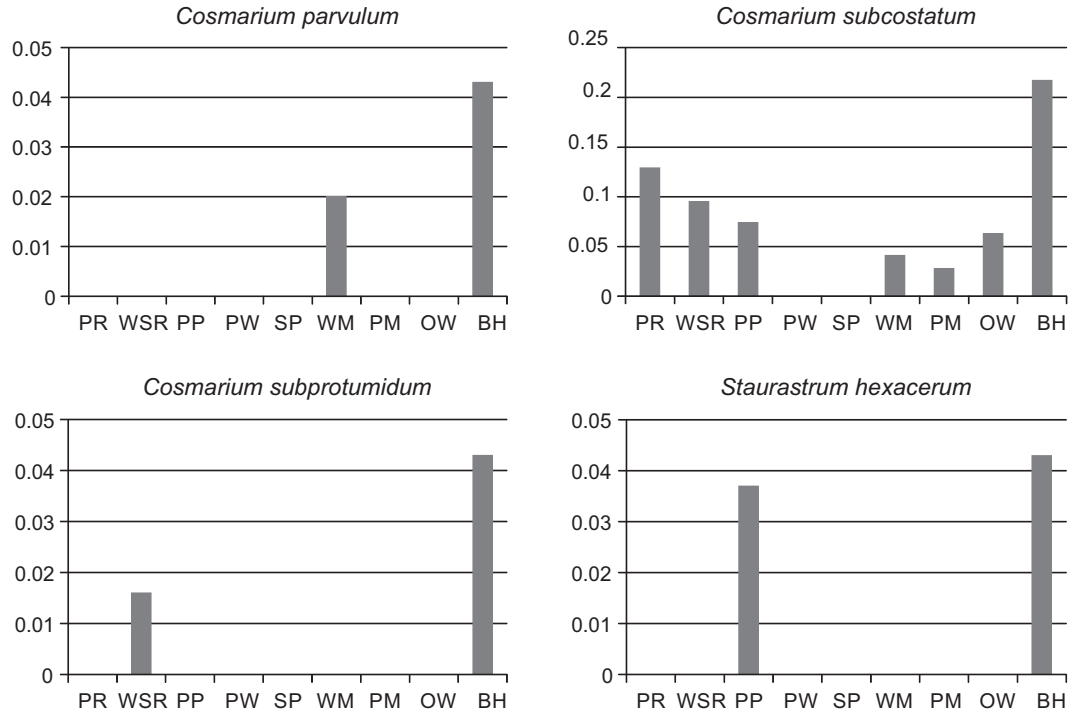

Figure 56d. Continued

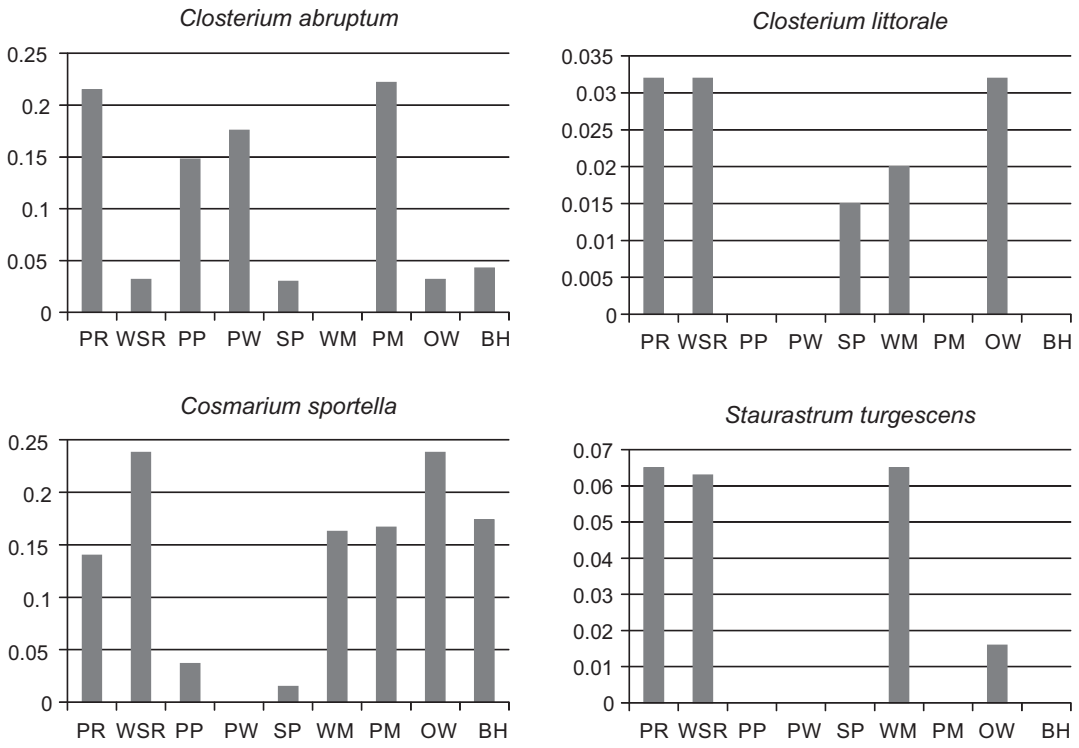

Figure 56e. Frequency of desmid species occurrence (samples with more than 50 cells in the microscope preparation) in different habitats. Species with wide habitat spectrum.

Differences in species richness between types of natural and semi-natural habitats

The most important factor affecting the species diversity of various desmid habitats, both natural and semi-natural, was pH. Acidic habitats, with the exception of extremely acidic ones, were characterized by significantly higher species richness than alkaline habitats. Some species were found only in polyhumic waterbodies and *Sphagnum* puddles, avoiding other habitats. This group includes, for example, *Closterium baillyanum*, *Cosmarium debaryi*, *Euastrum dubium*, *Micrasterias papilifera*, *Staurastrum inflexum* and *Micrasterias dickiei*. Acidic habitats, which include polyhumic waterbodies and *Sphagnum* puddles, had a higher proportion of species of the genera *Euastrum*, *Micrasterias*, *Staurastrum* and *Staurodesmus*. Although fewer species were found in polyhumic waterbodies than in *Sphagnum* puddles, both habitats can be considered richer in species. All of the taxa identified in them were found at two sites: Stawek Pucołowski pond and Polana Jeziorne meadow in the Lubań range. More species were found in single samples from polyhumic waterbodies than in the *Sphagnum* puddles.

Alkaline habitats showed lower species richness and higher shares of *Closterium* and *Cosmarium* species. Marsh habitats associated with *Bryidae* mosses were much poorer in species than habitats associated with *Sphagnum* peat mosses. Unlike the southern part of the Carpathian Mts at the border of the Czech Republic, Poland and Slovakia, where no desmids were found in samples from alkaline marshes (Kitner et al. 2004), the alkaline marshes of the Gorce area are inhabited by many species of them. Of all the studied natural and the semi-natural habitats, those associated with streams showed the lowest species diversity. A number of species associated with marshes and streams avoided habitats dominated by peat mosses. Examples are *Closterium pseudolunula*, *Cosmarium holmiense* var. *integrum*, *Co. galeritum* and *Staurastrum merianii*.

The second most important factor influencing desmid species diversity and richness in these habitats was the availability of water. Regardless of water pH, habitats more vulnerable to drought had higher shares of *Cosmarium* species and those of the *Mesotaeniaceae* family, and lower shares of *Staurastrum* taxa.

Habitat preferences

Habitat preferences were determined by a method similar to the one used for habitat pH preference, that is, by inference from the survey data. It was possible to specify habitat preferences for 164 taxa.

The most numerous group contains species that prefer habitats associated with peat mosses (56 species in polyhumic waterbodies, 16 in *Sphagnum* puddles). Seventy-four species (45.1% of those 164 taxa) were associated with these habitats. The second most numerous group includes species preferring anthropogenic habitats associated with roads and paths, containing 42 species (25.6%). Habitats associated with marshes (puddles, damp mosses of the *Bryidae* class, old wells) were preferred by 32 species (19.5%), habitats associated with streams were preferred by 11 species (6.7%), and 5 species showed a wide habitat spectrum (Fig. 57).

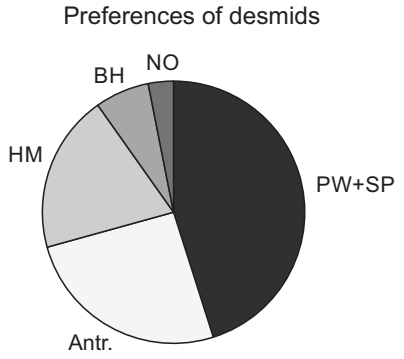

Figure 57. Percentage shares of desmid species with different habitat preferences. PW – polyhumic water bodies, SP – *Sphagnum* puddles, Antr. – anthropogenic habitats (mountain roads, paths), HM – habitats related to mountain wetlands, BH – habitats related to mountain streams, NO – species of indeterminate preference.

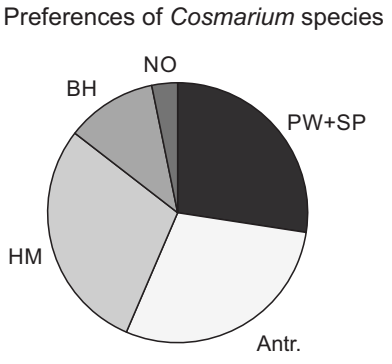

Figure 58. Percentage shares of Cosmarium species with different habitats preferences. PW – polyhumic water bodies, SP – *Sphagnum* puddles, Antr. – anthropogenic habitats (mountain roads, paths), HM – habitats related to marshes, BH – habitats related to mountain streams, NO – species of indeterminate preference.

The habitat preferences of *Cosmarium* species differ from those of the total pool of desmid taxa found in the Gorce area (Fig. 58): 18 species (29%) preferred marsh habitats, another 18 preferred anthropogenic habitats, 17(27.4%) preferred habitats associated with peat mosses, 7(11.3%) were associated with streams, and 2(3.2%) showed a broad habitat spectrum.

The distribution of preferences for all desmids and *Cosmarium* taxa probably depends to a great extent on the fluctuation of pH in each habitat.

Phytogeographical diversity of desmids in the Gorce Mountains

Quantitative data of the desmid flora

During the study, 247 desmid species were recorded. This is not the definitive number. It was not possible to sample all the potential habitats in the Gorce Mts, so no doubt many species were not found and identified. To draw up a list of all the species that might be found in the Gorce Mts is not feasible, but it cannot be ruled out that some of the species recorded from the Tatra Mts, such as *Cosmarium binum* or *Cosmarium dovrense*, will also be found

in the Gorce. The desmid floras of the Carpathian ranges have never been comprehensively studied using modern methods, and the floristic lists from the Tatra or Beskid Mts prepared by previous authors are largely incomplete and most likely not up to date.

Based on the algal species catalogue housed in the Department of Phycology (Algology), W. Szafer Institute of Botany, Polish Academy of Sciences in Kraków and published by Siemińska and Wołowski (2003), and taking into account the synonyms, it can be assumed that ~650 desmid species have been recorded from Poland. Thus, ~38% of our desmid flora is represented in the Gorce Mts. For vascular plants, the percentage of the Polish flora represented in the Gorce Mts is similar (38.8%) according to Kornaś's (1957) pioneering vascular plant flora of the Gorce Mts, which used Szafer et al.'s (1953) *Rośliny Polskie* (Polish Plants) in that calculation.

The shares of genera (by number of species) in the desmid flora of the Gorce Mts are as follows: *Closterium* 15.3%, *Cosmarium* 39.8%, *Euastrum* 7.3%, *Micrasterias* 1.6%, *Staurastrum* 15.8%, *Staurodesmus* 2.8%, *Mesotaeniaceae* genera 4%, genera forming filamentous coenobia (*Desmidium*, *Hyalotheca*, *Spondylosium*, *Teilingia*) 2%, and others (*Actinotaenium*, *Haplotaenium*, *Penium*, *Pleurotaenium*, *Tetmemorus*, *Xanthidium*) 10.5%. (Fig. 59). For Poland as a whole the corresponding shares are as follows: *Closterium* 9.5%, *Cosmarium* 34.5%, *Euastrum* 6.1%, *Micrasterias* 2.9%, *Staurastrum* 18.6%, *Staurodesmus* 5.4%, *Mesotaeniaceae* genera 3.4%, genera forming filamentous coenobia (*Bambusina*, *Desmidium*, *Groenbladia*, *Hyalotheca*, *Sphaerozosma*, *Spondylosium*, *Teilingia* 3.7%, and others (*Actinotaenium*, *Cosmocladium*, *Docidium*, *Haplotaenium*, *Heimansia*, *Octacanthium*, *Oocardium*, *Pachyphorium*, *Penium*, *Pleurotaenium*, *Tetmemorus*, *Triploceros*, *Xanthidium*) 15.9% (graphically illustrated in Fig. 60). The Gorce area has larger shares of *Cosmarium* and *Closterium*; this is probably related to the abundance of alkaline and subaerophytic habitats. The huge variety of *Cosmarium* species is particularly noteworthy. The lower shares of *Staurastrum* and *Staurodesmus* apparently are due to the number of planktonic species in these genera; the Gorce area has few such potential habitats. In various habitats of the Gorce, there are mainly representatives of the genera *Cosmoastrum*, *Cylindrastum* and *Rhapidiastrum*, which were separated from the genus Staurastrum sensu West. According to Palamar-Mordvintseva (1976, 1982), *Staurastrum* mostly contains planktonic species living mainly in waterbodies. The absence of many species in the flora of the Gorce area, including genera known from Poland, may be due to the preference of those species for peat bogs and polyhumic waterbodies. The Gorce area has few such habitats and they are scattered.

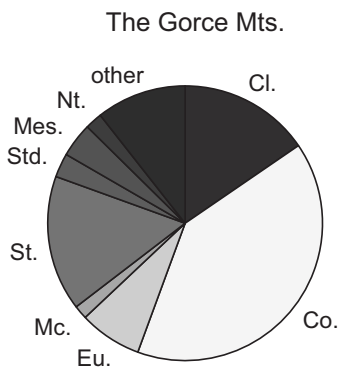

Figure 59. Percentage shares of desmid species in the Gorce Mts flora. Cl. – *Closterium*, Co. – *Cosmarium*, Eu. – *Euastrum*, Mc. – *Micrasterias*, St. – *Staurastrum*, Std. – *Staurodesmus*, Mes. – species of *Mesotaeniaceae* family, Nt. – *Netrium*.

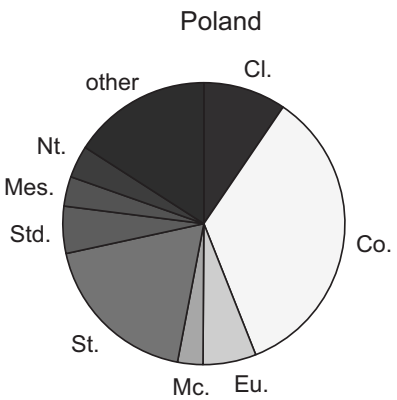

Figure 60. Percentage shares of desmid species in the Polish flora (approximate). Cl. – *Closterium*, Co. – *Cosmarium*, Eu. – *Euastrum*, Mc. – *Micrasterias*, St. – *Staurastrum*, Std. – *Staurodesmus*, Mes. – species of *Mesotaeniaceae* family, Nt. – *Netrium*.

The shares of rare and common species follow a pattern similar to that described for vascular plants from the Gubałówka range by Grodzińska & Pancer-Kotejowa (1960). The largest group is formed by very rare species, and the common ones constitute only a small percentage (Fig. 61). This is probably due to the fact that the probability of finding another station of species with specific habitat preferences decreases exponentially.

The least frequent species in the Gorce area occurred at single stations (76 species) and represented 31.8% of the Gorce desmid flora. Of these, 51 species (67.1%) were found in peat bog habitats and polyhumic waterbodies, 11 (14.5%) in puddles and on moist soil of forest roads and paths, 8 (11.5%) in alkaline marshes, and 6 (2.4%) in other habitats such as temporary waterbodies and puddles on rocks near streams (Fig. 62). The high share of species from peat bogs and polyhumic waterbodies is understandable, as these habitats are rare in the Gorce area and are surrounded by alkaline habitats. The high proportion of rare taxa identified in anthropogenic habitats, such as roads and paths, is interesting. Among the vascular plants in the Gorce area (Kornaś 1957), most peat bog species and many synanthropic species are rare taxa. Among the desmids identified from single stations in the Gorce area are algae rare for Poland, such as *Closterium exile*, *Cosmarium paragranatoides* and *Staurastrum lapponicum*, and also common ones such as *Closterium closterioides*, *Cosmarium connatum* and *Staurastrum tetracerum*.

Common taxa with occurrence of 20–51.3% from all localities in Gorce Mts are represented by 21 species, or 8.5% of the whole desmid flora. The most common species in the Gorce area is *Cosmarium subcrenatum*, found at 210 stations. Most of these algae prefer alkaline habitats, but also show high tolerance to acidification. The exception is acidophilic *Cylindrocystis brebissonii*

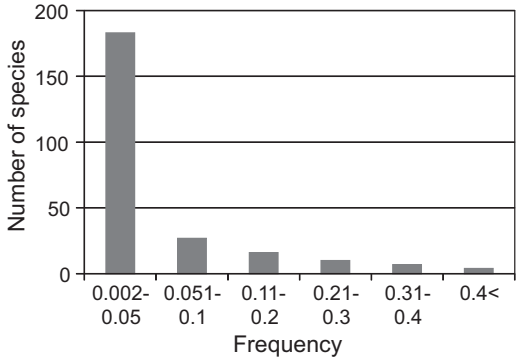

Figure 61. Number of desmid species belonging to different frequency classes.

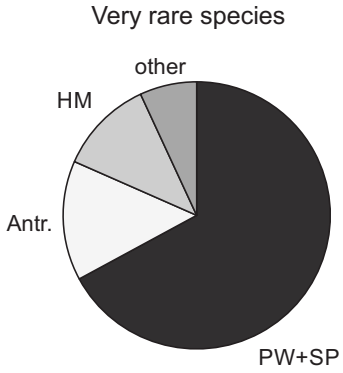

Figure 62. Percentage shares of very rare desmids related to different habitats. PW – polyhumic water bodies, SP – *Sphagnum* puddles, Antr. – anthropogenic habitats (mountain roads, paths), HM – habitats related to marshes

which tolerates habitat alkalization. In Poland, these are usually common taxa; the rarely recorded algae include *Cosmarium anceps*, *Co. holmiense* var. *integrum*, *Co. hornavanense*, *Co. speciosum*, *Co. sportella*, *Co. subcucumis*, *Co. subspeciosum* var. *transiens* and *Co. vexatum*.

During the study, 38 desmid species new for the Carpathians (15.4% of the Carpathian desmid flora) were found: *Actinotaenium borgeanum*, *Ac. cruciferum*, *Ac. diplosporum*, *Ac. gelidum*, *Ac. perminutum*, *Ac. silvae-nigrae*, *Closterium idiosporum*, *Cl. pseudolunula*, *Cl. pygmaeum*, *Cl. sublaterale*, *Cl. tumidulum*, *Cosmarium alpestre*, *Co. dispersum*, *Co. elegantissimum*, *Co. exiguum*, *Co. gonioides*, *Co. limnophilum*, *Co. paragranatoides*, *Co. sexnotatum*, *Co. sphagnicola*, *Co. staurastroides*, *Co. subarctoum*, *Co. subbroomei*, *Co. subquadratum*, *Cylindrocystis crassa*, *Euastrum dissimile*, *Eu. pulchellum*, *Mesotaenium degreyi*, *Staurasstrum arcuatum*, *St. bieneanum*, *St. botrophilum*, *St. dispar*, *St. gladiosum*, *St. pungens*, *St pyramidatum*, *St. scabrum* and *St. subavicula*. As also found for the whole desmid flora of the Gorce area, the most numerous Gorce species new for the Carpathians were *Cosmarium* taxa (36.9%), followed by *Staurastrum* (23.7%) and *Closterium* (13.2%). The majority (71%) were rare taxa having 1–5 stations. Ten species were new for Poland (4% of the Gorce desmid flora): *Actinotaenium borgeanum*, *Ac. gelidum*, *Ac. perminutum*, *Closterium pygmaeum*, *Cl. sublaterale*, *Cosmarium alpestre*, *Co. dispersum*, *Co. paragranatoides*, *Staurasstrum arcuatum* and *St. pyramidatum.*

Mountain and lowland taxa of the Gorce Mountains

The desmid species found in the study can be divided into four groups: (1) those common in the Gorce and rarely reported from other parts of Poland, (2) those often recorded from lowland areas and rare in the Gorce area, (3) those rare throughout Poland, and (4) those common in the Gorce area and in lowland Poland. In geobotanical studies of vascular plants, two vertical elements were distinguished: montane and non-montane (Kornaś 1955). Montane species are those that in Central Europe have their center of occurrence in mountains (Szafer 1930), and non-montane species show no relation to mountains. This issue is discussed in relation to desmids below.

Montane species. No one has made a list of montane species or given clear criteria for determining that a species is montane. In comments about species ranges or local occurrences, different authors use terms like 'montane species', 'more frequent in mountains', 'not reported from lowlands' or 'Arctic-alpine species', (Krieger & Gerloff 1962, 1965, 1969; Růžička 1977, 1981; Prescott et al. 1981; Palamar-Mordvintseva 1982; Lenzenweger 1996, 1997, 1999), but rather arbitrarily and without defining what a montane species is. The main reason for this is the lack of chorological studies on the distribution of desmids, due mostly to the scarcity of floristic data and the widespread belief in the cosmopolitan occurrence of freshwater algae. The affiliation of various vascular plant species to the Carpathians is associated with their formation in the area (rarely), or with specific habitat requirements. In the case of desmids, there is no reason to believe that some species have their center of origin in the Carpathians. According to Coesel (1996), the center of desmid species diversity is in tropical areas, and the floristic distinctiveness of mountains results from climatic conditions. Montane climate, unlike lowland climate, has lower average temperature and higher average precipitation. Changes in average temperature at different elevations are indicated as an important factor differentiating the species composition of desmids living in reservoirs of Papua New Guinea (Vywerman 1992). There is no similar information from Europe in relation to species of aquatic and subaerophytic habitats. In the temperate zone, the occurrence of *Ancylonema nordenskiöldi*, an alga comprising the cryoplankton of alpine and polar glaciers, is determined by thermal factors (Kosinskaja 1952). Higher precipitation in mountains is a very important factor, especially for algae living in subaerophytic habitats such as exposed soil, rocks and moss swards.

There is not enough knowledge about the desmid flora of Poland to draw up a list of montane species for the country. Authors often differ about the montane character of an individual species range. An example would be *Staurodesmus patens*. In Austria, it was recorded only from the Alps (Lenzenveger 1997). In the former Soviet Union, this alga showed no affiliation to mountains (Palamar-Mordvintseva 1982). In Poland, it has many lowland stations and probably its range is nonmontane. The differences in the distribution of this species may result from differences

in geography between the areas studied. The enumeration of montane species that follows is provisional, temporary and largely arbitrary. It includes taxa from Central Europe considered to be associated with mountains by Růžička (1977, 1981): *Actinotaenium gelidum*, *Closterium exile*, *Cl. pusillum*, *Cl. pygmaeum*, *Euastrum crassicolle*, *Eu. montanum*, *Eu. humerosum*, *Eu. subalpinum*, *Penium cylindrus*) and by Palamar-Mordvintseva (1982) (*Cosmarium anceps*, *Co. caelatum*, *Co. costatum*, *Co. crenatum*, *Co. cymatopleurum*, *Co. davidsonii*, *Co. decedens*, *Co. galeritum*, *Co. hammeri*, *Co. holmiense*, *Co. jenisejense*, *Co. microsphinctum*, *Co. nasutum*, *Co. notabile*, *Co. novae-semliae*, *Co. obliquum*, *Co.pericymatium*, *Co. pokornyanum*, *Co. pulcherrimum*, *Co. sexnotatum*, *Co. speciosum*, *Co. sphalaerostichum*, *Co. subspeciosum*, *Co. tatricum*, *Co. tetragonum*, *Staurastrum capitulum*, *St. lapponicum* and *St. merianii*. Species so far found in Poland in the Carpathians and adjacent highlands are added to this list: *Cosmarium arctoum*, *Co. dentiferum* var. *alpigenum*, *Co. saxicola*, *Co. subnotabile* and *Staurastum acutum*. In Poland, most of the above taxa occur in or near the Carpathians and Sudetes. Only *Cosmarium caelatum*, *Euastrum humerosum* and *Penium cylindrus* are widely distributed. On the basis of our current knowledge of their ranges, it is difficult to establish their montane character in Poland. Among the vascular plants, there are many montane species that have numerous sites in the lowlands of Poland (Zając 1996). The situation of the mentioned desmid species may well be similar, but this problem cannot be solved until we have good distribution maps of these species in Poland. The records of lowland stations of *Penium cylindrus* also require verification, as it can be confused with the common *Penium margaritaceum*, and different authors often use different characters to distinguish the two taxa.

Among the montane species of vascular plants, there are several geographical subelements (Zając 1996). Unfortunately, we do not have maps of the ranges of desmids in Europe like the ones we have for most of our vascular plants, so a full analysis of subelements is not possible. On the basis of fragmentary data, some of the species in the European part of their range can be considered to be Atlantic-Arctic-Alpine subelements. In Europe, *Cosmarium pokornyanum* has an interesting distribution. This alga was reported from a number of stations in the British Isles (Scotland, England, Ireland) (West & West 1905). It was found in the Netherlands (Coesel & Meester 2001). In Central Europe, it was reported from the Alps (Krieger & Gerloff 1965; Lenzenveger 1997), Carpathians and Sudetes, and in the former Soviet Union, it was reported from mountainous and northern areas (Palamar-Mordvintseva 1984). In Northern Europe, it was reported from Spitsbergen, Sweden and Finland (Krieger & Gerloff 1965). Outside Europe, in the Northern Hemisphere, this alga was reported from Greenland, Newfoundland, British Columbia and Alaska (Prescott et al. 1981). On the basis of my own observations, I think that the range of this taxon in the Northern Hemisphere shows Arctic-alpine character, with a clear disjunction in Central and Eastern Europe, but it also shows an affiliation to the Atlantic Provinces, where it occurs in lowland areas *Cosmarium anceps*, *Co. caelatum*, *Co. decedens*, *Co. speciosum*, *Co. tatricum* and *Staurastrum lapponicum* probably have a similar type of range in Europe. *Euastrum subalpinum* may belong to the Arctic-Alpine subelement. It has not been recorded in the lowlands of Western Europe and shows an Arctic-alpine disjunction in the central part of the continent (Růžička 1981).

In the Gorce Mts, 44 montane species of desmids (listed above) were distinguished, constituting 17.7% of the area's desmid flora. This percentage is similar to that given for montane species in the vascular plant flora of the Gorce Mts (~18%; Kornaś 1955). The number of montane desmid species and their percentages of the desmid flora in different habitats of the Gorce Mts are as follows: polyhumic waterbodies – 8 species (7.8%), *Sphagnum* puddles – 18 (12.6%), puddles on roads – 27 (20.1%), moist soil on roads – 23 (21.5%), puddles on tourist trails – 12 (17.1%), puddles in marshes – 18 (19.4%), wet mosses of the *Bryidae* class – 21 (22.6%), old wells in marshes – 19 (22.4%), and oxbow lakes, old stream branches and puddles on rocks near rivers – 9 (20.9%) (Fig. 63). Interestingly, the habitats widely recognized as most suitable for desmids (polyhumic waterbodies and *Sphagnum* puddles) had the smallest share of montane species. The largest share of montane species was noted in marshes and puddles on roads. These numerical data suggest that in the Gorce Mts the montane desmid species occur primarily in subaerophytic habitats. These may be photophilous algae sensitive to CO_2 or O_2 deficit and resistant to drought. The presence of numerous montane species in alkaline habitats (most of the marshes, habitats associated with streams) is another interesting finding. Alkalophilic algae that tolerate habitat acidification occur in such habitats, including *Cosmarium anceps*, *Co. davidsonii*, *Co. galeritum*, *Co. holmiense* var. *integrum*, *Co. notabile*, *Co. pokornyanum*, *Co. speciosum*, *Co. subspeciosum* var. *transiens* and *Staurastrum merianii*, as well as taxa with very low tolerance of acidification (*Cosmarium crenatum*, *Co. cymatopleurum*, *Co. pericymatium*). Among the montane taxa there are also acidophilic species. The most numerous ones are desmids that tolerate alkaline habitats, such as *Cosmarium caelatum*, *Cosmarium dentiferum* var. *alpinum*, *Cosmarium nasutum*,

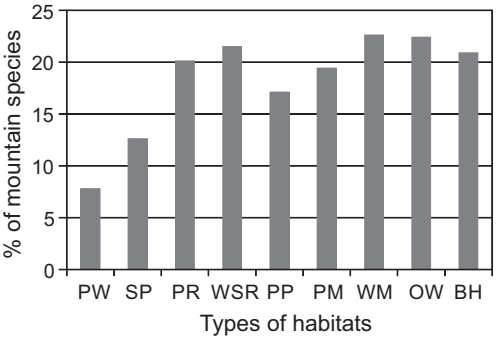

Figure 63. Percentage shares of mountain desmid species in different habitats. PW – polyhumic water bodies, SP – *Sphagnum* puddles, PR – puddles on mountain roads, WSR – wet soil on mountain roads, PP – puddles on paths, PM – puddles on marshes, WM – wet mosses from *Bryidae* class on marshes, OW – old wells, BH – habitats related to mountain streams.

Cosmarium novae-semliae, *Euastrum crassicolle*, *Euastrum humerosum*, *Penium cylindrus* and *Staurastrum acutum*. The acidophilic species with low tolerance of alkalization include *Euastrum montanum*, *Eu. subalpinum*, *Staurastrum capitulum* and *St. pileolatum*. Other montane species were not found frequently enough to draw conclusions about their habitat preference. Generally, the montane species found in the Gorce Mts avoided habitats associated with *Sphagnum* mosses (polyhumic waterbodies, *Sphagnum* puddles).

From analyses of the habitat preferences of the montane desmids occurring in the Gorce area, we can infer the reasons why they are reported so rarely from Polish lowlands. Most of them do not have many potential habitats in our lowlands: low total precipitation and frequent periods of drought limit the presence of algae on exposed soils, habitats resembling the Gorce marshes of the *Valeriano-Caricetum fuscae* community with *Bryidae* mosses are rare, and the old oxbow lakes of lowland rivers are completely different in character from the habitats associated with mountain streams. The relatively numerous stations of *Cosmarium caelatum*, *Euastrum humerosum* and *Penium cylindrus* in lowland can be understood, whereas the extremely rare occurrence of desmids such as *Euastrum montanum*, *Eu. subalpinum* or *Staurastrum pileolatum* in lowland peat bogs is difficult to explain. Temperature may be the limiting factor.

As with many vascular plant species, many montane desmid species such as *Closterium exile*, *Cosmarium decedens* or *Co. tatricum* are rare or very rare in the Gorce area. Montane species very rarely dominated the samples; generally, they were not numerous or occurred only as a single cell in a sample. This may be because they have their center of occurrence at higher elevation.

Among the montane vascular plants, altitudinal subelements associated with plant zones (foothill species, montane species, etc.) can be distinguished (Walas 1938; Kornaś 1955), but for desmids this is not possible due to the lack of data on the vertical distribution of desmids in the Carpathians.

Non-montane species. Most of the desmid species found in the Gorce area are algae not related to mountains. Some of them are taxa often reported from Polish lowlands and occurring frequently in the Gorce Mts. *Actinotaenium cucurbitinum*, *Closterium acerosum*, *Cl. intermedium*, *Cosmarium botrytis*, *Co. tetraophthalmum* and *Staurastrum punctulatum* are some of them. Many taxa often reported from lowland in the studied area were rare or very rare (e.g., *Closterium baillyanum*, *Cosmarium connatum*, *Micrasterias rotata*, *Staurodesmus convergens*); these are mostly algae associated with peat bogs.

It is possible that many desmid species that are frequent in the lowlands and rare in the Gorce area have their local range limit in the Carpathians; such is the case for many vascular plant species (Zając & Zając eds. 2001).

Some desmid species are common in the Gorce Mts and are known from very few lowland stations, but are not referred to as montane species in the literature. These include *Cosmarium hornavanense*, *Co. didymochondrum*, *Co. sportella*, *Co. subcucumis* and *Co. vexatum*. The ranges of some of them may in fact be montane, but the paucity of data prevents such a characterization at present. Most of them were found mainly in alkaline habitats, which have rarely been studied by desmid researchers.

Distribution of desmid species in vegetation zones

The occurrence of altitude zones in mountains is a well-known phenomenon among vascular plants. In our Carpathians, the plant zones are associated with climate zones (Hess 1965). The change in height above sea level has been found to be a factor in the distribution of various desmid species in the mountains of Papua New Guinea (Wywerman 1991), Alaska (Takeuhi 2001), in the Himalayas (Yoshimura 1997) and Austrian Alps (Lenzenweger 1996, 1997, 1999). In the above-cited works, lower and upper range limits have been identified for many species, but the zone phenomenon has not been established. For our Tatras, Gutwiński (1909) found that certain algal species occur only in specific altitude zones of vascular plants, but this information is preliminary.

Individual vegetation zones have been distinguished for the vascular plants of the Gorce area on the basis of the plant density at vertical range borders at different altitudes (Kornaś 1955). The following zones have been distinguished: foothills at less than 600 m a.s.l., lower montane at 600–1150 m a.s.l., and upper montane above 1150 m a.s.l. A similar methodology is not possible for desmids because, unlike for vascular plants, the habitats of these algae are not distributed along a continuous altitude gradient. In addition, many species are associated with specific habitats whose existence does not depend on height above sea level. In the Gorce area, most of the species associated with polyhumic waterbodies and *Sphagnum* puddles have their lower range limit at 870 m a.s.l., where the lowest-elevation peat bog in the Gorce occurs. Though it is not feasible to distinguish altitude zones for the desmids, it is worth tracking the relation between the vertical distribution of different desmid species and the altitude zones of higher plants. As the zones cover completely different areas, the comparison requires us to take into consideration the frequency of occurrence of particular species (Tab. 4) and not just the number of stations in each zone. Figure 64a–c summarizes the basic numerical data for individual zones (number of species, percentage of rare, common and montane species), and Figure 65a–c gives the percentage shares of each species in the floristic lists of zones.

Foothill zone. This area contains the lowest stations and covers 11.7% of the study area. Desmids occur here in stream-related habitats, on moist soil, in puddles on roads, paths and rarely in marshes. In the foothill zone, there are no peat bogs; 74 desmid species were found here, representing 29.6% of the Gorce desmid flora. The percentage shares of individual genera (number of species) in the flora of the foothill zone are as follows: *Closterium* 15%, *Cosmarium* 57.9%, *Euastrum* 1.4%, *Staurastrum*

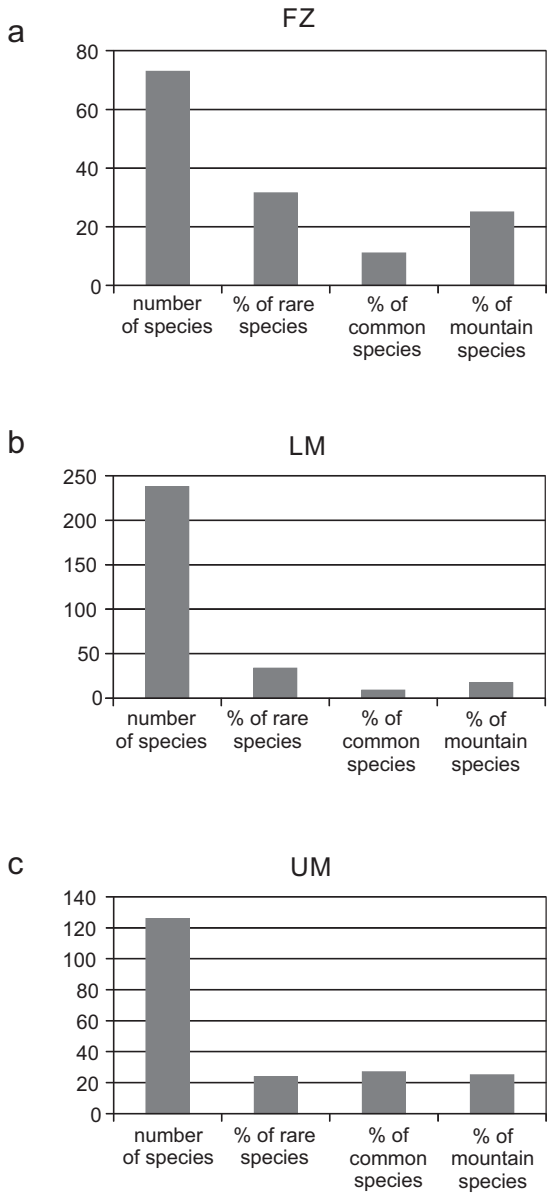

Figure 64. Characteristics of the desmid flora in Gorce Mts montane zones (number of species, percentage shares of rare, common and mountain species). a – foothill zone (FZ); b – lower montane zone (LM); c – upper montane zone (UM).

8.6%, *Mesotaeniaceae* genera 5.4%, and others (*Actinotaenium*, *Penium*, *Pleurotaenium*, *Tetmemorus*) 12.1%. As compared to the entire Gorce desmid flora, the share of *Cosmarium* species is clearly higher, and the shares of *Euastrum* and *Staurastrum* species clearly lower. There are no representatives of the genera *Micrasterias* or *Staurodesmus*, nor those of genera forming filamentous coenobia (e.g., *Desmidium*, *Hyalotheca*). Species with only one station in the foothill zone constitute 31.5% of its flora. The most common species (frequency greater than 0.2) represent ~11%. These include *Closterium acerosum*, *Cl. moniliferum*, *Cosmarium holmiense* var. *integrum*, *Co. impressulum*, *Co. quadratum*, *Co. speciosum*, *Co. subcrenatum* and *Co. vexatum*. These are alkalophilic species with high tolerance of acidification. Only *Cosmarium quadratum*, present at a wide range of pH, shows no clear preference for alkaline habitats. Species that in the Gorce Mts have their maxima of occurrence in the foothill zone include *Closterium acerosum*, *Cl. littorale*, *Cl. pseudolunula*, *Cosmarium biretum*, *Co. crenatum*, *Co. didymochondrum*, *Co. holmiense* var. *integrum*, *Co. impressulum*, *Co. microsphinctum*, *Co. nitidulum*, *Co. parvulum* and *Co. vexatum*. These are mainly algae associated with alkaline habitats. The only species whose occurrence in the Gorce is limited to the foothill zone is *Cosmarium crenulatum*, which was found at a single station. This may be an accidental result, since this alga is often reported from the whole area of Poland. Montane species constitute ~25% of the flora of the lowest zone. This flora indicates a degraded area in which there are no habitats for most desmid species. The predominance of alkaline habitats is the important factor here.

Lower montane zone. This is the middle zone, covering 78.8% of the Gorce area. It includes all types of habitats in which desmids were found. In the lower montane zone, there are two stations: the Jeziorne peatland in the Lubań

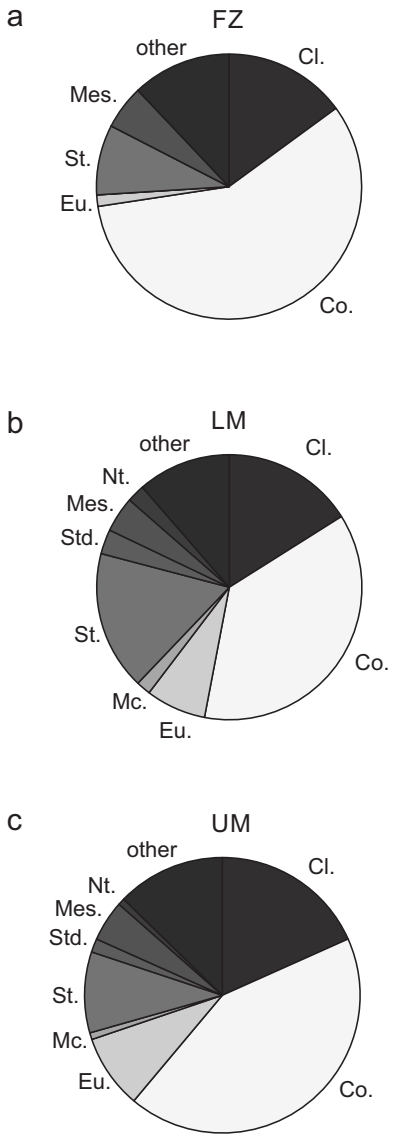

Figure 65. Percentage shares of desmid species in Gorce Mts montane zone floras. a – foothill zone (FZ); b – lower montane zone (LM); c – upper montane zone (UM), Cl. – *Closterium*, Co. – *Cosmarium*, Eu. – *Euastrum*, Mc. – *Micrasterias*, St. – *Staurastrum*, Std. – *Staurodesmus*, Mes. – species of *Mesotaeniaceae* family, Nt. – *Netrium*.

Table 4. Frequency of occurrence of particular desmid species in the Gorce Mts. G – Gorce Mts, TR – Turbacz range, LR – Lubań range, FZ – foothill zone, LM – lower montane zone, UM – upper montane zone.

Name of taxa	G	TR	LR	FZ	LM	UM
Actinotaenium borgeanum	0.012	0.015	–	–	0.021	0.013
Actinotaenium cruciferum	0.012	0.012	0.013	–	0.012	0.026
Actinotaenium cucurbita	0.149	0.161	0.101	0.104	0.146	0.231
Actinotaenium cucurbitinum	0.176	0.179	0.165	0.188	0.186	0.077
Actinotaenium curtum	0.002	0.003	–	–	0.003	–
Actinotaenium didymocarpum	0.005	0.003	0.013	–	0.06	–
Actinotaenium diplosporum	0.213	0.245	0.076	0.125	0.236	0.128
Actinotaenium gelidum	0.005	0.006	–	–	0.003	0.026
Actinotaenium perminutum	0.022	0.024	0.013	–	0.025	0.026
Actinotaenium silvae-nigrae	0.017	0.006	0.025	–	0.016	0.05
Actinotaenium spinospermum	0.02	0.024	–	–	0.025	–
Actinotaenium spirostriolatum	0.056	0.07	–	–	0.056	0.126
Actinotaenium turgidum	0.002	–	0.013	–	0.003	–
Closterium abruptum	0.088	0.104	0.013	–	0.081	0.026
Closterium acerosum	0.244	0.279	0.101	0.292	0.239	0.231
Closterium acutum	0.012	0.015	–	–	0.015	–
Closterium baillyanum	0.002	–	0.013	–	0.003	–
Closterium calosporum	0.002	–	0.013	–	0.003	–
Closterium closterioides	0.002	–	0.013	–	0.003	–
Closterium cornu	0.007	0.009	–	–	0.009	–
Closterium costatum	0.01	0.009	0.013	–	0.012	–
Closterium cynthia	0.005	0.003	0.013	–	0.006	–
Closterium dianae	0.015	0.015	0.013	0.021	0.016	–
Closterium ehrenbergii	0.154	0.155	0.152	0.063	0.143	0.359
Closterium exile	0.002	0.003	–	–	–	0.026
Closterium idiosporum	0.012	0.012	0.013	–	0.016	–
Closterium intermedium	0.108	0.127	0.025	–	0.109	0.231
Closterium jenneri	0.002	0.003	–	–	0.003	–
Closterium juncidum	0.12	0.145	0.013	–	0.134	0.154
Closterium kuetzingi	0.056	0.067	0.013	–	0.056	0.128
Closterium lineatum	0.002	0.003	–	–	0.003	–
Closterium littorale	0.073	0.079	0.051	0.125	0.068	0.051
Closterium lunula	0.044	0.052	0.013	–	0.05	0.051
Closterium macilentum	0.002	0.003	–	–	0.003	–
Closterium moniliferum	0.323	0.345	0.228	0.271	0.345	0.206
Closterium navicula	0.149	0.17	0.064	0.021	0.151	0.256
Closterium parvulum	0.328	0.367	0.165	0.125	0.357	0.333
Closterium praelongum	0.164	0.176	0.113	0.125	0.149	0.333
Closterium pritchardianum	0.029	0.036	–	–	0.034	0.026
Closterium pronum	0.002	–	0.013	–	0.003	–
Closterium pseudolunula	0.093	0.1	0.063	0.188	0.084	0.051
Closterium pusillum	0.005	0.006	–	–	0.003	0.026
Closterium pygmaeum	0.007	0.009	–	–	0.009	–
Closterium rostratum	0.078	0.097	–	–	0.087	0.103
Closterium strigosum	0.012	0.009	0.025	–	0.012	0.026
Closterium striolatum	0.076	0.085	0.038	0.042	0.062	0.231
Closterium sublaterale	0.051	0.055	0.038	0.042	0.05	0.077
Closterium tumidulum	0.032	0.036	0.013	–	0.037	0.026
Closterium tumidum	0.029	0.036	–	–	0.031	0.031
Closterium turgidum	0.002	–	0.013	–	0.003	–
Closterium venus	0.012	0.012	0.013	–	0.012	0.026
Cosmarium alpestre	0.002	–	0.013	–	0.003	–
Cosmarium anceps	0.247	0.264	0.177	0.146	0.258	0.282
Cosmarium angulosum	0.005	0.003	0.013	–	0.006	–
Cosmarium annulatum	0.002	0.003	–	–	–	0.026
Cosmarium arctoum	0.002	0.003	–	–	0.003	–
Cosmarium asphaerosporum	0.002	–	0.013	–	–	0.026
Cosmarium bioculatum	0.002	–	0.013	–	0.003	–
Cosmarium biretum	0.017	0.018	0.013	0.042	0.016	–
Cosmarium Blyttii	0.005	0.006	–	–	0.006	–
Cosmarium boeckii	0.005	0.003	0.013	–	0.006	–
Cosmarium botrytis	0.242	0.264	0.152	0.146	0.255	0.256

Table 4. Continued

Name of taxa	G	TR	LR	FZ	LM	UM
Cosmarium caelatum	0.13	0.154	0.025	0.021	0.133	0.231
Cosmarium connatum	0.002	–	0.013	–	0.003	–
Cosmarium conspersum	0.007	0.006	0.013	0.021	0.006	–
Cosmarium contractum	0.007	0.006	0.013	–	0.009	–
Cosmarium costatum	0.044	0.055	–	0.063	0.034	0.103
Cosmarium crenatum	0.054	0.063	0.013	0.063	0.056	0.026
Cosmarium crenulatum	0.002	0.003	–	0.021	–	–
Cosmarium cyclicum	0.071	0.076	0.051	0.042	0.071	0.103
Cosmarium cymatopleurum	0.01	0.012	–	–	0.012	–
Cosmarium davidsonii	0.112	0.13	0.048	0.021	0.118	0.179
Cosmarium debaryi	0.002	–	0.013	–	0.003	–
Cosmarium decedens	0.015	0.015	0.013	–	0.016	0.026
Cosmarium dentiferum	0.034	0.042	–	–	0.025	0.154
Cosmarium depressum	0.002	–	0.013	–	0.003	–
Cosmarium didymochondrum	0.161	0.161	0.165	0.167	0.161	0.154
Cosmarium difficile	0.01	0.009	0.013	–	0.01	0.026
Cosmarium dispersum	0.002	–	0.013	–	0.003	–
Cosmarium elegantissimum	0.022	0.024	0.013	–	0.028	–
Cosmarium exiguum	0.002	0.003	–	–	0.003	–
Cosmarium formosulum	0.095	0.115	0.013	0.021	0.102	0.128
Cosmarium galeritum	0.13	0.145	0.063	–	0.115	0.41
Cosmarium garrolense	0.017	0.018	0.013	–	0.016	0.051
Cosmarium gonioides	0.002	–	0.013	–	0.003	–
Cosmarium granatum	0.098	0.103	0.076	0.083	0.099	0.102
Cosmarium hammeri	0.01	0.009	0.013	–	0.009	0.026
Cosmarium holmiense var. *holmiense*	0.017	0.018	0.013	–	0.021	–
Cosmarium holmiense var. *integrum*	0.257	0.258	0.253	0.292	0.258	0.205
Cosmarium hornavanense	0.244	0.264	0.165	0.167	0.271	0.128
Cosmarium humile	0.002	–	0.013	–	0.003	–
Cosmarium impressulum	0.232	0.236	0.215	0.375	0.22	0.167
Cosmarium jenisejense	0.002	–	0.013	–	0.003	–
Cosmarium laeve	0.381	0.388	0.354	0.188	0.407	0.41
Cosmarium limnophilum	0.002	–	0.013	–	0.003	–
Cosmarium majae	0.002	–	0.013	–	0.003	–
Cosmarium margaritatum	0.002	–	0.013	–	0.003	–
Cosmarium margaritiferum	0.039	0.036	0.051	–	0.043	0.051
Cosmarium meneghinii	0.005	0.003	0.013	–	0.006	–
Cosmarium microsphinctum	0.007	0.009	–	0.042	0.003	–
Cosmarium nasutum	0.037	0.045	–	0.021	0.034	0.077
Cosmarium nitidulum	0.01	0.012	–	0.06	0.003	–
Cosmarium notabile	0.166	0.181	0.101	0.063	0.177	0.205
Cosmarium novae-semliae	0.01	0.012	–	–	0.009	0.026
Cosmarium obliquum	0.012	0.015	–	–	0.009	0.051
Cosmarium obtusatum	0.2	0.218	0.127	0.167	0.205	0.205
Cosmarium ochthodes	0.284	0.306	0.19	0.125	0.304	0.308
Cosmarium ornatum	0.002	0.003	–	–	0.003	–
Cosmarium pachydermum	0.022	0.025	0.013	0.021	0.021	0.026
Cosmarium paragranatoides	0.002	–	0.013	–	0.003	–
Cosmarium parvulum	0.007	0.009	–	0.021	0.006	–
Cosmarium pericymatium	0.017	0.021	–	0.104	0.003	–
Cosmarium pokornyanum	0.078	0.088	0.038	0.063	0.081	0.077
Cosmarium porteianum	0.005	–	0.025	–	0.006	–
Cosmarium praemorsum	0.015	0.012	0.025	–	0.018	–
Cosmarium pseudoexiguum	0.002	0.003	–	–	0.003	–
Cosmarium pseudopyramidatum	0.073	0.088	0.013	0.042	0.078	0.077
Cosmarium pulcherrimum	0.002	0.003	–	–	–	0.026
Cosmarium pyramidatum	0.005	0.003	0.013	–	0.003	0.026
Cosmarium quadratum	0.484	0.533	0.278	0.271	0.509	0.538
Cosmarium quadratulum	0.002	0.003	–	–	–	0.026
Cosmarium quadrum	0.005	0.003	0.013	–	0.003	0.026
Cosmarium rectangulare	0.005	0.003	0.013	–	0.003	–
Cosmarium regnellii	0.049	0.055	0.025	–	0.059	0.026
Cosmarium reniforme	0.017	0.012	0.026	–	0.021	–

Table 4. Continued

Name of taxa	G	TR	LR	FZ	LM	UM
Cosmarium saxicola	0.002	0.003	–	–	0.003	–
Cosmarium sexangulare	0.002	0.003	–	–	0.003	–
Cosmarium sexnotatum	0.01	0.012	–	–	0.006	0.051
Cosmarium speciosum	0.311	0.333	0.215	0.396	0.28	0.462
Cosmarium sphagnicola	0.002	–	0.013	–	0.003	–
Cosmarium sphalerostichum	0.039	0.003	0.013	0.042	0.034	0.077
Cosmarium sportella	0.281	0.285	0.266	0.125	0.32	0.154
Cosmarium staurastroides	0.002	–	0.013	–	0.003	–
Cosmarium subarctoum	0.012	0.012	0.013	–	0.012	0.026
Cosmarium subbroomei	0.093	0.103	0.051	0.125	0.099	–
Cosmarium subcostatum	0.108	0.124	0.038	0.063	0.106	0.179
Cosmarium subcrenatum	0.513	0.506	0.544	0.479	0.516	0.538
Cosmarium subcucumis	0.433	0.442	0.392	0.146	0.466	0.513
Cosmarium subgranatum	0.037	0.039	0.023	0.021	0.043	–
Cosmarium subnotabile	0.005	0.006	–	–	–	0.05
Cosmarium subprotumidum	0.002	0.003	–	–	0.003	–
Cosmarium subquadratum	0.005	0.006	–	–	–	0.05
Cosmarium subspeciosum	0.328	0.348	0.241	0.167	0.36	0.256
Cosmarium subtumidum	0.005	0.006	–	0.021	0.003	–
Cosmarium tatricum	0.01	0.012	–		0.006	0.051
Cosmarium tetragonum	0.034	0.042	0.025	0.042	0.028	0.077
Cosmarium tetraophthalmum	0.152	0.127	0.253	0.146	0.149	0.179
Cosmarium thwaitesii	0.002	0.003	–	–	0.003	–
Cosmarium tinctum	0.02	0.024	–	–	0.019	0.051
Cosmarium turpinii	0.005	0.006	–	–	0.006	–
Cosmarium venustum	0.002	–	0.013	–	0.003	–
Cosmarium vexatum	0.325	0.333	0.291	0.417	0.323	0.231
Cylindrocystis brebissonii	0.34	0.379	0.177	0.146	0.254	0.718
Cylindrocystis crassa	0.046	0.045	0.051	0.083	0.04	0.051
Desmidium grevillei	0.005	0.003	0.013	–	0.006	–
Desmidium swartzii	0.005	0.003	0.013	–	0.006	–
Euastrum ansatum	0.022	0.024	0.013	–	0.019	0.077
Euastrum bidentatum	0.042	0.048	0.013	–	0.037	0.128
Euastrum binale	0.054	0.061	0.025	–	0.053	0.128
Euastrum crassicolle	0.005	0.006	–	–	0.006	–
Euastrum denticulatum	0.042	0.048	0.013	–	0.047	0.051
Euastrum didelta	0.017	0.021	–	–	0.016	0.051
Euastrum dissimile	0.005	0.003	0.013	–	0.003	0.026
Euastrum dubium	0.002	–	0.013	–	0.003	–
Euastrum elegans	0.002	0.003	–	–	0.003	–
Euastrum erosum	0.029	0.021	0.063	0.042	0.031	–
Euastrum gayanum	0.002	0.003	–	–	0.003	–
Euastrum humerosum	0.02	0.018	0.025	–	0.019	0.051
Euastrum insigne	0.002	0.003	–	–	–	0.026
Euastrum montanum	0.005	0.006	–	–	0.006	–
Euastrum oblongum	0.044	0.052	0.013	–	0.04	0.154
Euastrum pulchellum	0.002	–	0.013	–	0.003	–
Euastrum subalpinum	0.022	0.024	0.013	–	0.019	0.077
Euastrum verrucosum	0.017	0.021	–	–	0.019	0.026
Gonatozygon brebissonii	0.073	0.085	0.025	0.063	0.074	0.077
Gonatozygon monotaenium	0.002	–	0.013	–	0.003	–
Haplotaenium rectum	0.002	–	0.013	–	0.003	–
Hyalotheca dissiliens	0.054	0.061	0.025	–	0.047	0.179
Mesotaenium degreyi	0.098	0.112	0.038	0.021	0.071	0.41
Mesotaenium endlicherianum	0.002	0.003	–	–	0.003	–
Mesotaenium macrococcum	0.01	0.009	0.013	–	0.01	0.026
Micrasterias americana	0.002	0.003	–	–	0.003	–
Micrasterias dickiei	0.002	–	0.013	–	0.003	–
Micrasterias papillifera	0.01	0.009	0.013	–	0.012	–
Micrasterias rotata	0.012	0.012	0.013	–	0.016	–
Micrasterias truncata	0.017	0.018	0.013	–	0.014	0.026
Netrium digitus	0.188	0.224	0.038	–	0.189	0.41
Netrium oblongum	0.012	0.009	0.025	0.021	0.012	–

Table 4. Continued

Name of taxa	G	TR	LR	FZ	LM	UM
Penium cylindrus	0.071	0.088	0.025	0.021	0.071	0.128
Penium margaritaceum	0.098	0.115	0.025	0.021	0.09	0.256
Planotaenium interruptum	0.007	0.006	0.013	–	0.009	–
Pleutotaenium crenulatum	0.027	0.031	0.013	–	0.025	0.077
Pleutotaenium ehrenbergii	0.002	–	0.013	–	0.003	–
Pleutotaenium trabecula	0.056	0.061	0.038	0.021	0.056	0.103
Roya obtusa	0.046	0.058	–	–	0.037	0.103
Spondylosium pulchellum	0.002	0.003	–	–	0.003	–
Spirotaenia condensata	0.002	0.003	–	–	0.003	–
Spirotaenia obscura	0.005	0.006	–	–	0.006	–
Staurastrum aculeatum	0.002	–	0.013	–	0.003	–
Staurastrum acutum	0.005	0.003	0.013	0.021	0.003	–
Staurastrum alternans	0.005	0.003	0.013	–	0.006	–
Staurastrum arcuatum	0.002	–	0.013	–	0.003	–
Staurastrum avicula	0.005	0.003	0.013	–	0.006	–
Staurastrum bieneanum	0.002	–	0.013	–	0.003	–
Staurastrum botrophilum	0.002	–	0.013	–	0.003	–
Staurastrum capitulum	0.007	0.006	0.013	–	0.009	–
Staurastrum controversum	0.002	0.003	–	–	0.003	–
Staurastrum dispar	0.002	–	0.013	–	0.003	–
Staurastrum furcatum	0.002	–	0.013	–	0.003	–
Staurastrum gladiosum	0.005	0.003	0.013	–	0.006	–
Staurastrum hexacerum	0.01	0.009	0.013	–	0.012	–
Staurastrum hirsutum	0.07	0.081	–	0.021	0.05	0.28
Staurastrum inflexum	0.005	0.003	0.013	–	0.006	–
Staurastrum lapponicum	0.002	0.003	–	–	0.003	–
Staurastrum lunatum	0.002	–	0.013	–	0.003	–
Staurastrum margaritaceum	0.012	0.14	0.05	–	0.11	0.41
Staurastrum merianii	0.076	0.082	0.051	0,042	0.085	0.077
Staurastrum muricatum	0.095	0.112	0.025	–	0.074	0.385
Staurastrum muticum	0.002	–	0.013	–	0.003	–
Staurastrum orbiculare	0.071	0.085	0.013	0.021	0.071	0.128
Staurastrum oxyacanthum	0.002	–	0.013	–	0.003	–
Staurastrum pileolatum	0.024	0.027	0.013	–	0.016	0.128
Staurastrum pilosum	0.031	0.036	0.013	–	0.031	0.076
Staurastrum polymorphum	0.002	0.003	–	–	0.003	–
Staurastrum polytrichum	0.024	0.03	–	–	0.025	0.051
Staurastrum proboscideum	0.002	–	0.013	–	0.003	–
Staurastrum punctulatum	0.237	0.222	0.076	0.104	0.242	0.359
Staurastrum pungens	0.002	–	0.013	–	0.003	–
Staurastrum pyramidatum	0.002	0.003	–	–	0.003	–
Staurastrum scabrum	0.01	0.012	–	–	0.012	–
Staurastrum sexcostatum	0.042	0.045	0.025	0.021	0.043	0.051
Staurastrum spongiosum	0.002	0.003	–		0.003	–
Staurastrum subavicula	0.01	0.009	0.013		0.012	–
Staurastrum subbrebissonii	0.044	0.055	–	0.021	0.037	0.13
Staurastrum teliferum	0.005	0.003	0.013	–	0.006	–
Staurastrum tetracerum	0.002	–	0.013	–	0.003	–
Staurastrum turgescens	0.032	0.036	0.013	–	0.037	0.026
Staurodesmus controversus	0.007	0.009	–	–	0.003	0.051
Staurodesmus convergens	0.002	–	0.013	–	0.003	–
Staurodesmus cuspidatus	0.002	–	0.013	–	0.003	–
Staurodesmus extensus	0.002	–	0.013	–	–	0.026
Staurodesmus glaber	0.005	0.006	–	–	0.006	–
Staurodesmus patens	0.005	0.003	0.013	–	0.006	–
Teilingia granulata	0.002	–	0.013	–	0.003	–
Tetmemorus granulatus	0.056	0.067	0.013	0.021	0.047	0.18
Tetmemorus laevis	0.17	0.197	0.063	0.042	0.168	0.359
Xanthidium antilopaeum	0.002	–	0.013	–	0.003	–
Xanthidium cristatum	0.002	–	0.013	–	0.003	–

range, and Pucołowski Stawek pond, both of which have very high species diversity. Overall, 238 desmid species were identified in this zone, accounting for 96.4% of the Gorce desmid flora. The shares of individual genera in the flora of the lower montane zone are as follows: *Closterium* 15.5%, *Cosmarium* 35.7%, *Euastrum* 7.1%, *Micrasterias* 1.7%, *Staurastrum* 16.4%, *Staurodesmus* 2.9%, *Mesotaeniaceae* genera 4.2%, genera forming filamentous coenobia (*Desmidium*, *Hyalotheca*, *Spondylosium*, *Teilingia*) 2.1%, and others (*Actinotaenium*, *Haplotaenium*, *Penium*, *Pleurotaenium*, *Tetmemorus*, *Xanthidium*) 11%. Such percentage shares are generally similar to those of the total Gorce desmid flora, but the share of *Cosmarium* species in the latter is clearly lower. This is probably related to the high proportion of species from peatland habitats in the flora of this zone. These habitats are not particularly rich in *Cosmarium* species. Species known only from one station constitute 33.6% of the zone's flora, about half of which are species associated with peat bog habitats. Common species (frequency greater than 0.2) constitute 8.8%. This group includes *Actinotaenium diplosporum*, *Closterium acerosum*, *Cl. moniliferum*, *Cl. parvulum*, *Cosmarium anceps*, *Co. botrytis*, *Co. holmiense* var. *integrum*, *Co. hornavanense*, *Co. impressulum*, *Co. laeve*, *Co. obtusatum*, *Co. ochthodes*, *Co. quadratum*, *Co. speciosum*, *Co. sportella*, *Co. subcrenatum*, *Co. subcucumis*, *Co. subspeciosum* var. *transiens*, *Co. vexatum*, *Cylindrocystis brebissonii* and *Staurastrum punctulatum*. Alkalophilic species clearly dominate. *Actinotaenium diplosporum*, *Cosmarium quadratum* and *Staurastrum punctulatum* show no strong pH preference. *Cylindrocystis brebissonii* prefers acidic habitats, but is resistant to alkalization. Many of these species are often recorded in Poland. The rare taxa include *Cosmarium anceps*, *Co. holmiense* var. *integrum*, *Co. hornavanense*, *Co. speciosum*, *Co. sportella*, *Co. subcucumis*, *Co. subspeciosum* var. *transiens* and *Co. vexatum*. There were 108 desmid species found only in the lower montane zone. They occurred mostly at a few stations, so it is difficult to consider them characteristic for this zone. Species that in the Gorce Mts have their maxima of occurrence in the lower montane zone include *Actinotaenium borgeanum*, *Ac. diplosporum*, *Closterium moniliferum*, *Cl. parvulum*, *Cl. pritchardianum*, *Cl. tumidulum*, *Cosmarium hornavanense*, *Co. pokornyanum*, *Co. regnellii*, *Co. subgranatum*, *Co. subspeciosum* var. *transiens* and *Staurastrum merianii*. These are mostly algae that prefer alkaline habitats. *Actinotaenium diplosporum* shows no clear habitat preference, while *Actinotaenium silvae-nigrae* and *Cosmarium regnellii* prefer acidic habitats. Montane species constitute 17.2% of the lower montane zone flora.

Upper montane zone. The top vegetation zone of the Gorce includes the top parts of Turbacz, Czoło Turbacza, Mostownica, Kiczora, Jaworzyna Kamieniecka, Kudłoń and Lubań, and covers 9.5% of the studied area. All of the habitat types of Gorce desmids occurred there, except for oxbow lakes and puddles on rocks near streams. In the upper montane zone, there were 126 desmid species recorded, representing ~51% of the Gorce desmid flora. The percentage shares of individual genera in the upper montane zone are as follows: *Closterium* 18.3%, *Cosmarium* 42.8%, *Euastrum* 8.7%, *Micrasterias* 0.8%, *Staurastrum* 9.5%, *Staurodesmus* 1.6%, *Mesotaeniaceae* genera 4.8%, genera forming filamentous coenobia (*Hyalotheca*) 0.8%, and others (*Actinotaenium*, *Penium*, *Pleurotaenium*, *Tetmemorus*) 12.7%. As compared to the whole desmid flora of the Gorce Mts, there were higher shares of *Cosmarium* and *Closterium* species, and much lower shares of *Staurastrum*, *Staurodesmus* and coenobia-forming filamentous genera. This is probably related to the fact that the upper montane zone has mainly subaerophytic habitats, with few potential habitats for planktonic species. This is particularly true for *Staurastrum*. Species with only one station constitute 23.8% of the zone's flora, whereas the common species (frequency above 0.2) represent 27%. Such a low share of rare species and the high share of common ones can be attributed to the high density of habitats in a small area. The most common species in the upper montane zone include *Actinotaenium cucurbita*, *Closterium abruptum*, *Cl. acerosum*, *Cl. ehrenbergii*, *Cl. intermedium*, *Cl. moniliferum*, *Cl. navicula*, *Cl. parvulum*, *Cl. praelongum*, *Cl. striolatum*, *Cosmarium anceps*, *Co. botrytis*, *Co. caelatum*, *Co. galeritum*, *Co. holmiense* var. *integrum*, *Co. laeve*, *Co. notabile*, *Co. ochthodes*, *Co. quadratum*, *Co. speciosum*, *Co. subcrenatum*, *Co. subcucumis*, *Co. subspeciosum* var. *transiens*, *Co. vexatum*, *Cylindrocystis brebissonii*, *Mesotaenium degreyi*, *Netrium digitus*, *Penium margaritaceum*, *Staurastrum hirsutum*, *St. margaritaceum*, *St. muricatum*, *St. punctulatum* and *Tetmemorus laevis*. This group has a high share (~38%) of acidophilic species resistant to alkalization (bolded in the above list). Some of them, such as *Cylindrocystis brebissonii* (the most common desmid species in the upper montane zone) or *Staurastrum margaritaceum*, prefer extremely acidic habitats. Fifty-eight desmid species have their maxima of occurrence in the upper montane zone. In this group, the most numerous taxa are acidophilic (33, ~57%). Mostly, these are algae resistant to habitat alkalization. Only *Euastrum subalpinum* and *Staurastrum pileolatum* avoid alkaline habitats. Montane species constitute ~25% of the upper montane zone flora.

Some conclusions can be drawn from the above characterization of the altitude zones.

There are clear differences between the zones. Only 59 desmid species were recorded in all altitude zones. Others had ranges limited to one or two zones. Among the desmids found in the lower montane zone and having more than one station there, 90 species had their lower limit there, and 50 species had their upper limit. Among the species reaching their lower limit, acidophilic species dominated; these occurred in peatland, puddles and on moist soil on roads. Probably the absence of many of them in the foothill zone is due to a lack of suitable habitats. Alkaline habitats dominate the foothill zone. The fact that alkalophilic species, such as *Cosmarium galeritum* or *Staurastrum merianii*, reach their lower limit in the lower montane zone is related to the scarcity of alkaline marshes of the *Caricetalia davalianae* class (which are

habitats for many desmid species) in the lowest zones of the Gorce Mts. As phytosociological studies of nonforest plant communities in the Gorce have shown (Kozak 2007), alkaline marshes of this class occur only occasionally below 700 m a.s.l. Communities dominated by flowering plants such as *Mentha longifolia*, *Filipendula ulmaria*, *Caltha palustris* and *Carex* species that reach large size usually develop in similar alkaline marsh habitats. These plants effectively shade the ground; desmids were found only occasionally in the places where they grow. Most of the species that reach the upper limit of their range in the lower montane zone are rare taxa. The more frequent ones include *Cosmarium subbroomei* and *Cosmarium subgranatum*.

Alkalophilic taxa dominated among the species reaching their maxima of occurrence in the foothill zone, whereas acidophilic species prevailed among the desmids reaching their maxima of occurrence in the upper montane zone. Alkalophilic algae also predominated among the most common species of the foothill zone, while acidophilic species predominated among those of the upper montane zone: In both of these cases, the lower montane was a transitional zone for those species. This phenomenon is probably conditioned by hydrological and climatic factors. Algae living in the Gorce Mts use water from orogens and water of atmospheric origin. The rocks that constitute the Gorce Mts contain much calcite, so the orogen-sourced water is generally alkaline and of high ionic conductivity. The water originating from rain is usually acidic and of low ionic conductivity, especially after passing through upper layers of soil (acidic soils dominate the upper montane zone). Since total precipitation increases with altitude, the availability of acidic water increases as well. This is probably why acidophilic species have better conditions in the upper montane zone than in the foothill zone.

The desmid flora of the lower montane zone seems to be representative of the entire desmid flora of the Gorce area. Almost the entire desmid flora in the lower montane zone, which is roughly 75% of the Gorce area. The same is true for the percentage shares of each genus in the floristic lists and for the shares of rare and common species. Also, 10% of the Gorce terrain (the upper montane zone) contains about 51% of the desmid flora. This may be following the rule found for vascular plants, by which the number of reported species first increases steeply but levels off with the increase of the area studied once a certain critical value is reached. That regularity has been described by Tolmachieva (1931) and Schmidt (1976).

The flora does not become depauperate with the increase in altitude. In studying the distribution of vascular plants in the Gorce Mts, Kornaś (1957) observed that the number of species decreased with altitude above sea level. This was not the case in the present work on desmids Desmid species were most numerous in the lower montane zone and least numerous in the foothill zone, mostly due to the lack of suitable habitats in the latter, and also human impacts in that zone. The floristic impoverishment of the upper montane zone as compared to the flora of the lower montane zone is only apparent, as the lower montane zone area is about 7.5 times larger. The number of desmid species found in the upper montane zone was almost double the number of those found in the foothill zone, even though their areas are of similar size. The difference in numbers is due mostly to climatic conditions. Most of the desmid species occupy subaerophytic habitats. Their presence is largely conditioned by the availability of water of atmospheric origin, which is much higher in the upper montane zone, where periods of drought are also less likely. A similar pattern has been observed for mosses (Lisowski & Kornaś 1966) and liverworts (Mierzeńska 1994); bryophytes, like the desmids from subaerophytic habitats, depend largely on water of atmospheric origin.

The share of montane species does not increase with increasing altitude. This is a geobotanical characteristic that distinguishes desmids from vascular plants. In addition, the share of montane species in the lower montane zone was lower than in the foothill zone, probably due to the presence of two peat bogs in the lower montane zone, which are rich in species not associated with mountains. Excluding the 49 taxa with single stations in these peat bogs, a share of ~22% montane desmid species was calculated for the lower montane zone, similar to the percentage shares in other zones. A possible explanation for this is that the Gorce Mts are not high enough and some typical habitats are lacking, such as wet rocks, a type of habitat where many montane species were found in the area of Morskie Oko Lake in the Tatra Mts (Růžička 1964). In the Gorce area, montane species probably occur mostly in alternative habitats found in all of the zones.

Horizontal diversity of desmids in the Gorce Mountains

Since the Gorce area has two distinct ranges, this should be expected to have an impact on the horizontal distribution of desmids in the study area, as it does in the case of vascular plants (Kornaś 1957).

A majority of the Gorce desmid species occurred in both the Lubań and Turbacz ranges (129 species, 52.3%); 48 species (19.4%) occurred exclusively in the Lubań range, and 70 species (28.3%) exclusively in the Turbacz range. The majority of taxa found in only one of the ranges are rare, and the extent to which their local distribution is coincidental is unknown.

Lubań range. Overall, 178 species (72.1% of the flora) were identified there (Fig. 66a). The species-richest station of the Gorce Mts is located within this range, but it is still a species-poor area. Ten or fewer species were recorded at 58 stations (73% of the stations in the range), 11–20 at 19 stations (24.1%) (Fig. 66b), More than 20 species were found at only two stations (2.6%). Apart from Polana Jeziorne meadow (see sections on polyhumic waterbodies and *Sphagnum* puddles), most species were found in the Przełęcz Knurowska pass (24), Knurowski Potok stream valley (18), Huba settlement (18), Mizerzanka stream valley (19) and Jeziorko Iwanowskie pond near Ochotnica Górna. The stations are mainly in the western part of the range.

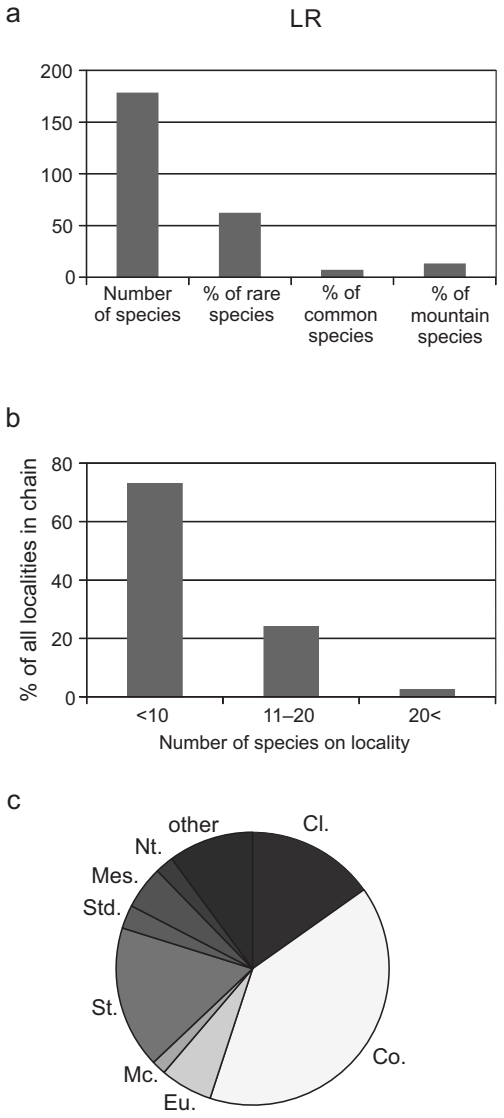

Figure 66. Characteristics of the Lubań range (LR). a – quantitative characteristics of desmid flora (number of species, percentage shares of rare, common and mountain species); b – percentage shares of sites with different numbers of species; c – percentage shares of desmid species in the Lubań range flora: l. n.sp. – number of species, % sp.r – % of rare species, % m.sp. – % of mountain species. Cl. – *Closterium*, Co. – *Cosmarium*, Eu. – *Euastrum*, Mc. – *Micrasterias*, St. – *Staurastrum*, Std. – *Staurodesmus*, Mes. – species of *Mesotaeniaceae* family, Nt. – *Netrium*.

The shares of genera in the desmid flora of the Lubań range are as follows: *Closterium* 15.2%, *Cosmarium* 39.9%, *Euastrum* 6.2%, *Micrasterias* 1.7%, *Staurastrum* 16.9%, *Staurodesmus* 2.8%, *Mesotaeniaceae* genera 5.1%, genera forming filamentous coenobia (*Desmidium*, *Hyalotheca*, *Teilingia*) 2.2%, and others (*Actinotaenium*, *Haplotaenium*, *Penium*, *Pleurotaenium*, *Tetmemorus*, *Xanthidium*) 10.1% (Fig. 66c). The shares are similar to those of the entire Gorce area. Within the Lubań range, 110 species with single stations were identified (61.8% of the desmid flora of the range); this is almost double the corresponding share in the total desmid flora of the Gorce Mts. The main reason for this is the presence of only one species-rich peatland in the Lubań range. Common species (frequency above 0.2) represent 6.7% of the desmid flora of the range. They include *Closterium moniliferum*, *Cosmarium holmiense* var. *integrum*, *Co. impressulum*, *Co. laeve*, *Co. quadratum*, *Co. speciosum*, *Co. sportella*, *Co. subcrenatum*, *Co. subcucumis*, *Co. subspeciosum*, *Co. tetraophthalmum* and *Co. vexatum*. All of these species except *Cosmarium tetraophthalmum* are common taxa of the Gorce Mts. Except for *Cosmarium quadratum*, they are all alkalophilic algae. Acidophilic taxa do not occur in this area at all.

The Lubań range contains 23 montane desmid species, ~13% of its desmid flora. The largest concentration of montane species is in the central part of the Mizerzanka valley. *Cosmarium jenisejense* is the only montane species found in the Lubań range that does not appear in the Turbacz range.

Turbacz range. Two hundred desmid species were found in this range, ~81% of the Gorce desmid flora (Fig. 67a). On the level of individual stations, this range is much richer in species than the Lubań range: About ten desmid

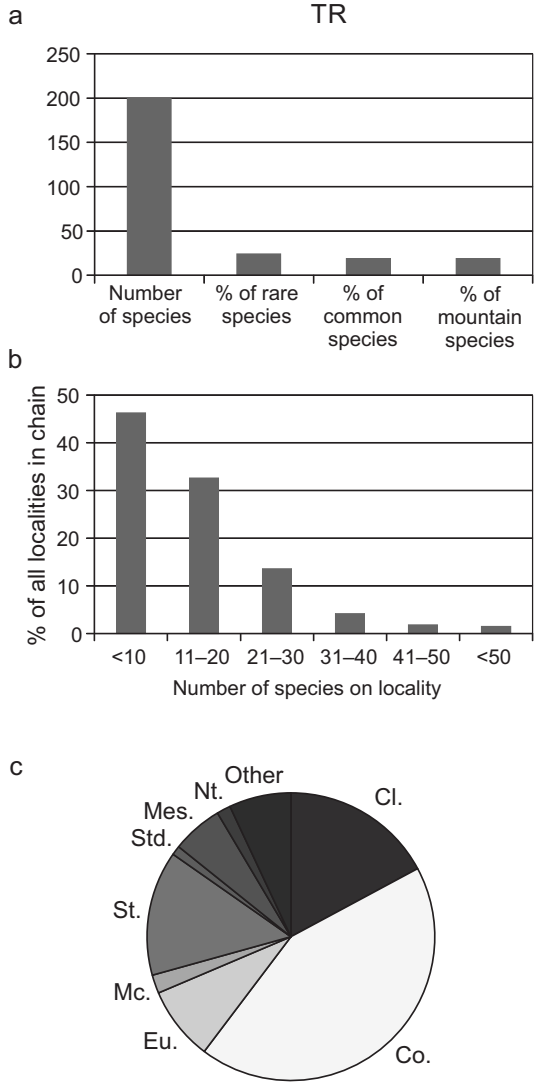

Figure 67. Characteristics of the Turbacz range (TR). a – quantitative characteristic of the desmid flora (number of species, percentage shares of rare, common and mountain species); b – percentage shares of sites with different numbers of species; c – percentage shares of desmid species in the Turbacz range flora: l. sp. – number of species, % r. sp. – % of rare species, % m. sp. – % of mountain species. Cl. – *Closterium*, Co. – *Cosmarium*, Eu. – *Euastrum*, Mc. – *Micrasterias*, St. – *Staurastrum*, Std. – *Staurodesmus*, Mes. – species of *Mesotaeniaceae* family, Nt. – *Netrium*.

species were found at 153 stations (46.3% of Turbacz stations), mainly in subaerophytic habitats: puddles, wet soil on roads and paths, *Sphagnum* puddles, alkaline marshes, puddles on rocks in the Kamienica stream valley. The only humotrophic waterbody of this region is Morskie Oko Lake, located in the vicinity of Kudłoń peak. The upper part of the Kamienica stream valley is a particularly interesting part of the Turbacz range. Thanks to its unique microclimate, puddles on old slope roads persist even during drought. The number of desmid species found in individual puddles often exceeds 20.

The shares of genera in the desmid flora of the Turbacz range are as follows: *Closterium* 16.5%, *Cosmarium* 41.5%, *Euastrum* 8%, *Micrasterias* 2%, *Staurastrum* 13.5%, *Staurodesmus* 1%, *Mesotaeniaceae* genera 5.5%, genera forming filamentous coenobia (*Desmidium*, *Hyalotheca*, *Teilingia*) 1.5%, and others (*Actinotaenium*, *Penium*, *Pleurotaenium*, *Tetmemorus*) 10.2% (Fig. 67c). These shares are similar those of the total desmid flora of the Gorce area. The smaller shares of *Staurastrum* and *Staurodesmus* are explained by the finding that many species of these genera have their only stations in Polana Jeziorne meadow in the Lubań range. Forty-eight species found in the Turbacz range had single stations there (24% of the Turbacz desmid flora), 9 of which were in polyhumic Stawek Pucołowski pond. The stations of the remaining species did not show any clear concentration. The common species (frequency exceeding 0.2) in this range include *Actinotaenium diplosporum*, *Closterium acerosum*, *Cl. moniliferum*, *Cl. parvulum*, *Cosmarium anceps*, *Co. botrytis*, *Co. holmiense* var. *integrum*, *Co. hornavanense*, *Co. impressulum*, *Co. laeve*, *Co. obtusatum*, *Co. ochthodes*, *Co. quadratum*, *Co. speciosum*, *Co. sportella*, *Co. subcrenatum*, *Co. subcucumis*, *Co. subspeciosum* var. *transiens*, *Co. vexatum*, *Cylindrocystis brebissonii*, *Netrium digitus* and *Staurastrum punctulatum*. All of these taxa are common throughout the Gorce Mts.

The Turbacz range contains 39 montane desmid species, ~19% of its desmid flora. The largest concentrations of montane species occur on Turbacz peak, Mostownica peak and Kudłoń peak. The Turbacz range is the center of occurrence of montane desmid species in the Gorce area (Fig. 68). Many desmid species that are limited to the Turbacz range (but may have single stations in the Lubań range) have a very distinct local range limit in its southern part. It runs west–east through Przełęcz Knurowska pass, Kiczora peak, Jaworzyna Kamieniecka peak, Gorc Kamieniecki peak and Przełęcz Wierch Młynne pass. This limit largely coincides with the border between the geobotanical provinces of the Lubań range and Turbacz range (Kornaś 1957). The desmid species that have such a limit include *Actinotaenium cucurbita*, *Closterium abruptum*, *Cl. intermedium*, *Cl. juncidum*, *Cl. kuetzingii*, *Cl. navicula*, *Cl. parvulum*, *Cl. rostratum*, *Cl. striolatum*, *Cosmarium caelatum*, *Co. davidsonii*, *Co. dentiferum*, *Co. nasutum*, *Co. pseudopyramidatum*, *Co. regnellii*, *Mesotaenium degreyi*, *Netrium digitus*, *Penium cylindrus*, *P. margaritaceum*, *P. spirostriolatum*, *Roya obtusa*, *Staurastrum hirsutum*, *St. margaritaceum*, *St. muricatum*, *St. orbiculare*, *St. punctulatum*, *Tetmemorus granulatus* and *T. laevis*. Most of these are acidophilic taxa resistant to habitat alkalization. Many of the species occurring in both the Lubań and Turbacz ranges, even common algae such as *Cosmarium speciosum* and *Cosmarium subcucumis*, show rarefaction of stations on the cartograms to the southeast of this border.

The differences between the desmid floras of the Turbacz and Lubań ranges are very clear, but they are not enough to assign geobotanical ranks to each range, as was done in the case of vascular plants. Most of the

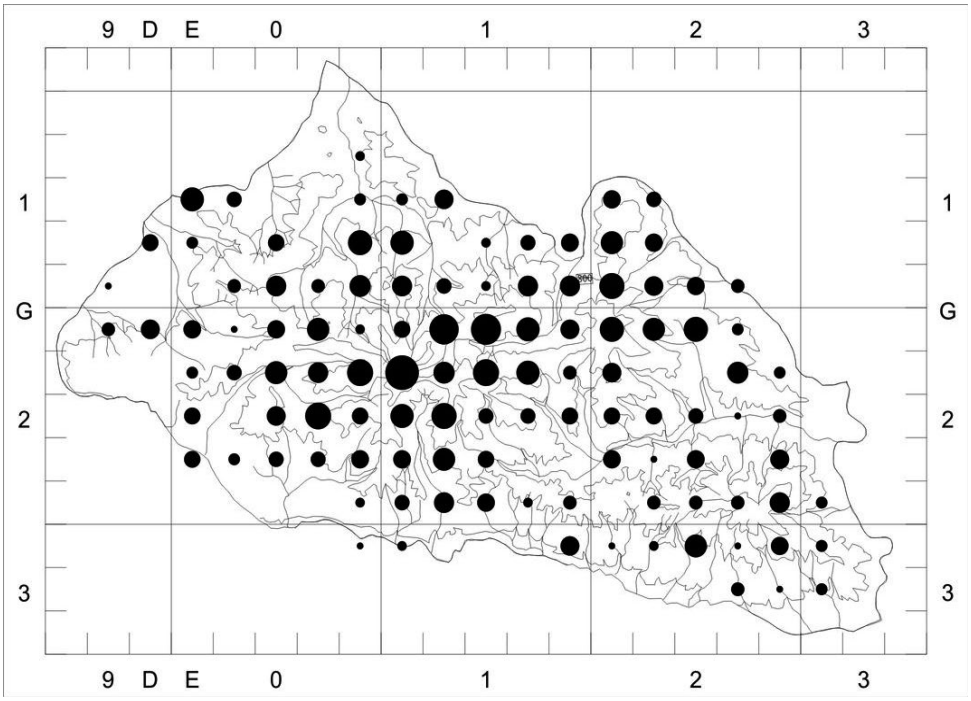

Figure 68. Distribution of mountain desmid species in different parts of the Gorce Mts.

species found only in the Lubań range are known from individual stations, whereas most of the taxa occurring with greater frequency in the Lubań range are rare algae (except for *Cosmarium tetraophthalmum*). It is not known whether such a distribution of algae is coincidental. The sparseness of species in the Lubań range as compared to the Turbacz range stands out, especially in regard to acidophilic and montane species. A similar phenomenon has been observed in mosses (Lisowski & Kornaś 1966) and liverworts (Mierzeńska 1994). This is probably due to climatic factors. The Lubań range is in the rain shadow of the Turbacz range (most of the front rain comes from the northwest), so there are fewer habitats for subaerophytic algae. The lower precipitation also means weaker washing out of $CaCO_3$ from the ground, reducing the occurrence of acidophilic species. The same factors also explain the species richness of the area around Turbacz peak and the upper part of the Kamienica stream valley, as well as the more numerous occurrences of desmids at stations in the western part of the Lubań range.

Comparison of the desmids of the Gorce Mts with those of the Carpathians and their foreland

Comparisons of the flora of different areas are of great importance in geobotanical analyses. Since for desmids there are no relatively complete floristic lists (with records of stations and the frequency of occurrence of given taxa in a given area), neither for regions in the Carpathians nor in the lowlands, such comparisons are not possible. Nevertheless, it is of some value to compare even fragmentary lists of flora from different areas. For the Carpathians, there are lists of desmids from the Tatra Mts, Pieniny Mts, Orava-Nowy Targ Basin and Beskid Mts (environs of Sucha Beskidzka and Maków Podhalański). For the Polish lowlands, there are lists from the Lublin Upland (Wyżyna Lubelska; Międzyrzecz Podlaski vicinity), Mazovian Lowland (Nizina Mazowiecka; Warsaw vicinity) and the surroundings of Wigry Lake. Phycologists who specialize in this group of algae analyzed lowland areas to the north of the Carpathians and to the east of the Vistula, where more than a hundred desmid species were found. Table 5 presents species occurrence in specific areas. Numbers of species and shares of montane species are compared in Figure 69. The shares of particular genera in the floristic lists of the compared areas are given in Figure 70.

Tatra Mountains

This, the highest Carpathian range, bordering the north of the Orava-Nowy Targ Basin, has been eagerly studied by phycologists. Data on the distribution of desmids in this area were collected by Gutwiński (1909, 1914), Kawecka (1966), Raciborski (1885), Růžička (1964), Siemińska (1967), Starmach (1973), Szklarczyk-Gazdowa (1960), Wasylik (1971) and Wołoszyńska (1919). They identified 218 desmid species in the Tatra Mts. The shares of genera in the floristic list breaks down as follows: *Closterium* 10.6%, *Cosmarium* 39.9%, *Euastrum* 8.7%,

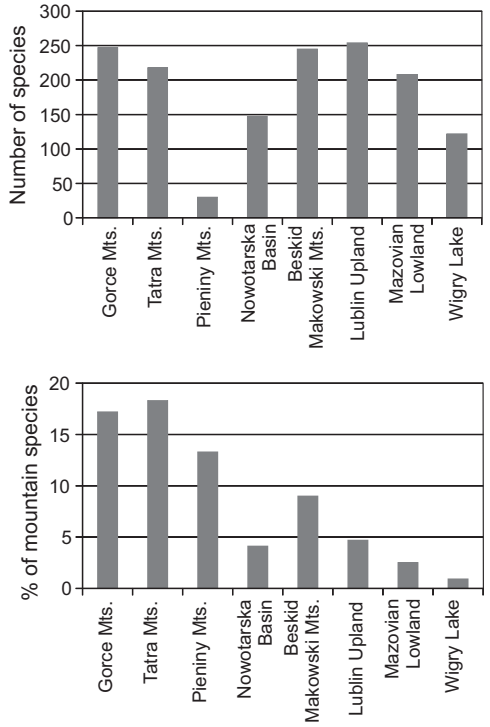

Figure 69. Comparison of species numbers and percentage shares of mountain species between the Gorce Mts and desmid floras of some areas of Poland: Tatra Mts, Pieniny Mts, Nowotarska Basin, Beskid Makowski Mts (surroundings of Sucha Beskidzka and Maków Podhalański), Lublin Upland, Mazowiecka Lowland (surroundings of Warsaw), surroundings of Wigry Lake.

Micrasterias 1.8%, *Staurastrum* 16.1%, *Staurodesmus* 2.8%, *Mesotaeniaceae* genera 5.5%, genera forming filamentous coenobia (*Bambusina*, *Desmidium*, *Hyalotheca*, *Sphaerozosma*, *Spondylosium*, *Teilingia*) 3.7%, and others (*Actinotaenium*, *Penium*, *Pleurotaenium*, *Tetmemorus*) 10.9%. Such a breakdown is similar to that in the Gorce Mts; only *Closterium* has a significantly lower share in the Tatras. The shares of genera forming filamentous coenobia and of *Mesotaeniaceae* genera are higher in the Tatras. Seventy-four species that do not occur in the Gorce area were identified in the Tatra Mts. Acidophilic algae predominate in this group, including *Closterium directum*, *Cl. archerianum*, *Cosmarium amoenum*, *Co. ralfsii*, *Micrasterias crux-melitensis* and *Staurastrum decipiens*. There are more acidic habitats in the Tatra Mts than in the Gorce area. Many of the above-mentioned species inhabit Tatra lakes, which often are polyhumic waterbodies (e.g., Stawek Smreczyński pond, Stawek Toporowy Niżny pond). A number of plankton species, such as *Staurastrum gracile*, are related to Tatra ponds and lakes. *Staurastrum* species form ~19% of the Tatra species that do not occur in the Gorce area. Other Tatra species not found in the Gorce Mts include *Closterium pseudopusillum*, *Cosmarium binum*, *Co. dovrense*, *Co. speciosissimum* and *Staurastrum alpinum*. Many species that are associated with the Tatra Mts are rare in Poland (e.g., *Actinotaenium minutissimum*, *Cosmarium eductum*, *Co. ordinatum*, *Co. raciborskii*). Some Tatra species such as *Bambusina borreri*, *Closterium leibleinii* and *Cosmarium punctulatum* are common algae in Poland, but, for unknown reasons, have not been found in the Gorce Mts.

Table 5. List of species occurring in the Gorce Mts (G), Tatra Mts (T), Pieniny Mts (P), Beskid Makowski Mts (BM, vicinity of Sucha Beskidzka and Maków Podhalański), Nowotarska Basin (NB), Lublin Upland (LU), Mazowiecka Lowland (ML, vicinity of Warsaw), vicinity of Wigry Lake (WL). Mountain species are bolded.

Name of taxa	G	T	P	BM	NB	LU	ML	WL
Actinotaenium borgeanum	1	–	–	–	–	–	–	–
Actinotaenium clevei	–	–	–	–	–	1	–	–
Actinotaenium cruciferum	1	1	–	1	–	–	1	–
Actinotaenium cucurbita	1	1	1	1	1	1	1	1
Actinotaenium cucurbitinum	1	1	–	1	–	–	1	–
Actinotaenium curtum	1	1	–	1	–	–	–	–
Actinotaenium didymocarpum	1	–	–	–	–	–	–	–
Actinotaenium diplosporum	1	–	–	–	–	1	–	–
Actinotaenium gelidim	1	–	–	–	–	–	–	–
Actinotaenium globosum	–	–	–	–	–	–	1	–
Actinotaenium inconspicuum	–	–	–	–	–	–	–	1
Actinotaenium minutissimum	–	1	–	–	–	–	–	–
Actinotaenium mooreanum	–	1	1	1	–	–	–	–
Actinotaenium palangula	–	1	–	–	–	1	–	–
Actinotaenium perminutum	1	–	–	–	–	–	–	–
Actinotaenium phymatosporum	–	1	–	–	–	–	–	–
Actinotaenium silvae-nigrae	1	–	–	–	–	–	1	1
Actinotaenium spinospermum	1	–	–	–	–	–	–	–
Actinotaenium subglobosum	–	–	–	1	–	–	–	–
Actinotaenium truncatum	–	1	1	1	–	–	–	–
Actinotaenium turgidum	1	–	–	1	–	1	–	–
Actinotaenium wollei	–	–	–	–	–	–	1	–
Bambusina borreri	–	1	–	–	1	1	1	1
Closterium abruptum	1	1	–	1	1	–	1	–
Closterium acerosum	1	1	1	1	1	1	1	–
Closterium acutum	1	–	–	1	1	1	1	1
Closterium angustatum	–	1	–	1	1	1	1	–
Closterium archerianum	–	1	–	1	1	–	1	–
Closterium attenuatum	–	–	–	1	–	1	–	–
Closterium baillyanum	1	–	–	–	–	1	1	1
Closterium braunii	–	–	–	–	–	1	–	–
Closterium calosporum	1	–	–	1	–	1	–	–
Closterium closterioides	1	1	–	1	1	1	–	–
Closterium cornu	1	–	–	1	1	1	1	–
Closterium costatum	1	1	–	1	1	1	1	1
Closterium cynthia	1	–	–	1	1	1	1	–
Closterium decorum	–	–	–	–	–	1	–	–
Closterium delpontei	–	–	–	–	–	1	–	–
Closterium dianae	1	1	–	1	1	1	1	1
Closterium didymotocum	–	–	–	1	1	1	–	1
Closterium directum	–	1	–	–	1	–	1	1
Closterium ehrenbergii	1	1	–	–	1	–	1	1
Closterium exiguum	–		–	–	–	–	1	–
Closterium exile	1	1	–	–	–	–	–	–
Closterium gracile	–	–	–	1	1	1	1	–
Closterium idiosporum	1	–	–	–	–	–	1	–
Closterium incurvum	–	–	–	–	–	–	–	1
Closterium intermedium	1	–	–	1	1	1	1	1
Closterium jenneri	1	1	–	1	–	–	1	–
Closterium juncidum	1	–	–	1	–	1	1	–
Closterium kuetzingii	1	–	–	1	1	1	1	–
Closterium lanceolatum	–	–	–	1	–	–	–	–
Closterium leibleinii	–	1	1	1	–	1	1	–
Closterium limneticum	–	–	–	–	–	–	1	–
Closterium lineatum	1	1	–	1	1	1	1	1
Closterium littorale	1	–	1	–	–	–	–	–
Closterium lunula	1	1	1	1	1	1	1	1
Closterium macilentum	1	–	–	–	–	1	1	–

Name of taxa	G	T	P	BM	NB	LU	ML	WL
Closterium moniliferum	1	1	1	1	1	1	1	–
Closterium navicula	1	–	–	1	–	1	1	1
Closterium parvulum	1	1	–	1	1	1	1	1
Closterium praelongum	1	–	–	1	1	1	1	–
Closterium pritchardianum	1	–	1	–	1	–	1	–
Closterium pronum	1	–	–	1	–	–	1	–
Closterium pseudolunula	1	–	–	–	–	–	–	–
Closterium pseudopusillum	–	1	–	–	–	–	–	–
Closterium pusillum	1	1	–	1	–	1	–	–
Closterium pygmaeum	1	–	–	–	–	–	–	–
Closterium ralfsii	–	–	–	–	1	1	–	–
Closterium rostratum	1	1	–	1	1	1	1	1
Closterium setaceum	–	1	–	–	1	1	1	–
Closterium strigosum	1	1	–	1		1	–	1
Closterium striolatum	1	1	–	1	1	–	1	–
Closterium sublaterale	1	–	–	–	–	–	–	–
Closterium toxon	–	–	–	–	–	–	1	–
Closterium tumidulum	1	–	–	–	–	–	–	–
Closterium tumidum	1	–	–	–	–	–	1	–
Closterium turgidum	1	–	–	1	1	–	–	–
Closterium venus	1	1	–	1	1	1	1	–
Cosmarium abbreviatum	–	1	–	–	–	–	–	1
Cosmarium alpestre	1	–	–	–	–	–	–	–
Cosmarium amoenum	–	1	–	1	1	–	1	1
Cosmarium anceps	1	1	–	1	–	1	–	–
Cosmarium angulosum	1	1	–	–	–	1	1	–
Cosmarium annulatum	1	–	–	1	–	1	–	–
Cosmarium arctoum	1	1	–	–	–	1	–	–
Cosmarium asphaerosporum	1	–	–	–	–	–	1	–
Cosmarium binum	–	1	–	–	–	–	–	–
Cosmarium bioculatum	1	1	–	1	1	1	1	–
Cosmarium biretum	1	–	–	1	–	–	–	–
Cosmarium blyttii	1	–	–	–	1	1	1	–
Cosmarium boeckii	1	–	–	1	–	–	–	1
Cosmarium botrytis	1	1	1	1	1	1	1	–
Cosmarium brebissonii	–	–	–	1	–	1	–	–
Cosmarium broomei	–	–	–	1	–	–	–	–
Cosmarium caelatum	1	1	–	1	1	1	1	–
Cosmarium calcareum	–	–	1	–	–	–	–	–
Cosmarium capitulum	–	–	–	–	–	1	–	–
Cosmarium circulare	–	–	–	1	–	–	–	–
Cosmarium clepsydra	–	–	–	1	–	1	–	–
Cosmarium connatum	1	–	–	1	1	1	–	–
Cosmarium conspersum	1	–	–	1	–	1	–	–
Cosmarium constrictum	–	–	–	1	–	–	–	–
Cosmarium contractum	1	1	–	1	–	1	1	–
Cosmarium corbula	–	–	–	1	–	–	–	–
Cosmarium costatum	1	1	–	–	–	–	1	–
Cosmarium crenatum	1	1	1	1	–	–	1	–
Cosmarium crenulatum	1	–	–	–	1	–	–	–
Cosmarium cucumis	–	–	–	1	–	1	–	1
Cosmarium cyclicum	1	1	–	1	–	1	1	–
Cosmarium cymatopleurum	1	1	–	1	–	–	–	–
Cosmarium davidsonii	1	1	–	–	–	–	–	–
Cosmarium debaryi	1	–	–	–	–	1	–	–
Cosmarium decedens	1	1	–	–	–	1	–	–
Cosmarium dentiferum	1	1	–	–	–	–	–	–
Cosmarium depressum	1	–	–	1	–	1	1	–

Table 5. Continued

Name of taxa	G	T	P	BM	NB	LU	ML	WL
Cosmarium didymochondrum	1	1	1	–	–	–	–	–
Cosmarium difficile	1	1	–	–	1	1	1	–
Cosmarium dispersum	1	–	–	–	–	–	–	–
Cosmarium dovrense	–	1	–	1	–	–	–	–
Cosmarium eductum	–	1	–	–	–	–	–	–
Cosmarium elegantissimum	1	1	–	–	–	–	1	–
Cosmarium etchachanense	–	1	–	–	–	–	–	–
Cosmarium exiguum	1	–	–	–	–	1	1	–
Cosmarium fontigenum	–	–	–	1	–	–	–	–
Cosmarium formosulum	1	1	–	1	1	–	1	–
Cosmarium galeritum	1	1	–	–	–	–	–	–
Cosmarium garrolense	1	1	–	–	–	–	–	–
Cosmarium gayanum	–	1	–	1	–	–	–	–
Cosmarium geminatum	–	–	–	1	–	1	–	–
Cosmarium gonioides	1	–	–	–	–	–	–	–
Cosmarium granatum	1	1	1	1	1	1	1	1
Cosmarium haynaldii	–	–	–	1	–	–	–	–
Cosmarium hammeri	1	1	–	1	1	1	–	–
Cosmarium holmiense var. ***holmiense***	1	1	–	1	–	1	–	–
Cosmarium holmiense var. ***integrum***	1	1	1	1	–	1	–	–
Cosmarium hornavanense	1	1	–	–	–	–	–	–
Cosmarium humile	1	–	–	1	–	–	–	–
Cosmarium impressulum	1	1	–	1	1	1	1	1
Cosmarium incertum	–	–	–	1	–	–	–	–
Cosmarium intermedium	–	1	–	–	–	–	–	–
Cosmarium isthmium	–	–	–	–	–	–	1	–
Cosmarium jenisejense	1	–	–	1	–	–	–	–
Cosmarium kjellmanii	–	1	–	–	–	–	–	–
Cosmarium laeve	1	1	1	1	–	1	1	–
Cosmarium latifrons	–	–	–	1	–	–	–	–
Cosmarium limnophilum	1	–	–	–	–	–	–	–
Cosmarium logiense	–	1	–	1	–	–	–	–
Cosmarium lundellii	–	–	–	–	–	1	1	–
Cosmarium majae	1	–	–	–	–	–	–	
Cosmarium margaritatum	1	1	–	–	1	–	1	1
Cosmarium margaritiferum	1	1	1	1	1	1	1	1
Cosmarium meneghinii	1	1	–	1	1	1	1	1
Cosmarium microsphinctum	1	1	–	1	–	–	–	–
Cosmarium miedzyrzecense	–	–	–	–	–	1	–	–
Cosmarium minimum	–	–	–	–	–	–	1	–
Cosmarium moniliforme	–	–	–	1	–	1	1	–
Cosmarium nasutum	1	1	–	–	–	–	–	–
Cosmarium nitidulum	1	–	–	1	–	–	–	–
Cosmarium norimbergense	–	–	–	–	–	1	–	–
Cosmarium notabile	1	1	–	1	–	–	–	–
Cosmarium novae-semliae	1	–	–	1	–	–	–	–
Cosmarium nymannianum	–	–	–	–	–	1	–	–
Cosmarium obliquum	1	1	–	1	–	–	1	–
Cosmarium obsoletum	–	–	–	1	–	–	–	–
Cosmarium obtusatum	1	1	1	1	1	1	–	1
Cosmarium ochthodes	1	1	1	1	1	1	–	–
Cosmarium orbiculatum	–	–	–	1	–	1	–	–
Cosmarium ordinatum	–	1	–	–	–	–	–	–
Cosmarium ornatum	1	1	–	1	1	1	–	1
Cosmarium orthopunctulatum	–	1	–	–	–	–	–	–
Cosmarium orthogonum	–	–	–	–	–	1	–	–
Cosmarium orthostichum	–	–	–	1	1	1	–	–
Cosmarium ovale	–	–	–	–	–	–	–	1
Cosmarium pachydermum	1	1	–	1	1	1	–	–
Cosmarium paragranatoides	1	–	–	–	–	–	–	–

Name of taxa	G	T	P	BM	NB	LU	ML	WL
Cosmarium parvulum	1	–	–	1	–	–	–	–
Cosmarium perforatum	–	–	–	1	–	1	–	–
Cosmarium pericymatium	1	1	–	–	–	–	–	–
Cosmarium phasoleus	–	–	–	1	–	1	–	1
Cosmarium pokornyanum	1	1	1	1	–	–	–	–
Cosmarium polonicum	–	–	–	1	–	1	–	–
Cosmarium porteanum	1	1	–	1	1	1	–	–
Cosmarium praemorsum	1	–	–	–	–	1	1	–
Cosmarium protractum	–	–	–	1	–	–	1	–
Cosmarium protuberans	–	–	–	–	–	1	–	–
Cosmarium pseudamoenum	–	–	–	1	–	–	–	1
Cosmarium pseudarctoum	–	1	–	–	–	–	–	–
Cosmarium pseudobroomei	–	–	–	1	–	–	–	1
Cosmarium pseudoconnatum	–	–	–	–	–	–	–	1
Cosmarium pseudoexiguum	1	1	–	–	1	–	–	–
Cosmarium pseudonitidulum	–	–	–	–	–	1	–	–
Cosmarium pseudoornatum	–	–	–	–	1	–	1	–
Cosmarium pseudoprotuberans	–	1	–	1	–	–	–	–
Cosmarium pseudopyramidatum	1	1	–	1	–	1	–	1
Cosmarium pulcherrimum	1	–	–	1	–	–	–	–
Cosmarium punctulatum	–	1	–	1	–	1	1	1
Cosmarium pygmaeum	–	1	–	–	1	1	–	–
Cosmarium pyramidatum	1	1	–	1	1	1	1	1
Cosmarium quadratum	1	1	–	1	1	1	1	–
Cosmarium quadratulum	1	–	–	–	–	–	1	–
Cosmarium quadrum	1	–	–	–	–	1	1	–
Cosmarium quasillus	–	–	–	–	–	1	–	–
Cosmarium quinarium	–	–	–	–	–	1	–	1
Cosmarium raciborskii	–	1	–	–	–	1	–	–
Cosmarium ralfsii	–	1	–	1	1	–	1	–
Cosmarium rectangulare	1	–	–	1	–	1	1	1
Cosmarium regnellii	1	1	1	1	–	1	1	1
Cosmarium regnesii	–	–	–	1	–	1	–	–
Cosmarium rehmanii	–	1	–	–	–	–	–	–
Cosmarium reniforme	1	1	–	1	–	1	1	1
Cosmarium repandum	–	1	–	–	–	–	–	–
Cosmarium retusiforme	–	–	–	–	–	1	–	–
Cosmarium rugulosum	–	1	–	–	–	–	–	–
Cosmarium saxicola	1	1	–	–	–	–	–	–
Cosmarium sexangulare	1	–	–	1	–	1	1	–
Cosmarium sexnotatum	1	–	–	–	–	–	–	–
Cosmarium speciosissimum	–	1	–	–	–	–	–	–
Cosmarium speciosum	1	1	1	1	–	–	–	–
Cosmarium sphagnicola	1	–	–	–	–	–	–	–
Cosmarium sphalerostichum	1	–	–	–	–	–	–	–
Cosmarium sportella	1	–	1	–	–	–	–	–
Cosmarium staurastroides	1	–	–	–	–	–	–	–
Cosmarium subarctoum	1	–	–	–	–	–	1	–
Cosmarium subbroomei	1	–	–	–	–	–	–	–
Cosmarium subcostatum	1	1	–	1	–	–	–	–
Cosmarium subcrenatum	1	1	1	1	–	1	–	1
Cosmarium subcucumis	1	1	–	1	1	–	–	–
Cosmarium subgranatum	1	1	–	1	–	–	–	–
Cosmarium subholmiense	–	–	–	1	–	–	–	–
Cosmarium sublatereundulatum	–	–	–	–	–	–	1	–
Cosmarium subnotabile	1	–	–	–	–	–	–	–
Cosmarium subprotumidum	1	–	–	1	–	–	–	–
Cosmarium subquadratum	1	–	–	–	–	–	–	–
Cosmarium subspeciosum	1	1	–	–	–	–	–	–
Cosmarium subtumidum	1	–	–	–	1	–	1	1

Table 5. Continued

Name of taxa	G	T	P	BM	NB	LU	ML	WL
Cosmarium tatricum	1	1	–	–	–	–	–	–
Cosmarium tenue	–	1	–	1	–	–	1	–
Cosmarium tetrachondrum	–	–	–	1	–	1	–	–
Cosmarium tetragonum	1	1	–	1	–	1	–	–
Cosmarium tetraophthalmum	1	1	1	1	–	–	1	–
Cosmarium tesselatum	–	–	–	1	1	1	–	–
Cosmarium thwaitesii	1	1	–	1	–	1	–	–
Cosmarium tinctum	1	1	–	1	–	1	1	1
Cosmarium trachypleurum	–	–	–	1	–	1	–	–
Cosmarium trilobulatum	–	–	–	1	–	1	–	–
Cosmarium truncatellum	–	1	–	–	–	–	–	–
Cosmarium tumidum	–	–	–	–	–	1	–	–
Cosmarium turpinii	1	–	–	1	–	1	1	–
Cosmarium undulatum	–	1	1	–	–	–	–	–
Cosmarium vanum	–	–	–	1	–	–	–	–
Cosmarium variolatum	–	1	–	1	–	1	–	–
Cosmarium venustum	1	1	–	1	1	1	–	–
Cosmarium vexatum	1	1	1	–	–	–	1	–
Cosmarium vogesiacum	–	–	–	–	1	–	–	–
Cosmarium zonatum	–	–	–	1	–	1	–	–
Cylindrocystis brebissonii	1	1	–	1	1	1	1	1
Cylindrocystis crassa	1	–	–	–	–	–	1	1
Desmidium aptogonum	–	–	–	1	1	1	–	–
Desmidium baileyi	–	–	–	1	–	–	–	–
Desmidium graciliceps	–	–	–	–	–	1	–	–
Desmidium grevillei	1	1	–	1	1	1	1	1
Desmidium quadratum	–	–	–	–	–	1	–	–
Desmidium swartzii	1	1	–	1	1	1	1	1
Docidium baculum	–	–	–	1	–	1	–	1
Desmidium undulatum	–	–	–	–	–	1	–	1
Euastrum ampulaceum	–	–	–	–	1	–	1	–
Euastrum ansatum	1	1	–	1	1	1	1	1
Euastrum bidentatum	1	1	–	1	1	1	1	1
Euastrum binale	1	1	–	1	1	1	1	1
Euastrum crassicolle	1	1	–	1	–	–	–	–
Euastrum crassum	–	–	–	–	–	1	–	1
Euastrum cuneatum	–	–	–	–	–	1	–	–
Euastrum denticulatum	1	1	–	1	1	–	1	1
Euastrum didelta	1	1	–	1	1	1	–	1
Euastrum dissimile	1	–	–	–	–	–	–	–
Euastrum divaricatum	–	1	–	–	–	1	–	–
Euastrum dubium	1	–	–	–	–	–	1	–
Euastrum elegans	1	1	–	1	1	1	1	1
Euastrum erosum	1	1	–	1	–	–	–	–
Euastrum gayanum	1	1	–	–	1	1	1	1
Euastrum gemmatum	–	–	–	–	1	–	–	–
Euastrum humerosum	1	1	–	–	1	1	1	1
Euastrum insigne	1	1	–	–	1	1	1	1
Euastrum insulare	–	–	–	1	1	–	1	–
Euastrum intermedium	–	–	–	–	–	1	–	–
Euastrum montanum	1	1	–	–	–	–	–	–
Euastrum oblongum	1	1	–	1	1	1	1	1
Euastrum pectinatum	–	1	–	1	1	–	1	1
Euastrum pinnatum	–	1	–	–	–	–	–	1
Euastrum pulchellum	1	–	–	–	–	–	–	–
Euastrum spinulosum	–	–	–	1	–	–	–	–
Euastrum subalpinum	1	1	–	–	–	–	–	–
Euastrum sublobatum	–	–	–	–	–	1	1	1
Euastrum turneri	–	–	–	–	–	1	–	–
Euastrum verrucosum	1	1	1	1	1	1	1	–
Euastrum vigrense	–	–	–	–	–	–	–	1
Genicularia spirotaenia	–	–	–	–	–	–	–	1
Gonatozygon brebissonii	1	1	–	1	–	1	1	–
Gonatozygon kinahanii	–	–	–	–	–	1	–	1
Gonatozygon monotaenium	1	1	–	1	–	–	–	–
Haplotaenium rectum	1	–	–	1	1	1	1	–
Haplotaenium minutum	–	1	–	1	1	1	1	1
Heimansia pusilla	–	–	–	–	–	1	–	–
Hyalotheca dissiliens	1	1	–	1	1	1	1	1
Hyalotheca mucosa	–	–	–	1	–	1	1	1
Mesotaenium caldariorum	–	1	–	–	–	–	–	–
Mesotaenium chlamydosporum	–	1	–	–	–	1	–	–
Mesotaenium degreyi	1	–	–	–	–	–	1	–
Mesotaenium endlicherianum	1	1	–	1	–	1	1	–
Mesotaenium macrococcum	1	1	–	1	–	1	1	–
Micrasterias americana	1	–	–	–	1	1	1	1
Micrasterias apiculata	–	–	–	–	1	1	–	1
Micrasterias brachyptera	–	–	–	–	–	1	–	–
Micrasterias conferta	–	–	–	–	1	–	–	–
Micrasterias crux-melitensis	–	1	–	1	1	1	1	–
Micrasterias decemdentata	–	–	–	1	1	1	–	1
Micrasterias denticulata	–	1	–	1	1	1	1	1
Micrasterias dickiei	1	1	–	–	–	–	1	1
Micrasterias fimbriata	–	–	–	–	1	1	–	–
Micrasterias furcata	–	–	–	–	–	1	–	–
Micrasterias jenneri	–	–	–	–	–	1	1	–
Micrasterias papillifera	1	–	–	1	1	1	1	1
Micrasterias pinnatifida	–	–	–	–	–	1	–	1
Micrasterias radiosa	–	–	–	1	–	–	–	–
Micrasterias rotata	1	1	–	1	1	1	1	1
Micrasterias thomasiana	–	1	–	1	1	1	1	1
Micrasterias truncata	1	–	–	1	1	1	1	1
Netrium digitus	1	1	–	1	1	1	1	1
Netrium oblongum	1	1	–	–	1	–	1	1
Octacanthium bifidum	–	–	–	–	–	1	–	–
Oocardium striatum	–	–	1	–	–	–	–	–
Pachyphorium taxichondrum	–	–	–	1	–	1	–	–
Penium cylindrus	1	1	–	1	1	1	–	–
Penium exiguum	–	1	–	–	–	–	1	–
Penium margaritaceum	1	1	–	1	1	–	–	–
Penium polymorphum	–	1	–	–	1	–	1	1
Penium spirostriolatum	1	1	–	1	1	1	1	1
Planotaenium interruptum	1	1	–	1	1	1	–	–
Pleurotaenium coronatum	–	–	–	1	–	1	–	–
Pleutotaenium crenulatum	1	–	–	–	–	–	–	–
Pleutotaenium ehrenbergii	1	–	–	1	1	–	1	–
Pleutotaenium nodosum	–	1	–	1	–	–	–	–
Pleutotaenium nodulosum	–	–	–	1	–	1	–	–
Pleutotaenium trabecula	1	1	–	1	1	1	1	1
Pleutotaenium tridentulum	–	–	–	–	–	1	1	–
Pleutotaenium truncatum	–	–	–	1	1	1	–	1
Roya obtusa	1	1	–	1	–	1	–	–
Sphaerozosma auberiana	–	–	–	–	–	1	–	–
Sphaerozosma leave	–	–	–	–	–	1	–	1
Sphaerozosma vertebratum	–	1	–	1	–	1	–	–
Spirotaenia condensata	1	1	–	1	–	1	1	1
Spirotaenia minuta	–	–	–	–	–	1	–	–
Spirotaenia obscura	1	–	–	1	–	–	1	–
Spondylosium planum	–	–	–	–	–	–	1	–
Spondylosium pulchellum	1	1	–	1	1	1	1	1

Table 5. Continued

Name of taxa	G	T	P	BM	NB	LU	ML	WL
Spondylosium secedens	–	1	–	–	–	1	–	–
Staurastrum aciculiferum	–	–	–	–	–	–	1	–
Staurastrum aculeatum	1	1	–	–	–	–	–	–
Staurastrum acutum	1	1	–	–	–	–		–
Staurastrum alpinum	–	1	–	–	–	–	–	–
Staurastrum alternans	1	1	–	1	1	–	1	–
Staurastrum anatinum	–	–	–	–	–	–	1	–
Staurastrum angulare	–	–	–	–	–	1	–	–
Staurastrum arachne	–	1	–	1	1	1	–	–
Staurastrum arctiscon	–	–	–	–	–	–	–	1
Staurastrum arcuatum	1	–	–	–	–	–	–	–
Staurastrum avicula	1	–	–	1	–	1	1	–
Staurastrum bieneanum	1	–	–	–	1	–	1	–
Staurastrum bifidum	–	1	–	–	–	1	–	–
Staurastrum botrophilum	1	–	–	–	–	–	–	–
Staurastrum brachiatum	–	1	–	–	1	1	1	–
Staurastrum brasilense	–	–	–	–	–	–	–	1
Staurastrum capitulum	1	1	–	1	1	1	–	–
Staurastrum clevei	–	–	–	–	–	1	–	–
Staurastrum controversum	1	–	–	1	1	–	1	1
Staurastrum cristatum	–	–	–	1	–	1	–	–
Staurastrum cyrtocerum	–	–	–	–	1	–	–	–
Staurastrum decipiens	–	1	–	–	–	–	–	–
Staurastrum denticulatum	–	1	–	1	1	1	1	–
Staurastrum dilatatum	–	1	–	1	1	1	1	–
Staurastrum dispar	1	–	–	–	–	–	–	–
Staurastrum echinatum	–	–	–	–	–	1	1	–
Staurastrum eichleri	–	–	–	–	–	1	–	–
Staurastrum furcatum	1	1	–	1	1	1	1	1
Staurastrum furcigerum	–	–	–	1	1	1	1	–
Staurastrum gemilliparum	–	–	–	1	–	–	–	–
Staurastrum gladiosum	1	–	–	–	–	–	1	–
Staurastrum gracile	–	1	–	1	–	1	1	–
Staurastrum grallatiorum	–	–	–	–	–	1	–	–
Staurastrum granulosum	–	–	–	–	–	–	1	–
Staurastrum hexacerum	1	1	–	1	1	1	1	–
Staurastrum horametrum	–	–	–	1	–	–	–	–
Staurastrum hirsutum	1	–	–	1	1	1	1	1
Staurastrum hystrix	–	–	–	–	1	1	1	–
Staurastrum inconspicuum	–	1	–	–	1	1	1	1
Staurastrum inflexum	1	–	–	–	–	–	1	–
Staurastrum Insigne	–	–	–	–	–	1	–	–
Staurastrum iotanum	–	–	–	–	1	1	–	1
Staurastrum laeve	–	–	–	–	–	1	–	–
Staurastrum lanceolatum	–	–	–	–	1	–	–	–
Staurastrum lapponicum	1	–	–	–	–	–	1	–
Staurastrum lunatum	1	–	–	–	–	–	1	–
Staurastrum margaritaceum	1	1	–	1	1	1	1	1
Staurastrum merianii	1	1	–	1	–	–	–	–
Staurastrum micron	–	–	–	–	–	–	1	–
Staurastrum minutissimum	–	–	–	–	–	1	–	–
Staurastrum monticulosum	–	–	–	–	–	1	1	–
Staurastrum muricatum	1	1	–	1	1	1	1	1
Staurastrum muticum	1	–	–	1	–	–	1	1
Staurastrum oblongum	–	–	–	1	–	–	–	–
Staurastrum orbiculare	1	1	–	1	1	1	1	1
Staurastrum oxyacanthum	1	1	–	–	–	–	1	–
Staurastrum pachyrynchum	–	–	–	–	–	1	–	–
Staurastrum paradoxum	–	1	–	1	–	1	1	–
Staurastrum pileolatum	1	1	–	–	–	–	–	–

Name of taxa	G	T	P	BM	NB	LU	ML	WL
Staurastrum pilosum	1	–	–	1	–	1	1	–
Staurastrum polymorphum	1	1	–	1	1	1	1	1
Staurastrum polytrichum	1	1	–	1	1	1	–	–
Staurastrum proboscideum	1	1	–	–	–	–	1	1
Staurastrum pseudofurcigerum	–	–	–	–	–	1	–	–
Staurastrum pseudopelagicum	–	–	–	–	–	–	–	1
Staurastrum pseudotetracerum	–	–	–	–	–	–	1	–
Staurastrum punctulatum	1	1	1	1	1	1	1	1
Staurastrum pungens	1	–	–	–	–	–	–	–
Staurastrum pyramidatum	1	–	–	–	–	–	–	–
Staurastrum quadrangulare	–	–	–	1	–	1	–	–
Staurastrum quadrispinatum	–	–	–	–	–	–	1	–
Staurastrum renardii	–	–	–	–	–	1	–	–
Staurastrum retusum	–	–	–	1	–	–	–	–
Staurastrum rugulosum	–	1	–	1	–	–	–	–
Staurastrum saxonicum	–	1	–	–	–	–	–	–
Staurastrum scabrum	1	–	–	–	–	–	1	1
Staurastrum sebaldii	–	–	–	1	–	1	–	–
Staurastrum senarium	–	1	–	1	–	–	–	–
Staurastrum setigerum	–	–	–	–	–	1	1	–
Staurastrum sexcostatum	1	1	–	1	1	–	1	–
Staurastrum simonyi	–	–	–	1	–	–	1	–
Staurastrum smithii	–	–	–	1	–	–	–	–
Staurastrum spongiosum	1	–	–	1	1	1	1	–
Staurastrum striolatum	–	–	–	1	–	1	–	–
Staurastrum subavicula	1	–	–	–	–	–	–	–
Staurastrum subbrebissonii	1	1	–	–	–	–	–	–
Staurastrum teliferum	1	1	–	1	1	–	1	1
Staurastrum tetracerum	1	1	–	1	1	–	1	–
Staurastrum trapezicum	–	1	–	–	–	–	–	–
Staurastrum trifidum	–	–	–	–	–	1	–	–
Staurastrum turgescens	1	1	–	–	–	–	1	–
Staurastrum vestitum	–	–	–	1	1	1	1	1
Staurodesmus aristiferus	–	–	–	–	–	–	–	1
Staurodesmus boergesenii	–	–	–	–	–	–	–	1
Staurodesmus brevispina	–	–	–	1	–	1	–	1
Staurodesmus bulnheimii	–	–	–	–	–	1	–	–
Staurodesmus clepsydra	–	–	–	–	–	1	–	–
Staurodesmus connatus	–	–	–	–	1	1	1	1
Staurodesmus controversus	1	–	–	–	–	–	–	–
Staurodesmus convergens	1	1	–	1	1	1	1	–
Staurodesmus cuspidatus	1	1	–	1	–	1	–	–
Staurodesmus dejectus	–	1	–	1	1	1	1	1
Staurodesmus extensus	1	–	–	–	–	–	1	–
Staurodesmus glaber	1	–	–	–	–	–	1	–
Staurodesmus grandis	–	–	–	–	–	1	–	–
Staurodesmus incus	–	1	–	1	1	1	1	1
Staurodesmus isthmosus	–	–	–	–	–	–	1	1
Staurodesmus leptodermus	–	–	–	–	–	1	–	–
Staurodesmus mamillatus	–	–	–	–	–	–	1	–
Staurodesmus mucronatus	–	–	–	–	–	–	1	–
Staurodesmus o'mearae	–	–	–	–	–	–	1	–
Staurodesmus patens	1	1	–	–	–	1	1	–
Staurodesmus ralfsii	–	–	–	–	–	–	1	–
Staurodesmus spencerianus	–	–	–	–	–	–	1	–
Staurodesmus triangularis	–	–	–	–	1	–	1	1
Staurodesmus tumidus	–	–	–	1	–	1	–	–
Teilingia excavata	–	1	–	1	–	1	1	–
Teilingia granulata	1	–	–	1	–	–	–	1
Tetmemorus brebissonii	–	1	–	–	1	1	1	1

Table 5. Continued

Name of taxa	G	T	P	BM	NB	LU	ML	WL
Tetmemorus granulatus	1	1	–	1	1	1	1	1
Tetmemorus laevis	1	1	–	1	1	1	1	1
Tortitaenia acuta	–	–	–	–	–	1	–	–
Tortitaenia trabeculata	–	–	–	–	–	1	–	–
Xanthidium acanthophorum	–	–	–	–	–	1	–	–
Xanthidium aculeatum	–	–	–	1	–	1	–	–
Xanthidium antilopaeum	1	1	–	1	1	1	1	–
Xanthidium armatum	–	1	–	–	1	1	1	1
Xanthidium concinnum	–	–	–	1	–	1	1	–
Xanthidium cristatum	1	–	–	1	1	1	–	–
Xanthidium fasciculatum	–	–	–	1	–	1	1	–
Xanthidium smithii	–	1	–	1	–	1	1	–
Xanthidium tenuissimum	–	–	–	–	1	–	1	1
	248	217	30	244	146	253	208	122

More than 40 montane desmid species were identified in the Tatras comprising 18.3% of the whole Tatra desmid flora. That is a surprisingly low percentage. In the vascular plant flora of the Tatras, montane species form ~35% (Mirek & Piękoś-Mirkowa 1992).

In the Gorce area, 103 desmid species not identified in the Tatra Mts were found.

It is difficult to draw conclusions regarding differences between the floras of these two regions, since the data from the Tatra Mts are largely incomplete. The lists of desmids in the Tatras and the Gorce Mts do show some conspicuous similarities. The differences are due mainly to the greater availability of acidic and planktonic habitats in the Tatra Mts. It is not clear how much our view of

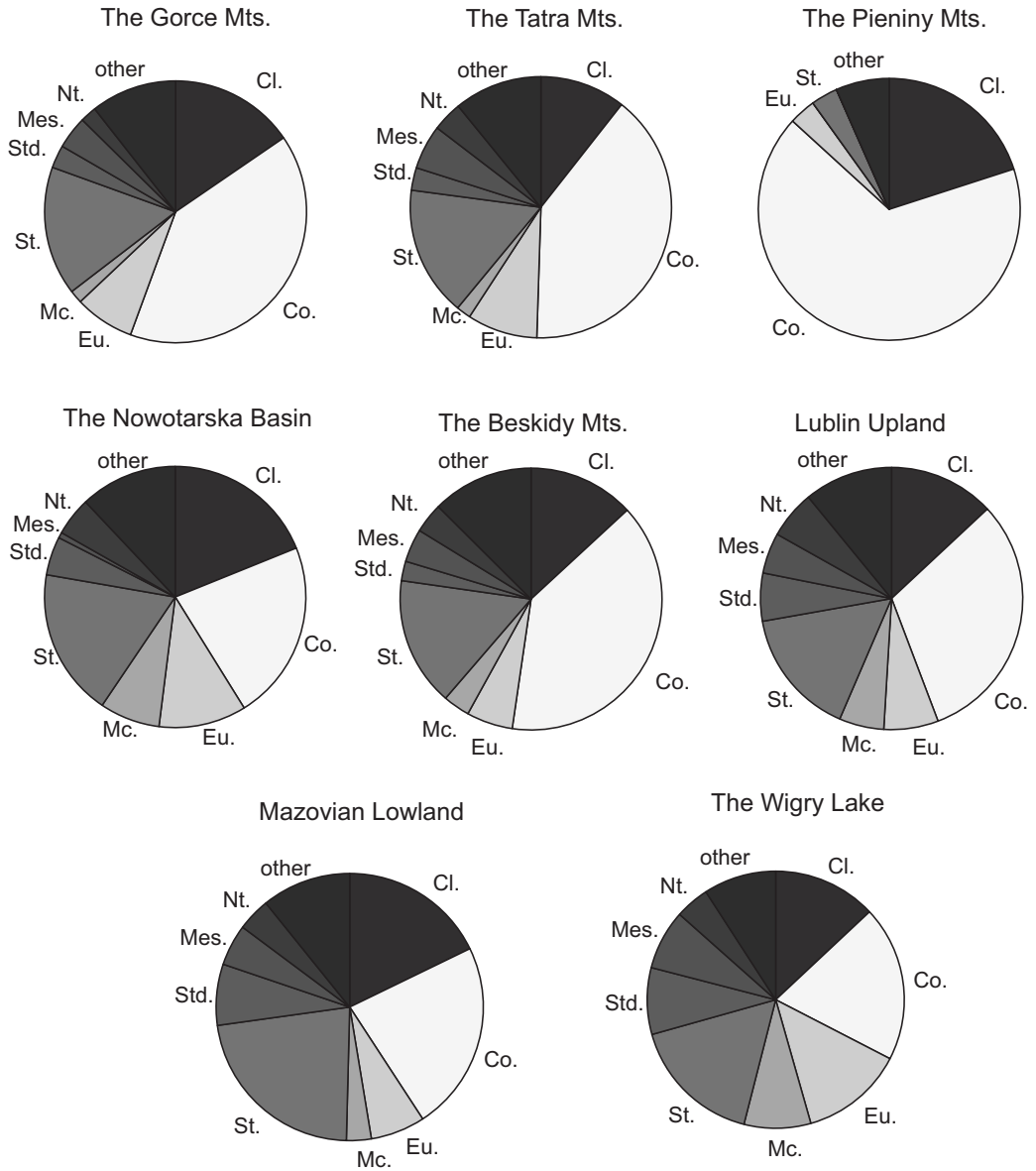

Figure 70. Percentage shares of desmid species in the floras compared in Fig. 69. (see above). Cl. – *Closterium*, Co. – *Cosmarium*, Eu. – *Euastrum*, Mc. – *Micrasterias*, St. – *Staurastrum*, Std. – *Staurodesmus*, Mes. – species of *Mesotaeniaceae* family, Nt. – *Netrium*.

desmid species richness in the Tatra Mts is dictated by the extent to which those mountains have been investigated. Most phycologists have concentrated their research on ponds, lakes and streams. Subaerophytic habitats such as wet rocks and marshes were studied only incidentally (Gutwiński 1909; Růžička 1964). This may be why so few montane species were recorded in the Tatra Mts and why many species found in Gorce marshes were not identified in the Tatras. The number of desmid species recorded in the Tatra Mts is probably much lower than the actual number. The area requires thorough floristic research.

Pieniny Mountains

The Pieniny Mts border the southeast side of the Gorce Mts. Data on the occurrence of desmids in this area were gathered by Filarszky & Filarszky (1900), Starmach (1975) and Mrozińska (1989). Thirty desmid species were identified in this region. *Closterium* species constitute 20% of the floristic list, *Cosmarium* 70%, *Euastrum* 3.3%, *Staurastrum* 3.3% and *Oocardium* 3.3%; *Euastrum*, *Staurastrum* and *Oocardium* are represented by single species. The floras of the two areas have 24 species in common. Six species identified in the Pieniny Mts were not encountered in the Gorce Mts, and 223 species found in the Gorce Mts were not found in the Pieniny Mts. Four montane species were found in the Pieniny Mts; this is 13.3% of that flora, much lower than the share of montane vascular plants in the vascular plant flora (~22%) (Zarzycki 1981). There are many indications that the list of desmid species recorded in the Pieniny Mts is quite complete. It is a small area, there are few potential desmid habitats there, and the terrain has been thoroughly studied. As compared with the Gorce area, the desmid flora of the Pieniny Mts is very poor. *Oocardium striatum*, an alga having the ability to deposit $CaCO_3$ crystals in secreted mucus, which prefers extremely calciferous habitats, is characteristic of the Pieniny Mts (Freytet & Verrecchia 1998). Other characteristic species are rare taxa, and their absence in the Gorce Mts may be coincidental. Almost no acidophilic species, even common ones such as *Cylindrocystis brebissonii*, occur in the Pieniny Mts.

The floristic composition of the Pieniny Mts is related to that of the Lubań range, but it is much poorer, mainly due to its strongly alkaline substrate and lower precipitation. The Pieniny area is in the rain shadow of the Gorce Mts. Areas with dry climate are characterized by a dearth of desmid species; for example, only about 165 species are known from Turkey (Sahin 2005).

Orava-Nowy Targ Basin

The Orava-Nowy Targ Basin borders the southwest side of the Gorce Mts. It is a lowland area, unlike the Gorce and Pieniny Mts. Desmids occur here mainly in fens, poor fens and bogs with pH ranging from strongly acidic to almost alkaline. The data on desmid occurrence there comes from Wasylik (1961), who found 147 species. The shares of genera on the list are as follows: *Closterium* 19%, *Cosmarium* 22.4%, *Euastrum* 10.9%, *Micrasterias* 7.5%, *Staurastrum* 18.4%, *Staurodesmus* 4.8%, *Mesotaeniaceae* genera 0.7%, genera forming filamentous coenobia (*Bambusina*, *Desmidium*, *Hyalotheca*, *Sphaerozosma*, *Spondylosium*) 4.8%, and others (*Actinotaenium*, *Haplotaenium*, *Penium*, *Pleurotaenium*, *Tetmemorus*) 12.1%. Ninety-six species occur in both the Gorce Mts and the Orava-Nowy Targ Basin, 51 species found in the Orava-Nowy Targ Basin were not found in the Gorce Mts, and 151 species of the Gorce Mts were not found in the Orava-Nowy Targ Basin. Only 6 montane species were identified in the Orava-Nowy Targ Basin, forming 4.1% of its desmid flora. The shares of *Micrasterias*, *Staurodesmus* and forms creating filamentous coenobia are much higher than in the Gorce Mts, and the shares of *Cosmarium* and *Mesotaeniaceae* genera are much lower. The differences in floras are largely conditioned by habitat differences. The Orava-Nowy Targ Basin is almost completely lacking in habitats for alkalophilic and subaerophytic species. Hence, the low shares of montane species. Among the desmid species identified in the Orava-Nowy Targ Basin that do not appear in the Gorce area, acidophilic taxa strongly dominate (e.g., *Closterium directum*, *Closterium gracile*, *Cosmarium amoenum*), whereas alkalophilic species dominate the characteristic *Chlorophyta* of the Gorce desmid flora (e.g., *Cosmarium anceps*, *Cosmarium didymochondrum*, *Staurastrum merianii*). The very scarce occurrence of *Mesotaeniaceae* is due to the paucity of the subaerophytic habitats they prefer.

Beskid Mountains

In 1893–1895, Gutwiński (1897, 1901) carried out phycological research in the northern part of the Beskids. The area that he studied covered several geographical units, including part of the Beskid Makowski Mts, Wielickie foothills and, to a smaller extent, the Jalowiec range and Vistula River valley. This is the largest area of the lower Carpathians studied for the occurrence of desmids. In all, 245 desmid species were identified there. The shares of species in the floristic list are as follows: *Closterium* 13.1%, *Cosmarium* 39.1%, *Euastrum* 5.7%, *Micrasterias* 3.3%, *Staurastrum* 15.9%, *Staurodesmus* 2.4%, *Mesotaeniaceae* genera 4.1%, genera forming filamentous coenobia (*Desmidium*, *Hyalotheca*, *Sphaerozosma*, *Spondylosium*) 3.7%, and others (*Actinotaenium*, *Docidium*, *Haplotaenium*, *Pachyphorium*, *Penium*, *Pleurotaenium*, *Tetmemorus*) 12.5%. In that area, 146 species also occurring in the Gorce desmid flora were found, and 99 species not recorded in the Gorce Mts: 102 Gorce desmid taxa were not noted in Gutwiński's survey of the northern Beskids. He noted 22 montane species, or ~9% of all the desmid species identified there. The number of species, shares of genera and the composition of the list are all generally similar to those of the Gorce Mts. Among the desmids identified in the northern part of the Beskids and not noted in the Gorce area, acidophilic taxa form a very numerous group which includes *Closterium archerianum*, *Cosmarium tesselatum* and *Euastrum insulare*, high shares of planktonic species, such as *Cosmarium tenue*, *Staurastrum gracile* and *St. paradoxum*, and many taxa that are generally rare, such as *Cosmarium brebissonii*, *Co. haynaldii*, *Co. subholmiense* and *Co. vanum*. Among

the Gorce desmids that do not occur in the northern part of the Beskids is a distinct group of montane species such as *Closterium exile*, *Cosmarium decedens*, *Co. tatricum*, *Euastrum subalpinum* and *Staurastrum pileolatum*. The similarities between the lists are largely due to habitat conditions, especially the high availability of subaerophytic habitats. Unfortunately, a detailed comparison of the two lists is hampered by the imprecision of habitat diagnoses used in the 19th century. The differences probably are due in part to the greater availability of acidic habitats in the northern part of the Beskids, which most of the species prefer. Also important is that there are more waterbodies in this area, including swamps and ponds. Climate factors may be responsible for the smaller number of montane species.

Lublin Upland

From 1890 to 1896, Eichler (1890, 1892, 1895, 1896) collected data on the occurrence of desmids on the northern edge of the Lublin Upland in the vicinity of Międzyrzec Podlaski. Overall, 254 species were collected in that area. The shares of genera noted there are as follows: *Closterium* 13%, *Cosmarium* 31.1%, *Euastrum* 6,7%, *Micrasterias* 5.5%, *Staurastrum* 15.7%, *Staurodesmus* 5.9%, *Mesotaeniaceae* genera 5%, genera forming filamentous coenobia, (*Bambusina*, *Desmidium*, *Hyalotheca*, *Sphaerozosma*, *Spondylosium*, *Teilingia*) 5.9%, and others (*Actinotaenium*, *Docidium*, *Haplotaenium*, *Heimansia*, *Pachyphorium*, *Penium*, *Pleurotaenium*, *Tetmemorus*, *Tortitaenia*) 10.9%. The Gorce Mts and the surroundings of Międzyrzec Podlaski have 120 species in common, 134 species of Międzyrzec Podlaski were not found in the Gorce Mts, and 127 Gorce species were not recorded in the Międzyrzec Podlaski area. Twelve montane species were identified there, which is 4.7% of the desmid flora. The share of *Cosmarium* species is much lower than in the Gorce Mts, and its shares of *Micrasterias*, *Staurodesmus* and genera forming filamentous coenobia are higher. The Międzyrzec Podlaski desmid species not recorded in the Gorce Mts include significant shares of acidophilic taxa (e.g., *Closterium gracile*, *Cl. setaceum*, *Tetmemorus brebissonii*). There are numerous desmids that are generally rare (e.g., *Closterium delpontei*, *Cosmarium miedzyrzecense*, *Co. polonicum*, *Micrasterias jenneri*). Among the Gorce desmid species not identified in the Międzyrzec Podlaski area are montane species such as *Closterium exile*, *Cosmarium cymatopleurum* and *Euastrum subalpinum*. The Międzyrzec Podlaski desmids also include a numerous group of alkalophilic desmids, such as *Cosmarium biretum*, *Co. crenatum* and *Co. subcucumis*. The great similarity between the floras of the Gorce and the area surrounding Międzyrzec Podlaski is explained by the abundance of alkaline and subaerophytic habitats in both regions. Eichler reported collecting material from *Hypnum* mosses, which also occur in alkaline marshes of the Gorce Mts. Interestingly, among the species common to both regions are many montane taxa such as *Closterium pusillum*, *Cosmarium anceps*, *Co. decedens*, *Co. tetragonum* and *Staurastrum capitulum*.

Mazovian Lowland

The floral data from the region of the Mazovian Lowland are very fragmentary. Studies have covered some peatlands (Wysocka 1934; Tomaszewicz 1973, 1974, 1988) and also some oxbow lakes of the Bug River (Tomaszewicz 1970), Kozłowski (1895) investigated the algae of different habitats near Warsaw. A total of 208 desmid species were reported from this region. The shares of genera on the floristic list are as follows: *Closterium* 17.8%, *Cosmarium* 23%, *Euastrum* 6.6%, *Micrasterias* 3%, *Staurastrum* 22.4%, *Staurodesmus* 7.4%, *Mesotaeniaceae* genera 5%, genera forming filamentous coenobia (*Bambusina*, *Desmidium*, *Hyalotheca*, *Spondylosium*, *Teilingia*) 4%, and others (*Actinotaenium*, *Haplotaenium*, *Penium*, *Pleurotaenium*, *Tetmemorus*) 10.8%. Among the species noted in this region are 135 species that also occur in the Gorce Mts and 73 that do not; 112 Gorce desmid species were not identified in the Mazovian Lowland. The 5 montane taxa found there constitute 2.5% of the desmid flora. The share of *Cosmarium* species is much lower than in the Gorce Mts. *Closterium*, *Micrasterias*, *Staurastrum*, *Staurodesmus* and genera forming filamentous coenobia are more species-rich than in the Gorce Mts. Acidophilic taxa dominate among the species reported from Mazovia, but not from the Gorce Mts (e.g., *Bambusina borreri*, *Closterium archerianum*, *Cosmarium amoenum*). The Gorce desmids that do not appear in the Mazovian Lowland include many alkalophilic taxa such as *Closterium pseudolunula*, *Cosmarium hornavanense* and *Co. subcucumis*. The majority of the montane species found in the Gorce Mts were not recorded in that lowland. The differences in species composition are attributable to habitat conditions. In Mazovia, unlike in the Gorce Mts, habitats related to peatlands, which are preferred by acidophilic algae, dominate.

Wigry Lake area

The vicinity of Wigry lake is one of the areas most thoroughly studied for the occurrence of desmids in northern Poland. The region includes the lake and the polyhumic ponds (called *suchary*) near it. The lake was investigated by Wołoszyńska (1922, 1924), and the ponds by Ryppowa (1925), Tomaszewicz and Kowalski (1993) and Tomaszewicz et al. (1996). Overall, 122 species were identified in that area. The shares of genera on the floristic list are as follows: *Closterium* 12.1%, *Cosmarium* 18.2%, *Euastrum* 12.1%, *Micrasterias* 7.8%, *Staurastrum* 15.5%, *Staurodesmus* 7.8%, *Mesotaeniaceae* genera 7%, genera forming filamentous coenobia (*Bambusina*, *Desmidium*, *Hyalotheca*, *Spondylosium*, *Teilingia*) 4%, and others (*Actinotaenium*, *Docidium*, *Haplotaenium*, *Penium*, *Pleurotaenium*, *Tetmemorus*, *Xanthidium*) 8.5%. Only one montane species was identified there (0.9% of the desmid flora). The shares of *Closterium* and *Cosmarium* are much lower than in the Gorce Mts, and the shares of *Euastrum*, *Micrasterias*, *Staurodesmus* and genera forming filamentous coenobia are higher. Seventy-two desmid species are common to the Wigry Lake and Gorce areas. Fifty Wigry desmid species were not recorded in

the Gorce Mts, and 176 Gorce desmid species were not recorded in the Wigry region. Most of the Wigry desmids not found in the Gorce Mts are acidophilic algae (e.g., *Bambusina borreri*, *Closterium directum*, *Cl. incurvum*, *Euastrum pinnatum*). The differences between the two floras are due mostly to habitat differences. Acidic habitats with pH 4.6–6.8 dominate the Wigry area (Tomaszewicz & Kowalski 1993), and alkaline subaerophytic habitats do not occur there at all.

Reasons for the distinctiveness of the Gorce desmid flora

On the dendrogram prepared from the desmid floristic lists of the Gorce Mts, Tatras, part of the Beskids, the Lublin Upland, Mazovian Lowland and Wigry Lake area (Fig. 71), the latter stands out the most. The Mazovian Lowland and the Orava-Nowy Targ Basin are the areas most different from the Carpathians and old uplands. Among all these groups, the biggest similarities are between the Gorce Mts and the Tatras, and between the Beskids and the Lublin Upland. The data from the Pieniny Mts were not included due to the impoverishment of its flora. The distinctiveness of the Wigry Lake area's desmid flora is understandable, as its habitat conditions differ greatly from those of the other areas. Desmids were found here mostly in lakes, which in the other regions are few or absent. The mountain floras are distinct from the lowland ones, and those of the analyzed parts of the Beskids and Małopolska Upland are of transitional character.

Some phycologists have drawn attention to the uniqueness of the mountain desmids. Coesel et al. (1988) showed that the mountains rising between the Amazon and Orinoco basins form a barrier to many species. Vuwerman (1992) addressed the distinctiveness of mountain habitats in New Guinea. On the continent of Europe such work has been done by Coesel (1998) Kouwets (1997, 1998), Lenzenweger (2003) and Negro et al. (2003). In Southern Europe, the main factor determining the phytogeographical distinctiveness of the mountains seems to be the greater availability of water, as Coesel (1998) demonstrated with the example of Spain. There the mountains host some tropical species (Kouwets 1988; Coesel 1998). In Central Europe, temperature turns out to be an important factor. Throughout Austria, the Alps provide habitats for arctic-alpine species (Lenzenweger 2003).

The differences in total annual precipitation between lowlands and mountains are much higher in Southern Europe than in Central Europe. Annual precipitation in the Polish lowlands does not exceed 600 mm, while in upland area it reaches 700 mm and in the mountains, it usually exceeds 800 mm and quite often 1000 mm. This has an impact on the living conditions of algae that use water of atmospheric origin. In a study of the desmids of Sudetes peatlands and adjacent land, Matuła (1995) did not identify any significant differences between the mountain and lowland peatland floras. This resembles the case of polyhumic waterbodies in the Gorce area. In Stawek Pucołowski pond, the Jeziorne peatland and Morskie Oko Lake below Kudłoń peak, species often identified in lowland peatlands dominate, and montane taxa are sparsely represented. To explain both cases, we may note that the occurrence of desmids in peatland habitats of both mountains and lowlands is not limited by the availability of water. Noticeable differences between mountain and lowland areas result from the occurrence of desmids related to subaerophytic habitats in the mountains, such as wet rocks, wet soil, puddles on roads, and marsh habitats. This refers mainly to alkaline habitats.

Based on a comparison of the floristic lists of the Polish areas mentioned above, the mountain flora should be expected to contain a high share of *Cosmarium* taxa and low shares of *Micrasterias* and *Staurodesmus*, whereas

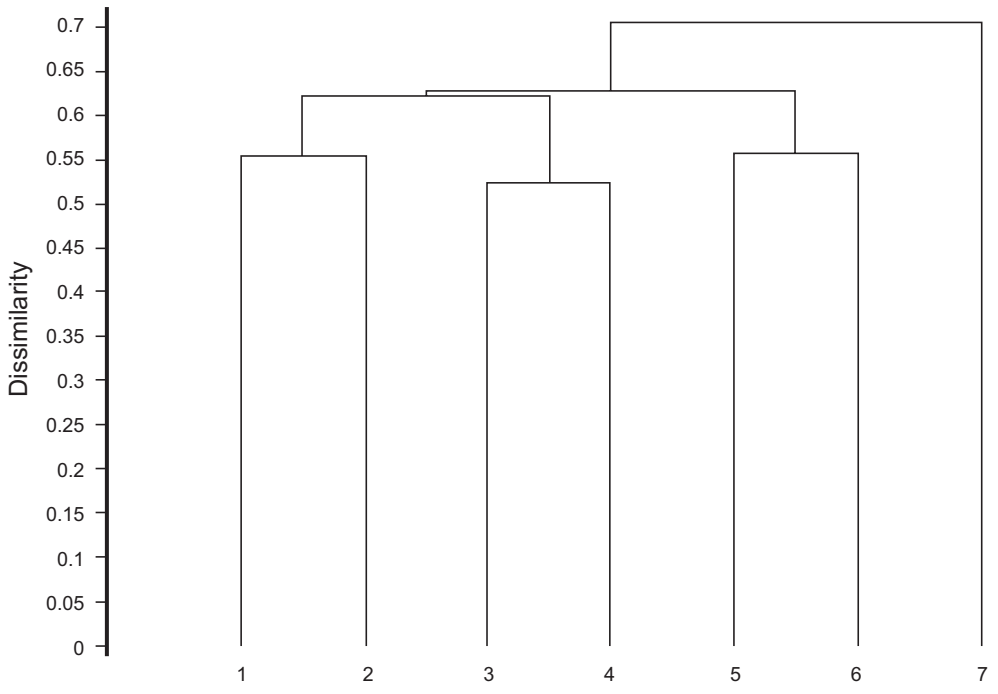

Figure 71. Dendrogram of similarity between the lists of desmid species from the areas compared in Fig. 69. (see above)

montane species will be numerous. A more detailed description of the differences between the lowland and mountain desmid floras will require more such studies devoted to those areas in Poland.

Human impacts on the desmid flora of the Gorce Mts

By transforming the natural environment, humans destroy the habitats of some species, but also create new habitats for others. Another consequence of human activity is the introduction of alien taxa to an area. For desmids, there are examples of negative human impacts on species diversity due to the degradation of peatlands (Scheer & Kusber 1997; Hutorowicz 2001) and eutrophication or oligotrophication of water (Coesel et al. 1978). There are documented cases of introduction of alien taxa of *Bacillariophyta* (Coste & Ector 2000) and *Chlorophyta* (Wells et al. 1999). Lenzenweger and Wertl (2001) discussed the introduction of foreign desmid species. Other interesting cases include the discovery of a station of *Staurastrum habeebense* in Slovakia, a species new for the European continent (Coesel & Hindak 2003), and the discovery of species that occur in South America (e.g., *Staurastrum botanense*, *Staurastrum floridense*) in Wielkopolska Province, Poland (Burchardt 1977). These may be instances of introduction.

In the Gorce Mts, the negative impacts involve mainly drainage of wetlands and regulation of rivers and streams. Drainage causes marsh habitats to disappear. This is probably why desmids have been almost completely eradicated in many places, and it may be responsible for the absence of the most common species around Rabka, Nowy Targ, Krościenko and the lower part of the Kamienica stream valley. Regulation of rivers and streams removes rocks and dead branches, and also the oxbow lakes that provide a habitat for many desmid species. In the last few decades that process has accelerated, for example in the Ochotnica Dolna region. In the Gorce area, wetland drainage and watercourse regulation do not significantly influence the species richness of desmids. Wetlands are drained mostly at lower locations, which generally were of low floristic value previous to that work, and watercourse regulation destroys the habitats of common desmids that have a broad ecological amplitude.

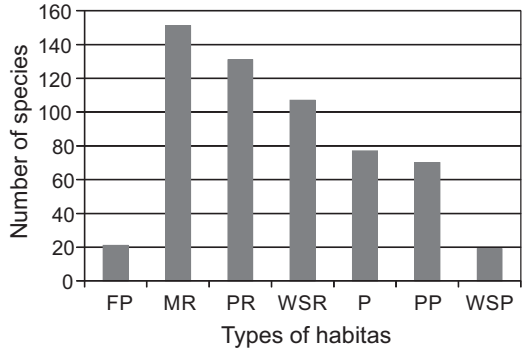

Figure 72. Number of desmid species occurring in different types of anthropogenic habitats. FP – fish ponds, MR – mountain roads, PR – puddles on mountain roads, WSR – wet soil on mountain roads, P – paths, PP – puddles on paths, WSP – wet soil on paths.

Human activity in the Gorce region has created new habitats for many desmid species (Fig. 72). These are artificial habitats maintained by human activity, and also seminatural habitats of natural origin, but also maintained by human activity. The former include fish ponds and habitats related to roads and paths, whereas the latter comprise marsh habitats on Gorce meadows whose existence strictly depends on the sheep-farming economy.

Fish Ponds

Fish ponds supply alternative habitats for many desmid species in southern Poland (Bucka 1960, 1966; Szklarczyk-Gazdowa 1965; Kyselewa 1966; Bucka & Kyselewa 1967; Bucka et al. 1968; Bucka & Krzeczkowska-Wołoszyn 1971). The taxa found in fish ponds were mostly common ones associated with eutrophic habitats (e.g., *Closterium acerosum*, *Closterium moniliferum*). Some rare species such as *Micrasterias mahabuleshwarensis* (Bucka et al. 1968) were encountered as well. The overall share of desmids among the algae of this type of habitat was small; frequent occurrence of these *Chlorophyta* was reported only in mid-forest ponds (Bucka & Krzeczkowska-Wołoszyn 1971).

The only pond complex in the Gorce area is in Łopuszna. These are small ponds 1.5 m deep, with water pH above 8.0 and ionic conductivity more than 200 µS. Twenty-two desmid species were found at this locality: *Actinotaenium cucurbita*, *Ac. cucurbitinum*, *Closterium acerosum*, *Cl. ehrenbergii*, *Cl. moniliferum*, *Cl. parvulum*, *Cl. pseudolunula*, *Cl. strigosum*, *Cosmarium botrytis*, *Co. crenatum*, *Co. didymochondrum*, *Co. holmiense* var. *integrum*, *Co. impressulum*, *Co. laeve*, *Co. meneghinii*, *Co. pericymatium*, *Co. sexangulare*, *Co. speciosum*, *Co. sportella*, *Co. subcostatum*, *Co. subcrenatum* and *Staurastrum punctulatum*. They occurred mostly in small numbers among filamentous algae of the genera *Mougeotia* and *Spirogyra*. These are almost all desmids that occur frequently in the study area; only *Closterium strigosum* and *Cosmarium pericymatium* are rare. Four montane species rarely reported from fish ponds were identified there. Most of these species prefer oxbow lakes and puddles on river rocks in the Gorce Mts. This finding probably reflects the fact that the ponds are supplied with water from Łopuszna stream.

Roads and paths

Forestry and sheep husbandry created a system of roads and paths which became habitats for many desmid species. The most important ones in this regard are the forest roads running across slopes, formerly used for transporting logs. Very often they have deep ruts where rain water accumulates, forming many puddles. Their pH ranges from 4.9 to 8.6, but is mostly acidic; ionic conductivity is usually below 100 µS, and often less than 30 µS. These puddles often persist through most of the growing season, especially in deep valleys. Desmids frequently occur in wet soil on slope roads in places below helocrenic streams. These habitats are mostly slightly acidic

to slightly alkaline. They also often last through most of the growing season. Unlike the slope roads, the puddles on paths are shallower and often temporary. They are usually acidic, especially in peak areas. The habitats associated with wet soil on paths are generally acidic and are generally temporary.

Phycologists have rarely taken an interest in roads and paths. Starmach (1962) investigated the occurrence of algae on paths in an area near the northern edge of the Gorce region. He reported only one desmid species, *Cylindrocystis brebissonii*. This alga is also frequently found on roads and mountain paths. Czosnowski (1952) discussed the role of puddles as habitats for various algal species, but did not identify any desmids in that habitat.

In the Gorce Mts, desmids were numerous in habitats associated with roads; 151 species (61% of the Gorce desmid flora) were found there. Table 6 lists the species found on roads and paths, and the shares of genera are given in Figure 73. Puddles on slope roads, where 131 species were found, were the species-richest habitats. In this group, the shares of genera were as follows: *Closterium* 17.6%, *Cosmarium* 39.7%, *Euastrum* 9.2%, *Micrasterias* 2.3%, *Staurastrum* 13.7%, *Staurodesmus* 1.5%, *Mesotaeniaceae* genera 6.9%, genera forming filamentous coenobia (*Desmidium*, *Hyalotheca*) 1.5%, and others (*Actinotaenium*, *Penium*, *Pleurotaenium*, *Tetmemorus*) 7.6%. The most frequently recorded species were *Closterium abruptum*, *Cl. intermedium*, *Cl. juncidum*, *Cl. navicula*, *Cl. parvulum*, *Cl. striolatum*, *Cosmarium laeve*, *Co. ochthodes*, *Co. subcrenatum*, *Cylindrocystis brebissonii*, *Netrium digitus*, *Penium cylindrus*, *P. spirostriolatum*, *Staurastrum margaritaceum*, *St. orbiculare*, *Tetmemorus granulatus* and *T. laevis*. This group was dominated by acidophilic species highly resistant to habitat alkalization. *Cosmarium ochthodes* and *Co. subcrenatum* are alkalophilic algae resistant to acidification, whereas *Closterium parvulum* has a wide habitat spectrum. As mentioned, the puddles on roads usually showed acidic pH.

The number of desmid species found in wet soil on roads was 107 (43.3% of the Gorce desmid flora). In this group, the shares of genera were as follows: *Closterium* 17.8%, *Cosmarium* 45.8%, *Euastrum* 4.7%, *Micrasterias* 2.3%, *Staurastrum* 12.1%, *Mesotaeniaceae* genera 8,4%, and others (*Actinotaenium*, *Penium*, *Pleurotaenium*, *Tetmemorus*) 11.2%. The species most frequently encountered in wet soil on roads were *Actinotaenium cucurbita*, *Actinotaenium cucurbitinum*, *Ac. diplosporum*, *Closterium moniliferum*, *Cosmarium anceps*, *Co. botrytis*, *Co. caelatum*, *Co. holmiense* var. *integrum*, *Co. hornavanense*, *Co. impressulum*, *Co. laeve*, *Co. notabile*, *Co. quadratum*, *Co. speciosum*, *Co. sportella*, *Co. subbroomei*, *Co. subcrenatum*, *Co. subcucumis*, *Co. subspeciosum*, *Co. vexatum*, *Cylindrocystis brebissonii*, *Penium margaritaceum* and *Tetmemorus laevis*. Alkalophilic species resistant to habitat acidification prevailed; only *Cylindrocystis brebissonii*, *Penium margaritaceum* and *Tetmemorus laevis* prefer acidic habitats. *Actinotaenium cucurbita*, *Cosmarium quadratum* and *Staurastrum punctulatum* have wide ecological spectra. Algae living in wet soil on roads often depend on alkaline water originating from bedrock explaining the predominance of alkalophilic taxa.

Only 77 species (28.3% of the Gorce desmid flora) were found on paths. Seventy species were identified in the puddles on paths. The shares of genera were as follows: *Closterium* 20%, *Cosmarium* 37.1%, *Euastrum* 10%, *Staurastrum* 8.6%, *Staurodesmus* 1.4%, *Mesotaeniaceae* genera 8.6%, genera forming filamentous coenobia (*Desmidium*, *Hyalotheca*) 2.8%, and others (*Actinotaenium*, *Penium*, *Pleurotaenium*, *Tetmemorus*) 9.4%. The species most frequently found were *Closterium navicula*, *Cl. striolatum*, *Cl. tumidum*, *Cylindrocystis brebissonii*, *Mesotaenium degreyi*, *Penium spirostriolatum*, *Staurastrum muricatum* and *Tetmemorus laevis*. All of these desmids are related to acidic habitats and are highly tolerant to habitat alkalization. *Cylindrocystis brebissonii*, *Mesotaenium degreyi* and *Staurastrum muricatum* prefer highly acidic habitats. The puddles on paths running along ridges are species-poor, especially in peak parts. Very often, fewer than 5 species were identified in the samples. These were often communities strongly dominated by *Cylindrocystis brebissonii*. Other desmid species occurred only singly.

Only 19 species (7.7% of the Gorce desmid flora) were found in wet soil on paths, a relatively rare habitat type in the Gorce Mts. *Cosmarium* species had the highest share, and *Cylindrocystis brebissonii* was the most common species.

It is understandable that the species-richest anthropogenic habitats were puddles on roads, and that the fewest desmids were found in wet soil on paths. Puddles on roads are much less exposed to the risk of drought than wet soil on paths is, especially in deep valleys and in upper parts. On both roads and paths, in habitats exposed to drought the most numerous species were those of the genus *Cosmarium*. The shape of these algae resembles a flattened ellipsoid and the low ratio of cell surface area to cell volume can help them survive drought periods. As compared with the total Gorce desmid flora, habitats associated with roads and paths have clearly larger shares of *Mesotaeniaceae* and *Closterium*, and a smaller share of *Staurastrum*. For *Mesotaeniaceae*, this may be related to the preference of many of its species for subaerophytic habitats (Kossinskaja 1952; Prescott et al. 1972). The poor representation of *Staurastrum* may be explained by the fact that many species of this genus are associated with planktonic communities and therefore prefer waterbodies.

In habitats associated with roads and paths, 157 desmid species (63.6% of the Gorce desmid flora) were identified. Puddles on roads were the third most species-rich type of habitat (after polyhumic waterbodies and *Sphagnum* puddles), probably due to higher insolation, a wider range of pH, and high availability of water. That it is a widespread type of habitat is also an important factor. There were many species associated with natural habitats such as polyhumic waterbodies, *Sphagnum* puddles (*Euastrum oblongum*, *Micrasterias rotata*), habitats related to streams (*Cosmarium crenatum*) and seminatural marsh communities (*Closterium praelongum*, *Cosmatium anceps*). The group of species having a clear preference for habitats associated with roads and paths included *Actinotaenium cucurbita*, *Ac. cucurbitinum*, *Ac. spinospermum*,

Table 6. List of desmid species occurring in different habitats on roads and paths: PR – puddles on roads, WSR – wet soil on roads, PP – puddles on paths, WSP – wet soil on paths (species known only from single stations are bolded)

Name of taxa	PR	WSR	PP	WSP
Actinotaenium borgeanum	–	1	–	–
Actinotaenium cruciferum	1	–	–	–
Actinotaenium cucurbita	1	1	1	1
Actinotaenium cucurbitinum	1	1	1	1
Actinotaenium curtum	–	1	–	–
Actinotaenium diplosporum	1	1	1	–
Actinotaenium perminutum	1	1	–	–
Actinotaenium silvae-nigrae	1	1	–	–
Actinotaenium spinospermum	1	1	–	–
Closterium abruptum	1	1	1	–
Closterium acerosum	–	1	1	–
Closterium acutum	1	–	–	–
Closterium cornu	1	1	–	–
Closterium costatum	–	–	1	–
Closterium dianae	–	1	–	–
Closterium ehrenbergii	1	1	1	–
Closterium idiosporum	1	1	–	–
Closterium intermedium	1	1	1	–
Closterium jenneri	1	–	–	–
Closterium juncidum	1	1	1	–
Closterium kuetzingii	1	–	–	–
Closterium littorale	1	1	–	–
Closterium lunula	1	1	1	–
Closterium macilentum	1	–	–	–
Closterium moniliferum	1	1	1	–
Closterium navicula	1	–	1	–
Closterium parvulum	1	1	1	–
Closterium praelongum	1	1	1	–
Closterium pritchardianum	–	1	–	–
Closterium pseudolunula	1	1	–	–
Closterium pygmaeum	1	–	–	–
Closterium rostratum	1	1	1	–
Closterium strigosum	1	1	–	–
Closterium striolatum	1	–	1	–
Closterium sublaterale	1	–	–	–
Closterium tumidulum	–	1	–	–
Closterium tumidum	1	1	1	–
Cosmarium anceps	1	1	1	–
Cosmarium arctoum	1	–	–	–
Cosmarium biretum	1	1	–	–
Cosmarium botrytis	1	–	–	–
Cosmarium caelatum	1	1	1	–
Cosmarium contractum	1	–	–	–
Cosmarium costatum	1	1	–	–
Cosmarium crenatum	1	1	–	–
Cosmarium cyclicum	1	1	1	–
Cosmarium cymatopleurum	–	1	–	–
Cosmarium davidsonii	1	1	1	–
Cosmarium decedens	1	1	–	–
Cosmarium dentiferum	1	1	1	–
Cosmarium didymochondrum	–	1	–	–
Cosmarium elegantissimum	1	–	–	–
Cosmarium formosulum	1	1	1	–
Cosmarium galeritum	1	1	–	–
Cosmarium garrolense	1	–	1	1
Cosmarium granatum	1	1	–	–
Cosmarium hammeri	–	1	1	–
Cosmarium holmiense var. *holmiense*	1	1	–	–
Cosmarium holmiense var. *integrum*	1	1	–	1

Name of taxa	PR	WSR	PP	WSP
Cosmarium hornavanense	1	1	–	1
Cosmarium impressulum	1	1	1	–
Cosmarium jenisejense	1	–	–	–
Cosmarium laeve	1	1	1	–
Cosmarium margaritiferum	1	1	1	–
Cosmarium microsphinctum	–	1	–	–
Cosmarium nasutum	1	–	–	–
Cosmarium nitidulum	1	1	–	–
Cosmarium notabile	1	1	1	–
Cosmarium novae-semliae	1	–	1	–
Cosmarium obliquum	–	1	–	–
Cosmarium obtusatum	1	1	–	1
Cosmarium ochthodes	1	1	1	–
Cosmarium pachydermum	1	1	–	–
Cosmarium pericymatium	–	1	–	–
Cosmarium pokornyanum	1	1	–	–
Cosmarium praemorsum	1	–	1	–
Cosmarium pseudoexiguum	–	1	–	–
Cosmarium pseudopyramidatum	1	1	1	–
Cosmarium quadratum	1	1	1	1
Cosmarium rectangulare	1	–	–	–
Cosmarium regnellii	1	–	–	–
Cosmarium reniforme	1	–	–	–
Cosmarium saxicola	–	–	1	–
Cosmarium sexnotatum	1	–	–	–
Cosmarium speciosum	1	1	1	–
Cosmarium sphalerostichum	1	1	–	–
Cosmarium sportella	1	1	1	1
Cosmarium subarctoum	–	1	1	–
Cosmarium subbroomei	1	1	–	–
Cosmarium subcostatum	1	1	1	–
Cosmarium subcrenatum	1	1	1	1
Cosmarium subcucumis	–	1	1	–
Cosmarium subgranatum	–	1	–	–
Cosmarium subnotabile	1	–	–	–
Cosmarium subspeciosum	1	1	1	–
Cosmarium subtumidum	1	1	–	–
Cosmarium tatricum	1	–	–	–
Cosmarium tetragonum	1	1	–	–
Cosmarium tetraophthalmum	–	1	–	–
Cosmarium tinctum	1	1	–	–
Cosmarium turpinii	–	1	–	–
Cosmarium vexatum	1	1	–	–
Cylindrocystis brebissonii	1	1	1	1
Cylindrocystis crassa	–	1	–	1
Desmidium grevillei	1	–	–	–
Desmidium swartzii	–	–	1	–
Euastrum ansatum	1	–	–	–
Euastrum bidentatum	1	–	1	–
Euastrum binale	1	1	1	–
Euastrum crassicolle	1	1	–	–
Euastrum denticulatum	1	1	1	–
Euastrum didelta	1	–	–	–
Euastrum dissimile	–	–	–	1
Euastrum elegans	1	–	–	–
Euastrum erosum	1	1	1	–
Euastrum humerosum	1	–	1	–
Euastrum oblongum	1	1	1	–
Euastrum subalpinum	1	–	–	–

Table 6. Continued

Name of taxa	PR	WSR	PP	WSP
Euastrum verrucosum	1	–	1	
Gonatozygon brebissonii	1	1	1	1
Gonatozygon monotaenium	–	–	–	–
Hyalotheca dissiliens	1	–	1	–
Mesotaenium degreyi	1	1	1	–
Mesotaenium endlicherianum	1	–	–	–
Mesotaenium macrococcum	1	1	–	–
Micrasterias americana	1	–	–	–
Micrasterias rotata	1	–	–	–
Micrasterias truncata	1	–	–	–
Netrium digitus	1	1	1	–
Netrium oblongum	1	1	–	–
Penium cylindrus	1	–	1	–
Penium margaritaceum	1	1	1	–
Penium spirostriolatum	1	–	1	–
Planotaenium interruptum	–	1	1	–
Pleutotaenium crenulatum	1	1	1	–
Pleutotaenium trabecula	1	1	–	–
Roya obtusa	–	1	1	–
Spirotaenia condensata	1	–	–	–
Spirotaenia obscura	1	–	–	–
Staurastrum capitulum	1	–	–	–
Staurastrum hexacerum	1	–	–	–
Staurastrum hirsutum	1	1	1	–
Staurastrum lapponicum	–	1	–	–
Staurastrum margaritaceum	1	1	1	1
Staurastrum merianii	–	1	–	–
Staurastrum muricatum	1	1	1	1
Staurastrum orbiculare	1	1	1	1
Staurastrum pileolatum	1	1	1	–
Staurastrum pilosum	1	1	–	–
Staurastrum polytrichum	1	1	–	–
Staurastrum punctulatum	1	1	1	–
Staurastrum scabrum	–	1	–	–
Staurastrum sexcostatum	1	1	–	1
Staurastrum spongiosum	1	–	–	–
Staurastrum subavicula	1	–	–	–
Staurastrum subbrebissonii	–	–	–	1
Staurastrum turgescens	1	1	–	–
Staurodesmus controversus	1	–	1	–
Staurodesmus glaber	1	–	–	–
Tetmemorus granulatus	1	–	1	–
Tetmemorus laevis	1	1	1	1
	131	107	70	19

Closterium acutum, *Cl. juncidum*, *Cl. pritchardianum*, *Cl. pusillum*, *Cl. striolatum*, *Cl. tumidum*, *Cl. tumidulum*, *Cosmarium dentiferum*, *Co. garrolense*, *Co. hornavanense*, *Co. nasutum*, *Co. notabile*, *Co. novae-semliae*, *Co. praemorsum*, *Co. pseudopyramidatum*, *Co. speciosum*, *Co. sphalaerostichum*, *Co. subarctoum*, *Co. subbroomei*, *Co. subspeciosum*, *Co. tetragonum*, *Co. tinctum*, *Cylindrocystis brebissonii*, *Cy. crassa*, *Euastrum denticulatum*, *Eu. verrucosum*, *Mesotaenium degreyi*, *Penium cylindrus*, *P. margaritaceum*, *P. spirostriolatum*, *Roya obtusa*, *Staurastrum muricatum*, *St. orbiculare* and *Tetmemorus granulatus* (Fig. 56b).

Montane species formed ~27% of the desmids found on roads and paths, which probably are substitute habitats for many of them. Such cases have been reported in Europe. Lukešová (2001) noted the occurrence of *Closterium pusillum* and *Cosmarium decedens* on exposed soil in brown coal surface mines in the Czech Republic and southern Germany. In Denmark, *Cosmarium pericymatium* was identified in material collected from anthropogenic alternative habitats, for example, roof gutters (Coesel et al. 2006).

Twenty species were found exclusively in the habitats related to roads and paths: *Actinotaenium curtum*, *Closterium cornu*, *Cl. jenneri*, *Cl. macilentum*, *Cosmarium arctoum*, *Co. microsphinctum*, *Co. pseudoesiguum*, *Co. saxicola*, *Co. subtumidum*, *Co. turpinii*, *Euastrum crassicolle*, *Eu. elegans*, *Eu. erosum*, *Mesotaenium endlicherianum*, *M. macrococcum*, *Micrasterias americana*, *Netrium oblongum*, *Spirotaenia condensata*, *Staurastrum lapponicum* and *Staurodesmus controversus*.

As the above information shows, 58 species (23.5% of the Gorce desmid flora) are synanthropic taxa, which owe their local distribution largely to human impacts. Apart from the synantrophic taxa, some species that are rare in Poland were found in habitats related to roads and paths (e.g., *Cosmarium obliquum*, *Staurastrum merianii*, *Staurastrum pileolatum*).

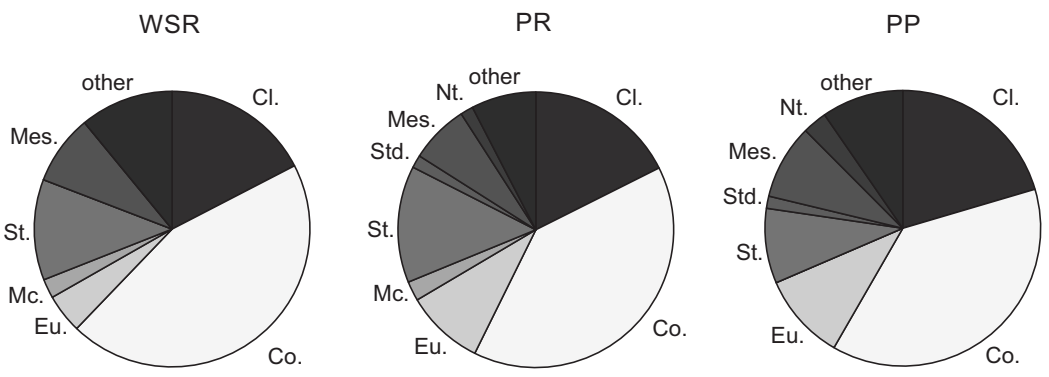

Figure 73. Percentage shares of desmid species occurring in different habitats of mountain roads and paths. WSR – wet soil on mountain roads, PR – puddles on mountain roads, PP – puddles on paths, Cl. – *Closterium*, Co. – *Cosmarium*, Eu. – *Euastrum*, Mc. – *Micrasterias*, St. – *Staurastrum*, Std. – *Staurodesmus*, Mes. – species of *Mesotaeniaceae* family, Nt. – *Netrium.*

Seminatural habitats

Sheep husbandry has created numerous meadows in the Gorce area. They persist only while in use. When grazing is abandoned, they undergo succession which eventually transforms them into forest habitats characteristic of a given elevation zone. In the case of the vascular plants, this process is accompanied by a decrease of species richness (Kornaś 1957; Kozak 2007). The effect of succession on algae in meadows has not been investigated so far.

Habitats related to marshes are very common in the Gorce meadows (discussed in detail in the section on habitat types). To examine the impact of abandonment of grazing on desmid species biodiversity in marsh habitats, two groups of meadows were distinguished:

Group I – meadows used for grazing and mowing until the 1980s, with a rich vascular plant flora; and Group II – meadows that have not been used consistently for a long period of time, with a poor vascular plant flora dominated mainly by communities with *Vaccinum* species (bilberry moors) and encroaching tree vegetation. The meadow desmid flora is presented along with the number of desmid species in Table 7. Only species in the marshes were taken into consideration (old wells, puddles, wet *Bryidae* mosses). Species occurring on roads were not considered since there was no such habitat type in Group II. In both groups, there were meadows in the upper and lower montane zones. Both groups had habitats with alkaline pH dominating. All of the meadows were in the Turbacz range. The Lubań range meadows were excluded because of the poverty of their flora. Table 8 lists the species identified in each group.

Sixty-six species were found in the Group I meadows. The number of species in each meadow ranged from 21 to 47 (mean 27.3, SD 6.9). Forty species were found in the Group II meadows. The number of species in each meadow ranged from 6 to 15 (mean 10.5, SD 1.1). Twenty-six Group I species were not identified in Group II meadows. All Group II species also appeared in Group I meadows.

These data make it clear that abandonment of meadow management (grazing and mowing) impoverishes the desmid species composition of marsh habitats. This is evident in a comparison of adjacent meadows belonging to different groups (Fig. 74). Group I contains a number of rare species such as *Cosmarium pokornyanum*, *Cosmarium pulcherrimum* and *Staurastrum merianii*. Group II is clearly dominated by common taxa.

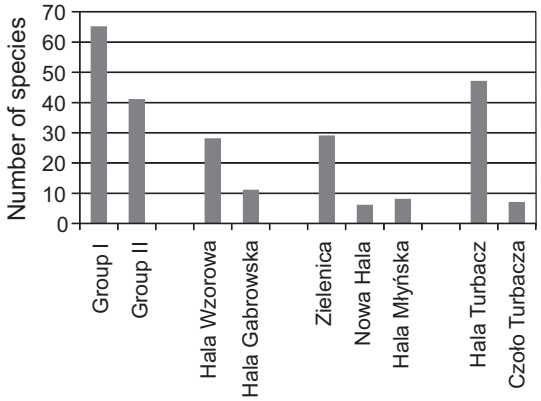

Figure 74. Comparison of desmid species diversity from neighboring mountain meadows from groups I and II.

In meadows, the desmids and vascular plants follow similar trends, but for different reasons. As succession advances after meadows are abandoned, it has been noted that vascular plant species of barren habitats begin to dominate, reflecting habitat depletion. Among the desmids in Group II meadows, there was a decrease in the share of species considered to be oligotrophic, oligo-mesotrophic and mesotrophic (Coesel 1982, 1983, 1985, 1991, 1994, 1997; Förster 1982), whereas among the desmids of Group I meadows, there was a significant increase in the share of species considered to be meso-eutrophic and eutrophic (Fig. 75). Abandonment of grazing does not necessarily mean a decrease in elements needed for desmids to live in marsh. They occupy depressions in the terrain into which biogens from the environment flow. The shading caused by burgeoning vegetation might be the factor behind the decrease in desmid species diversity.

Human activity in the Gorce Mts has contributed to an increase of desmid species diversity due to the creation of many new habitats such as roads, paths and ponds, and maintenance of semi-natural habitats (e.g., marshes in meadows). The human presence has helped increase the frequency of many desmid species. Unfortunately, it is impossible to state whether alien taxa have been introduced to the Gorce area. The negative impact of anthropopression on the desmid flora of the studied area is at the moment marginal and does not pose any major

Table 7. Number of desmid species occurring in particular meadows (for more information see text).

Group I	Number	Group II	Number
Długa Hala meadow	21	Bieniowe meadow	15
Dzigowa meadow	29	Czoło Turbacza meadow	7
Gorc Kamieniecki meadow	21	Gabrowska meadow	11
Hala Turbacz meadow	47	Hala Młyńska meadow	8
Jonkówki (Jankówki) meadow	17	Jaworzyna Kamieniecka meadow	14
Kułachowa meadow	23	Kosarzysko meadow	10
Pod Skały meadow	26	Polana Nowa meadow	6
Turbaczyk meadow	32	Przysłop meadow	11
Wzorowa meadow	28	Przysłop Górny meadow	15
Zielenica meadow	29	Średniak meadow	8

Table 8. List of desmid species occurring on meadows depending on the way they were used (for more information see the text).

Name of taxa	Group		Trophic status
	I	II	
Actinotaenium cruciferum	1	–	oligo
Actinotaenium cucurbita	1	–	oligo-mezo
Actinotaenium cucurbitinum	1	–	oligo-mezo
Actinotaenium diplosporum	1	1	mezo
Closterium acerosum	1	1	eu
Closterium ehrenbergii	1	1	eu
Closterium juncidum	1	1	mezo
Closterium kuetzingii	1	1	oligo-mezo
Closterium littorale	1	1	mezo
Closterium lunula	1	–	oligo-mezo
Closterium moniliferum	1	1	eu
Closterium navicula	1	–	oligo-mezo
Closterium parvulum	1	1	eu
Closterium praelongum	1	1	oligo-mezo
Closterium rostratum	1	1	oligo-mezo
Cosmarium anceps	1	1	?
Cosmarium annulatum	1	–	mezo
Cosmarium botrytis	1	1	mezo
Cosmarium caelatum	1	1	mezo
Cosmarium cyclicum	1	–	mezo
Cosmarium davidsonii	1	1	mezo
Cosmarium didymochondrum	1	1	mezo-eu
Cosmarium difficile	1	–	mezo
Cosmarium elegantissimum	1	–	mezo
Cosmarium formosulum	1	1	mezo-eu
Cosmarium galeritum	1	1	mezo
Cosmarium granatum	1	1	mezo
Cosmarium holigomiense var. *integrum*	1	1	mezo
Cosmarium hornavanense	1	1	mezo
Cosmarium impressulum	1	1	mezo
Cosmarium laeve	1	1	mezo-eu
Cosmarium nasutum	1	–	?
Cosmarium notabile	1	–	mezo
Cosmarium obtusatum	1	1	mezo-eu
Cosmarium ochthodes	1	1	mezo
Cosmarium pokornyanum	1	–	mezo
Cosmarium pseudopyramidatum	1	–	oligo
Co pulcherrimum	1	–	?
Cosmarium quadratum	1	1	mezo
Cosmarium quadratulum	1	–	mezo
Cosmarium regnellii	1	–	mezo-eu
Cosmarium reniforme	1	1	mezo-eu
Cosmarium speciosum	1	1	mezo
Cosmarium sportella	1	1	mezo
Cosmarium subcostatum	1	–	mezo
Cosmarium subcrenatum	1	1	mezo
Cosmarium subcucumis	1	1	mezo
Cosmarium subspeciosum	1	1	oligo-mezo
Cosmarium tatricum	1	–	mezo
Cosmarium tetragonum	1	1	?
Cosmarium tetraophthalmum	1	1	mezo
Cosmarium vexatum	1	1	mezo-eu
Cylindrocystis brebissonii	1	1	oligo
Euastrum subalpinum	1	–	oligo
Hyalotheca dissiliens	1	–	mezo
Mesotaenium degreyi	1	1	oligo
Netrium digitus	1	1	mezo
Pleurotaenium trabecula	1	–	mezo
Staurastrum margaritaceum	1	–	oligo
Staurastrum merianii	1	–	mezo
Staurastrum muricatum	1	–	oligo
Staurastrum pileolatum	1	–	?
Staurastrum polytrichum	1	1	mezo
Staurastrum punctulatum	1	1	oligo-mezo
Tetmemorus granulatus	1	–	mezo
Tetmemorus laevis	1	1	mezo
	66	40	

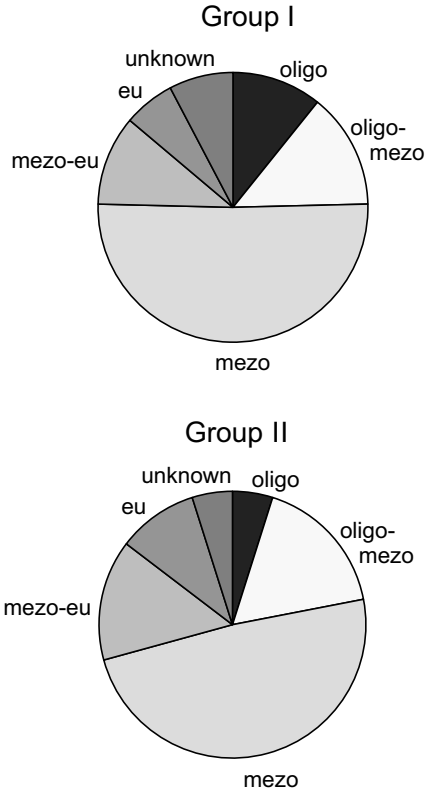

Figure 75. Percentage shares of species belonging to different trophic classes occurring in mountain meadows from groups I and II. oligo – species considered to be related to oligotrophic habitats, oligo-mezo – species considered to be related to oligotrophic and mesotrophic habitats, mezo – species considered to be related to mesotrophic habitats, mezo-eu – species considered to be related to mesotrophic and eutrophic habitats, eu – species considered to be related to eutrophic habitats.

risk to desmid species diversity. The situation is similar to that of the vascular plants. Moderate anthropopressure is contributing to an increase of species diversity.

Conclusions

1. In the Gorce Mountians, desmid species richness was greatest in moderately acidic and moderately alkaline habitats with pH 5.5–7.4, especially in polyhumic waterbodies and *Sphagnum* puddles.

2. A large number of the Gorce *Cosmarium* species prefer alkaline marsh habitats.

3. In total, 247 desmid species (~38% of Poland's desmid flora) were found in the Gorce Mts. The flora of this area is very similar to the desmid species composition of the Tatras and the Beskid Mts, and is clearly different from that of lowland areas of the Carpathian foreland. Thirty-eight species new for the Carpathians were recorded, 10 of which are taxa new for Poland.

4. Forty-four species considered by many authors to be related to mountains were found in the Gorce area. Most montane species were found in the Turbacz range, and most often in habitats associated with forest roads. The share of montane species did not increase with altitude.

5. Plant zones in the Gorce Mts differ in their desmid species composition. Species richness was greatest in the lower montane zone. There was no decrease in the number of species with altitude.

6. There are clear horizontal differences in the Gorce desmid flora. The Turbacz range has more species than the Lubań range, probably due to differences in climate. The floristic boundary between these ranges is the same as for vascular plants.

7. Humans have created new habitats for desmids in the Gorce Mts. The most important anthropogenic habitats are paths and forest roads, where a total of 157 species were found, 21 of which were found exclusively in anthropogenic habitats. Sheep husbandry has contributed to an increase in the species richness of the seminatural habitats associated with marshes.

Summary

Algae are often thought to be cosmopolitan organisms that always occur in waterbodies. At the beginning of the 20th century, however, Raciborski (1891) noted certain regularities in the geographical distribution of desmids.

The Gorce Mts, covering ~530 km^2 in the Western Carpathians, are relatively low; only 5% of the Gorce area rises above 1200 m a.s.l. Kornaś (1957) studied the occurrence of its vascular plants. I studied the occurrence of desmids there in 2000–2005. In many cases, the patterns I found were similar to those of Kornaś's vascular plants. For example, 247 desmid species were recorded in the study area, representing 37.9% of Poland's desmid flora. The share of Gorce vascular plant species in the Polish vascular plant flora is similar. In the Gorce Mts, the most numerous species are those that have only a few stations. They include species associated with peat bogs (e.g., *Cosmarium connatum*, *Micrasterias rotata*), planktonic species (e.g., *Staurastrum polymorphum*), species associated with mountains (e.g., *Euastrum montanum*) and species that are generally rare (e.g., *Cosmarium paragranatoides*). Many species that are common in Poland are rare or absent in the Gorce Mts. This situation is very similar to that of the vascular plants.

On the other hand, desmid species rarely reported from the Polish lowlands often occur in the Gorce area. As with vascular plants, these species may be widespread, but more frequent in the mountains. They include *Actinotaenium cucurbitinum*, *Cosmarium subcucumis* and species considered to be montane (e.g., *Closterium exile*, *Cosmarium tatricum*, *Euastrum subalpinum*). There are 43 montane species (17.7% of the Gorce desmid flora) in the Gorce Mts. They are primarily subaerophytic algae which are alkalophilic or tolerant to periodic habitat alkalization. Species previously known only from the Tatras were found in the study area, *Cosmarium tatricum* being one example. Much evidence indicates that the mountain and lowland desmid floras differ. Also observed in Poland is a northward decrease in the share of montane species, which is illustrated by the following vector: Tatras 18.3%, Gorce Mts 17.7%, Beskid Makowski Mts 9%, Lublin Upland (surroundings of Międzyrzec Podlaski) 4.7%, Mazowian Lowland (surroundings of Warsaw) 2.5%, surroundings of Wigry Lake 0.9%.

Vascular plant zones play an important role in the distribution of vascular plants in the mountains. I was able to confirm the same phenomenon in desmids. The mechanism of it in the studied area seems to involve the fact that the desmids use two sources of water: water flowing from the orogen, which has alkaline pH and high ionic strength, and water from precipitation, which has acidic pH (especially after filtration through the soil) and low ionic strength. Total precipitation increases with altitude (Ochotnica, 700 mm at 600 m a.s.l.; Turbacz, 1220 mm at 1310 m a.s.l.), and with it the water's acidicity increases and ionic strength decreases. Consequently, often found at higher stations are acidophilic species resistant to alkalization (in periods of drought, conditions are periodically alkaline), species with a wide habitat spectrum, and alkalophilic species resistant to periodic acidification; lower montane zones seem to be preferred by species sensitive to acidification. Three desmid species were found in the foothill zone, 238 in the lower montane zone and 126 in the upper montane zone. It should be mentioned here that the upper montane zone covers the smallest area. The high richness of this zone is probably due to its water availability (high total precipitation).

For vascular plants, Kornaś distinguished two geobotanical sections in the Gorce area: the Turbacz range, characterized by a high share of montane species; and the Lubań range, characterized by a larger share of thermophilous species. The border between these two sections runs roughly through Przełęcz Knurowska pass, Jaworzyna Kamieniecka peak, Gorc Kamieniecki peak and Twarogi peak. For desmids, the situation is similar. Montane species represent ~19% of the desmid flora in the Turbacz range, and ~13% in the Lubań range. There are a number of species that clearly prefer the Turbacz range. The boundary between these units runs in a similar way, probably because the Lubań range is in the rain shadow of the Turbacz range and therefore its water availability is lower. There were no species that prefer the Lubań range and most algae avoid xerothermic habitats. An important factor affecting the biodiversity of desmids in the Gorce area is human activity. In typically anthropogenic habitats, which in the study area include roads and paths, 157 species were found (63.7% of the Gorce desmid flora). Many montane species, such as *Closterium pusillum* and *Cosmarium decedens*, associated with wet moss on rocks, had secondary habitats there. A group of 21 species found only in anthropogenic habitats can be considered anthropophytes of the studied area. There are also semi-natural habitats in the form of meadows that can persist only due to human activity. The situation is similar to that of vascular plants. Clearings used until the 1980s showed significantly higher species richness than clearings where grazing has been abandoned for a long time. Overall, human activity has contributed to an increase of desmid species diversity in the Gorce region

Acknowledgments

The author is especially grateful to Dr. Grażyna Tomaszewicz of the University of Warsaw for her time and help in the determination of desmids, and to Prof. dr. hab. Konrad Wołowski for his help and time devoted to finalizing this work. He also

expresses sincere thanks to Dr. Magdalena Solarska and Msc. Agata Łukaszek for preparing the first version of the English text, to Michael Jacobs for line-editing parts of the final English version of the manuscript, to Msc. Elżbieta Nowotarska for preparation of hand-drawings for all reported taxa from the Gorce Mts, and to the team of the IB PAS Publishing House for constant friendly assistance during graphic typesetting. The work was developed in the Department of Plant Taxonomy and Phytogeography of the Jagiellonian University. It was supported in part by internal grants from the Institute of Botany of the Jagiellonian University, and additionally, in the final phase of preparation for printing by an anonymous sponsor.

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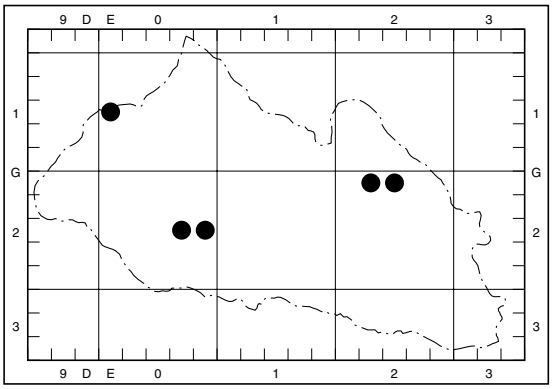
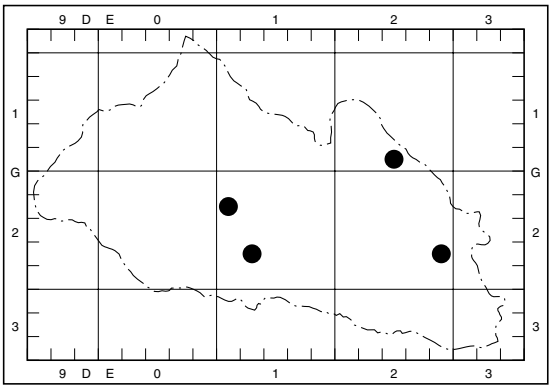
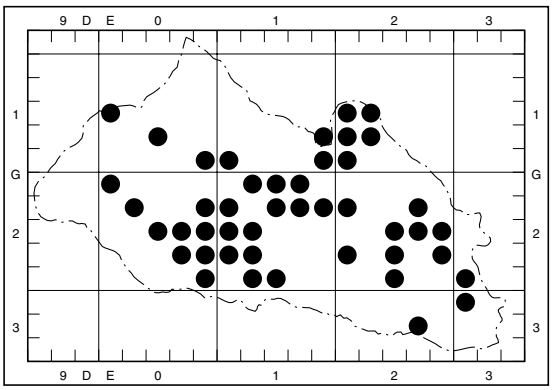
Appendix 1. Distribution of desmids species in the Gorce Mts.



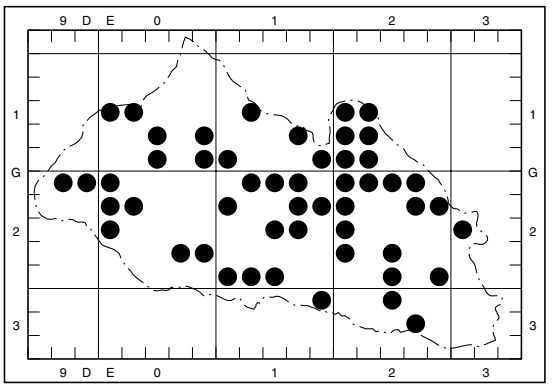
Map 1. *Actinotaenium borgeanum* (Skuja) Kouwets et Coesel



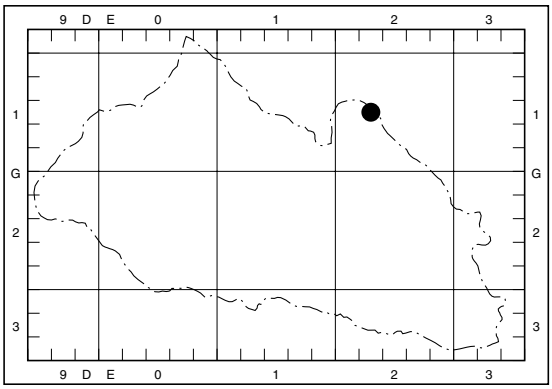
Map 2. *Actinotaenium cruciferum* (de Bary) Teiling



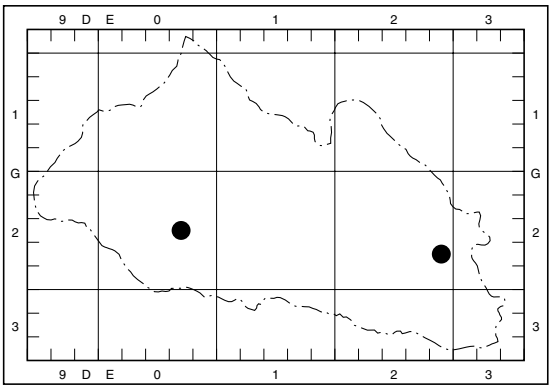
Map 3. *Actinotaenium cucurbita* (Brébisson ex Ralfs) Teiling



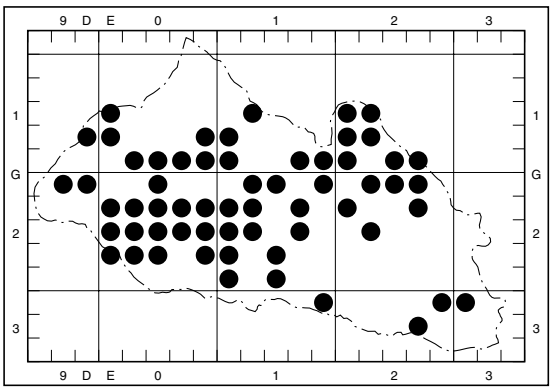
Map 4. *Actinotaenium cucurbitinum* (Bisset) Teiling



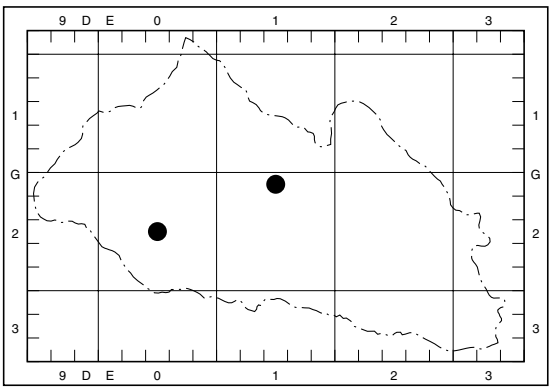
Map 5. *Actinotaenium curtum* (Brébisson ex Ralfs) Teiling



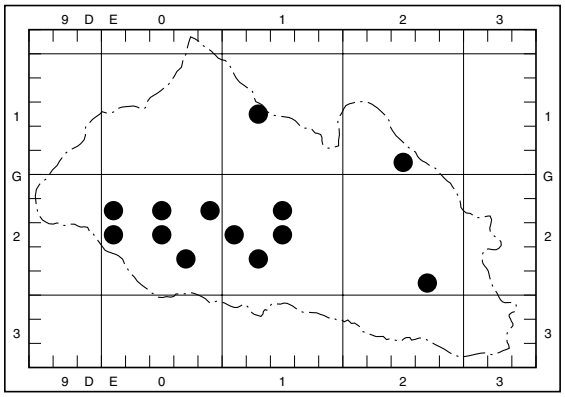
Map 6. *Actinotaenium didymocarpum* (P. Lundell) Coesel et Delfos



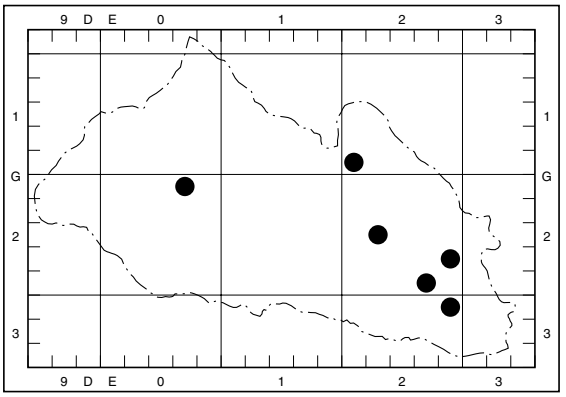
Map 7. *Actinotaenium diplosporum* (P. Lundell) Teiling



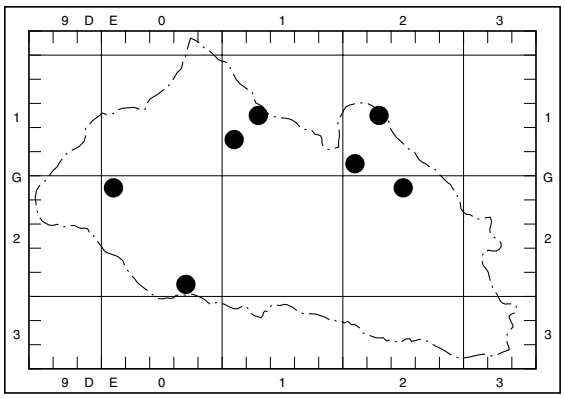
Map 8. *Actinotaenium gelidum* (Wittrock ex De Toni) Růžička



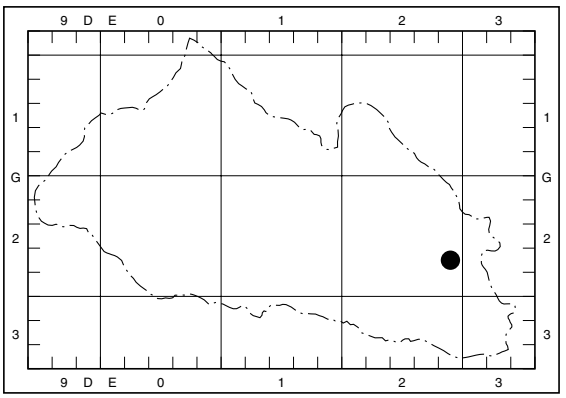
Map 9. *Actinotaenium perminutum* (G. S. West) Teiling



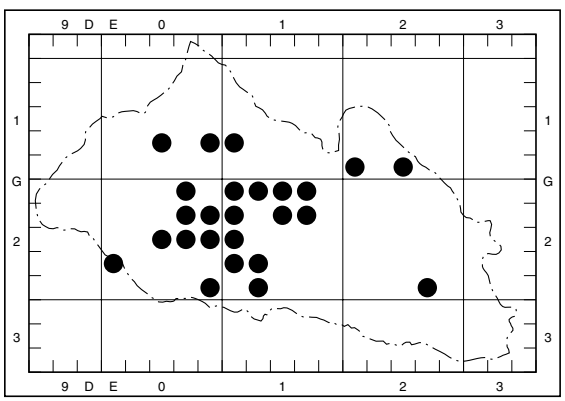
Map 10. *Actinotaenium silvae-nigrae* (Rabanus) Kouwets et Coesel



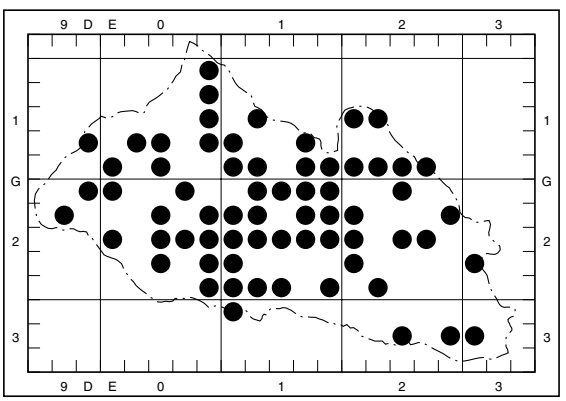
Map 11. *Actinotaenium spinospermum* (Joshua) Kouwets et Coesel



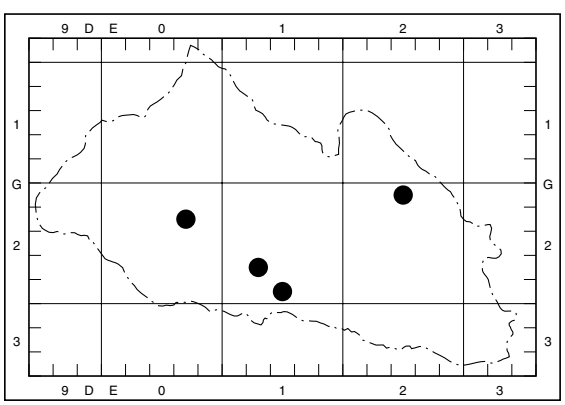
Map 12. *Actinotaenium turgidum* (Brébisson ex Ralfs) Teiling



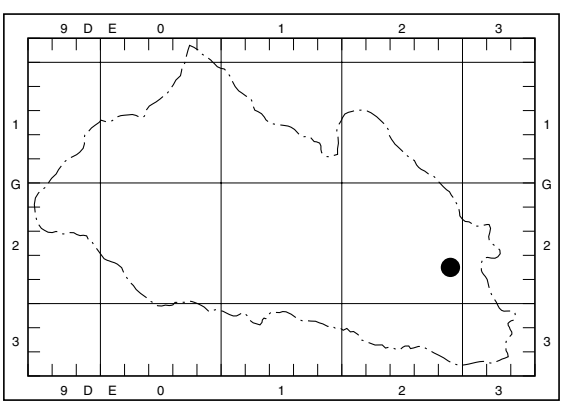
Map 13. *Closterium abruptum* West



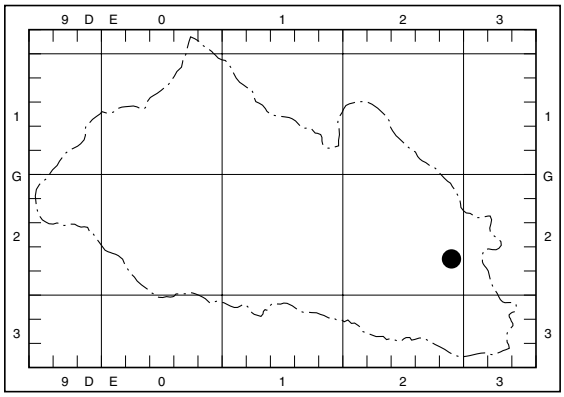
Map 14. *Closterium acerosum* Ehrenberg ex Ralfs



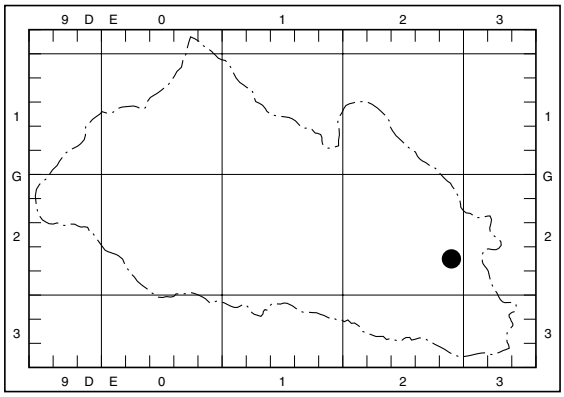
Map 15. *Closterium acutum* Brébisson ex Ralfs



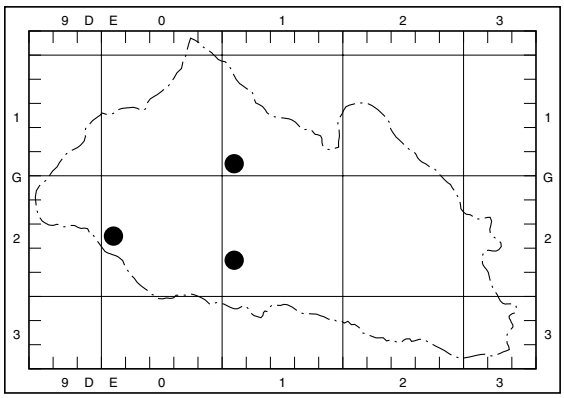
Map 16. *Closterium baillyanum* (Brébisson ex Ralfs) Brébisson



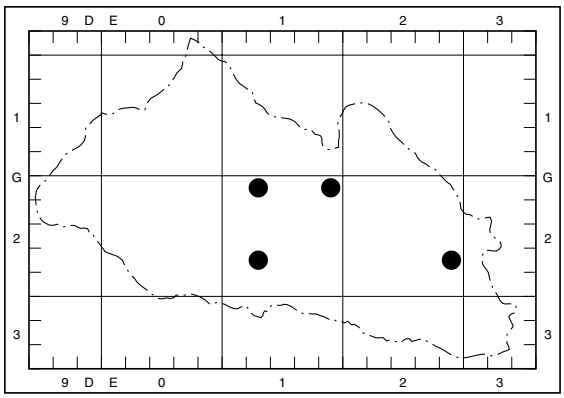
Map 17. *Closterium calosporum* Wittrock



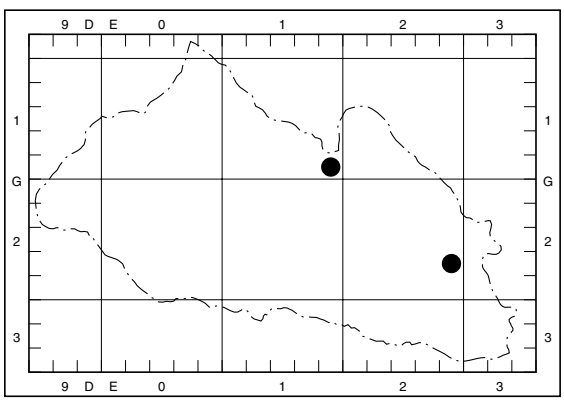
Map 18. *Closterium closterioides* (Ralfs) A. Louis et Peeters



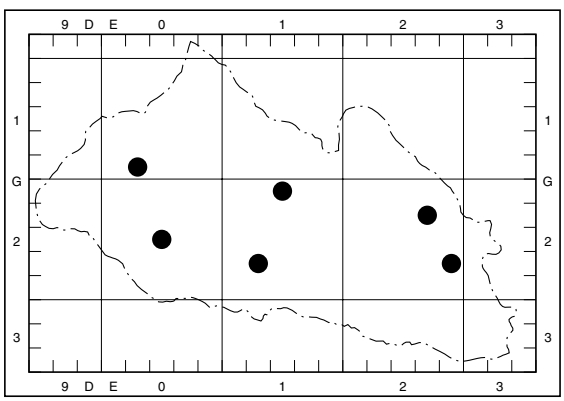
Map 19. *Closterium cornu* Ehrenberg ex Ralfs



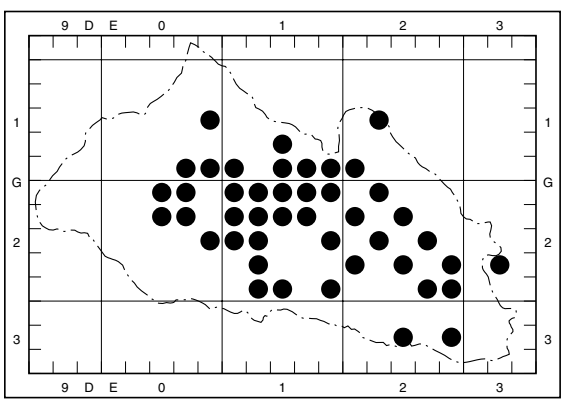
Map 20. *Closterium costatum* Corda ex Ralfs



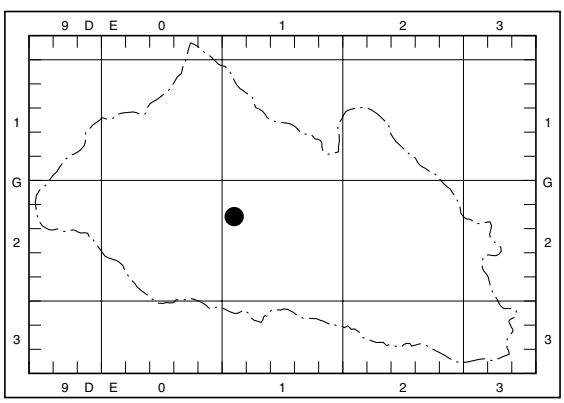
Map 21. *Closterium cynthia* De Notaris



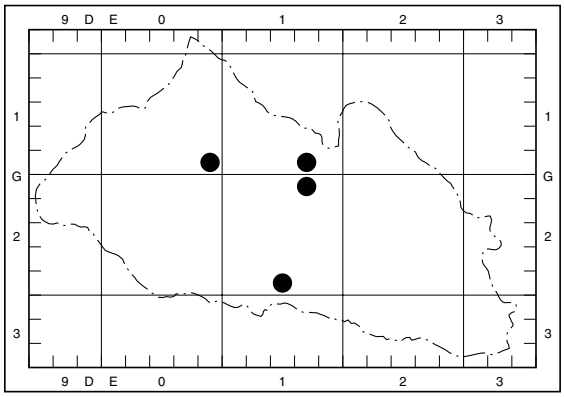
Map 22. *Closterium dianae* Ehrenberg ex Ralfs



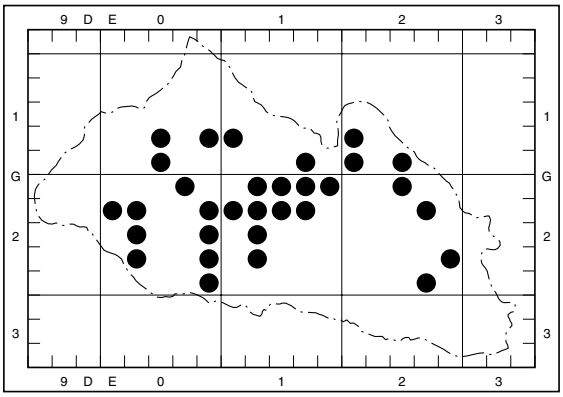
Map 23. *Closterium ehrenbergii* Meneghini ex Ralfs



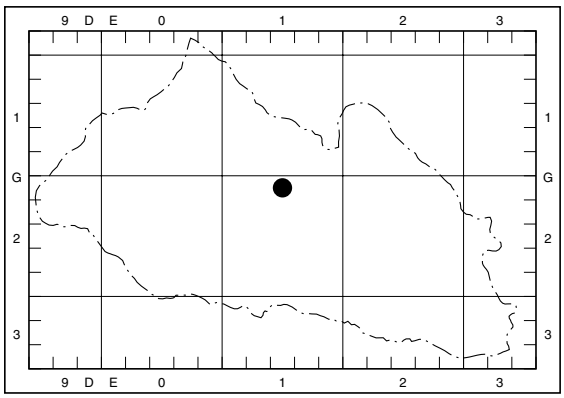
Map 24. *Closterium exile* West. et G. S. West



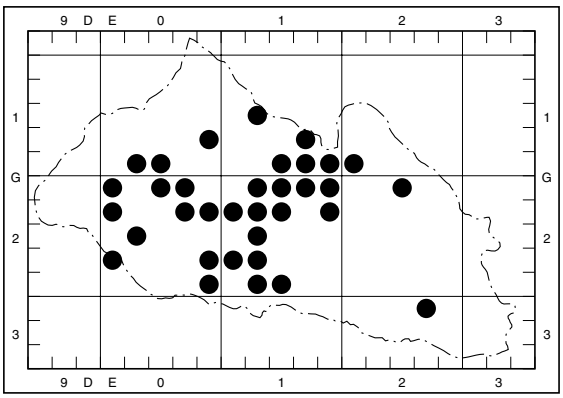
Map 25. *Closterium idiosporum* West. et G. S. West



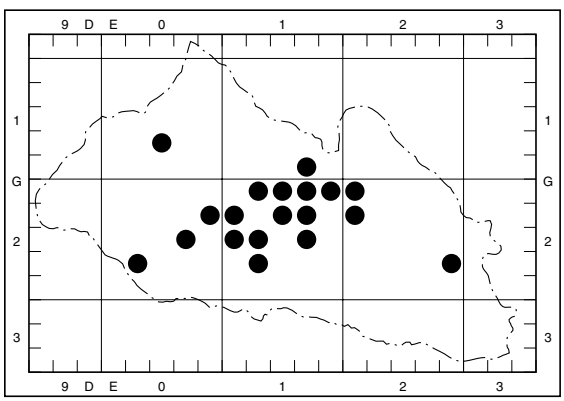
Map 26. *Closterium intermedium* Ralfs



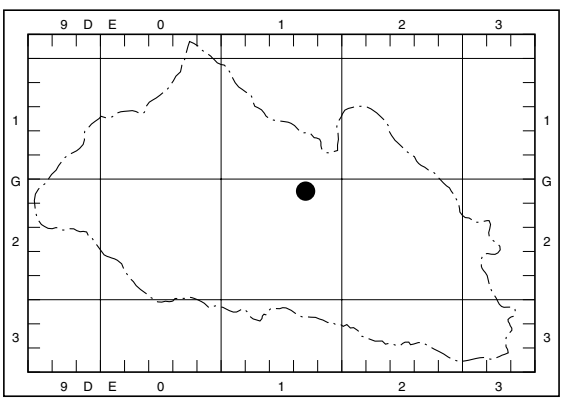
Map 27. *Closterium jenneri* Ralfs



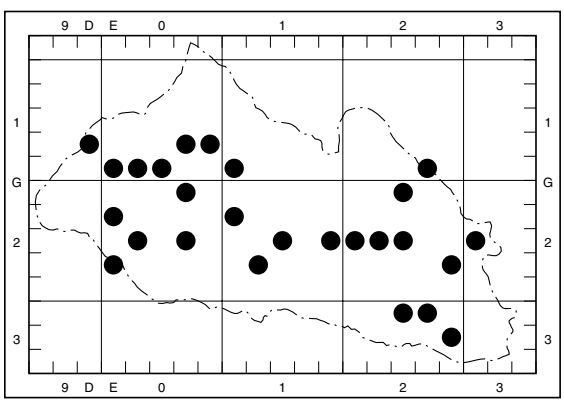
Map 28. *Closterium juncidum* Ralfs



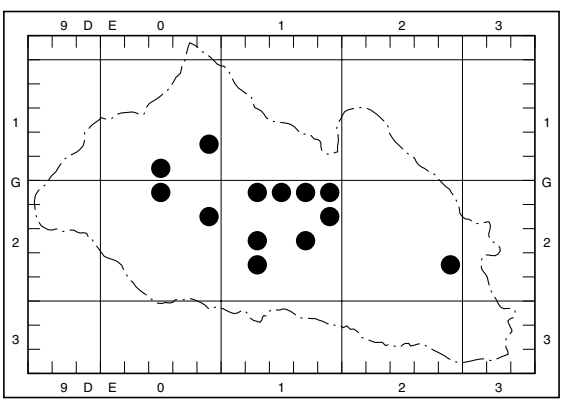
Map 29. *Closterium kuetzingii* Brébisson



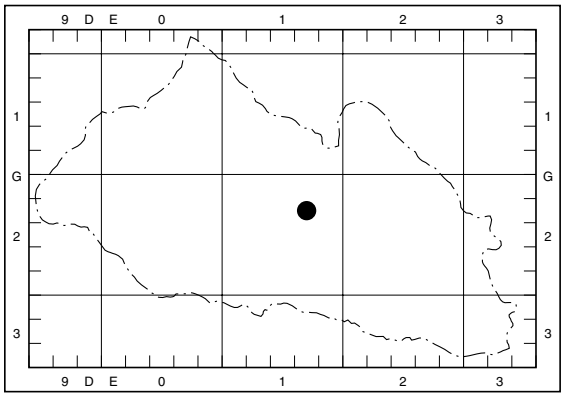
Map 30. *Closterium lineatum* Ehrenberg ex Ralfs



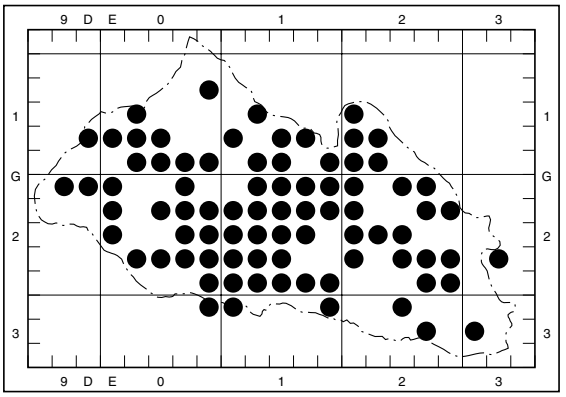
Map 31. *Closterium littorale* F. Gay



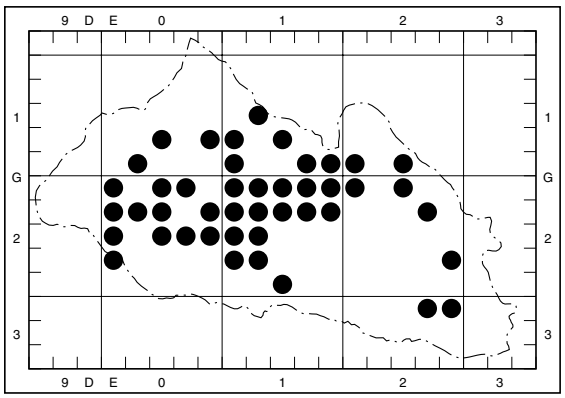
Map 32. *Closterium lunula* Ehrenberg et Hemprich ex Ralfs



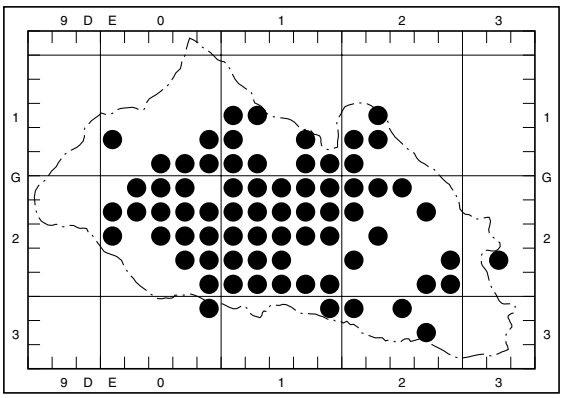
Map 33. *Closterium macilentum* Brébisson



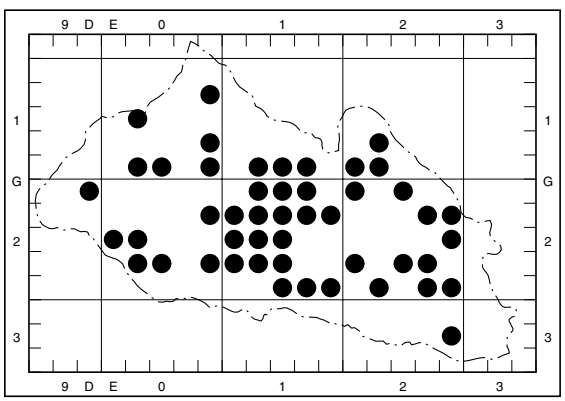
Map 34. *Closterium moniliferum* Ehrenberg ex Brébisson



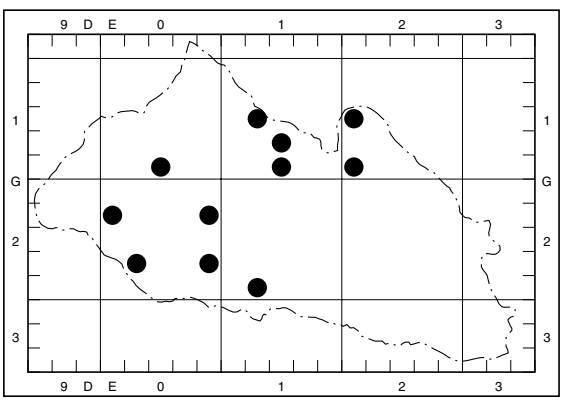
Map 35. *Closterium navicula* (Brébisson) Lütkemüller



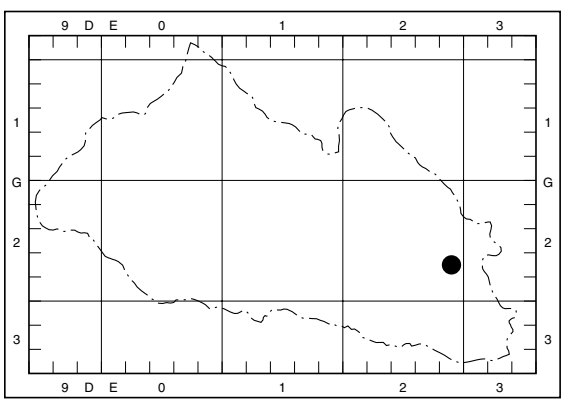
Map 36. *Closterium parvulum* Nägeli



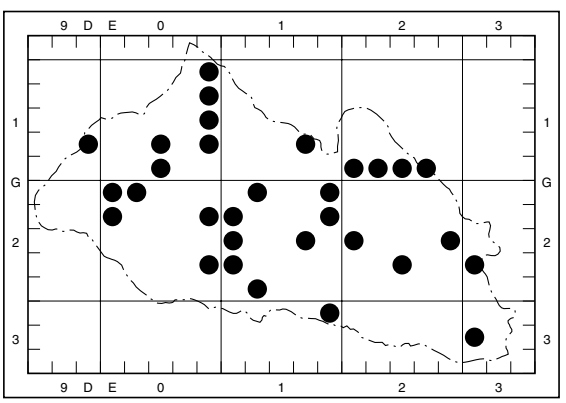
Map 37. *Closterium praelongum* Brébisson



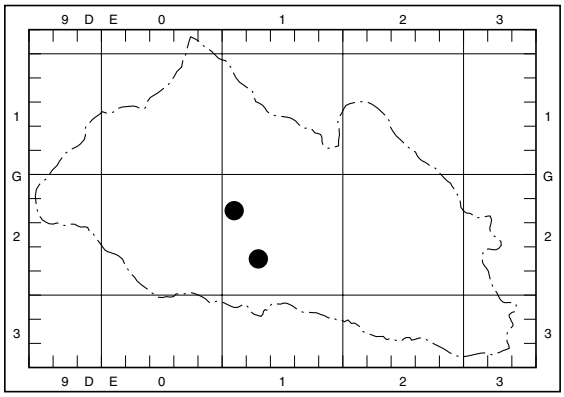
Map 38. *Closterium pritchardianum* W. Archer



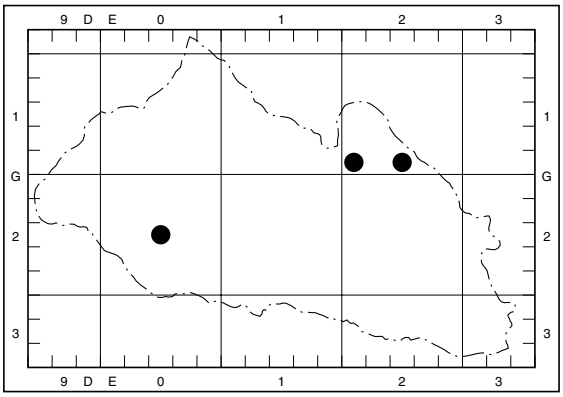
Map 39. *Closterium pronum* Brébisson



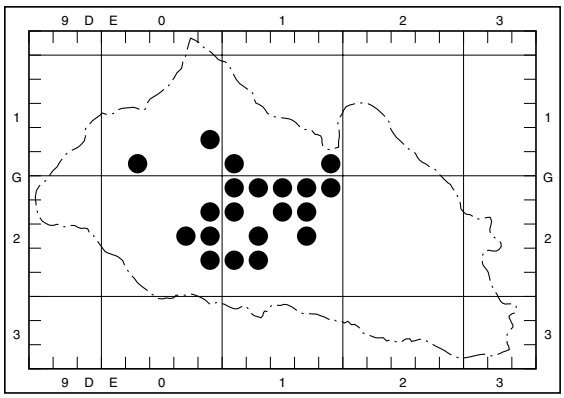
Map 40. *Closterium pseudolunula* Borge



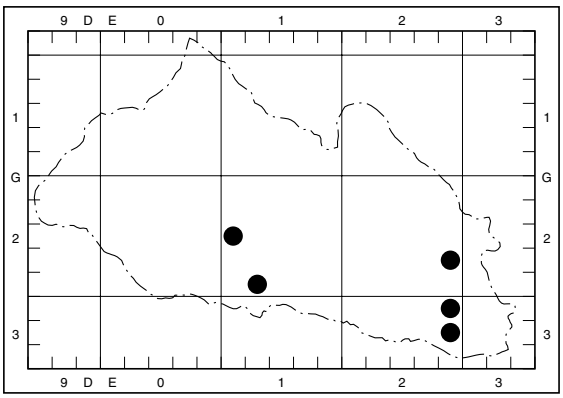
Map 41. *Closterium pusillum* Hantzsch



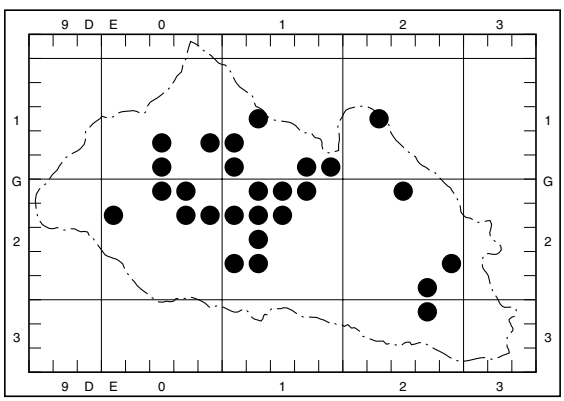
Map 42. *Closterium pygmaeum* Gutwiński



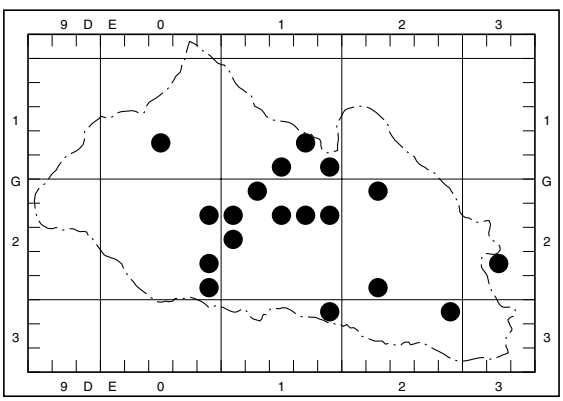
Map 43. *Closterium rostratum* Ehrenberg ex Ralfs



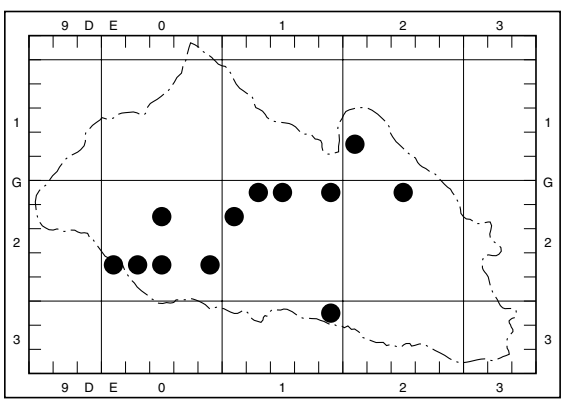
Map 44. *Closterium strigosum* Brébisson



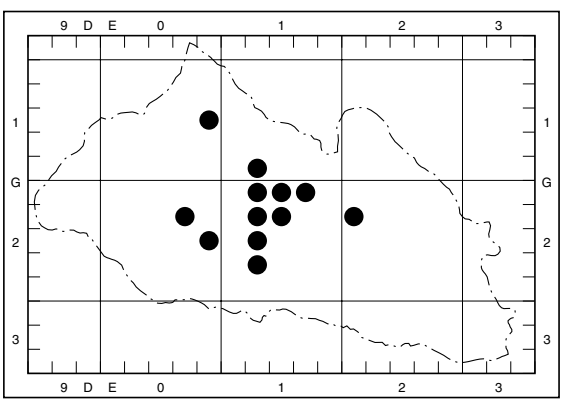
Map 45. *Closterium striolatum* Ehrenberg ex Ralfs



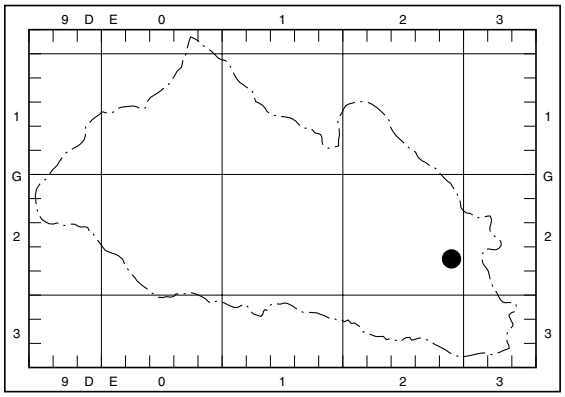
Map 46. *Closterium sublaterale* Růžička



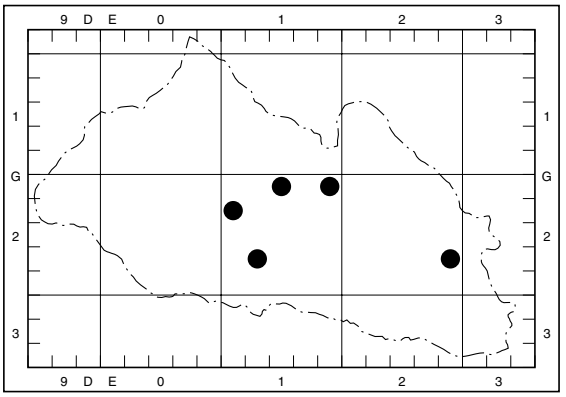
Map 47. *Closterium tumidulum* F. Gay



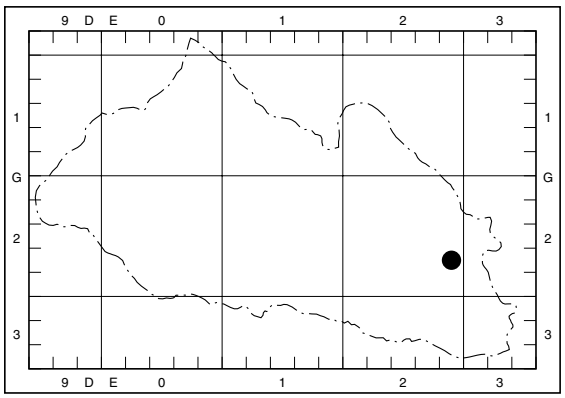
Map 48. *Closterium tumidum* L. N. Johnson



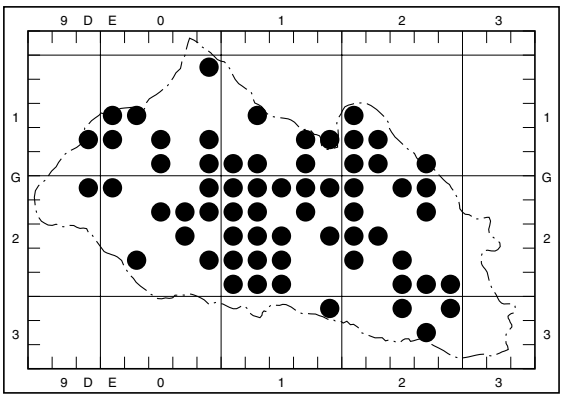
Map 49. *Closterium turgidum* Ehrenberg ex Ralfs



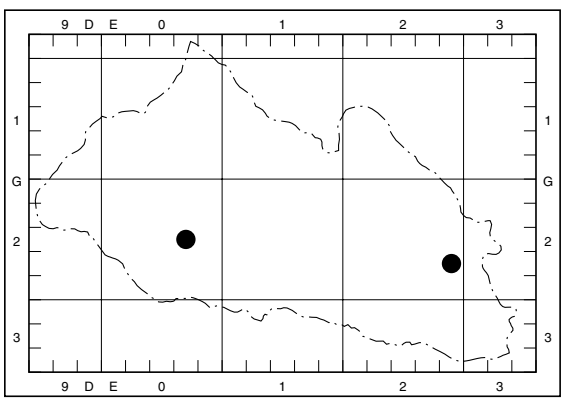
Map 50. *Closterium venus* Kützing ex Ralfs



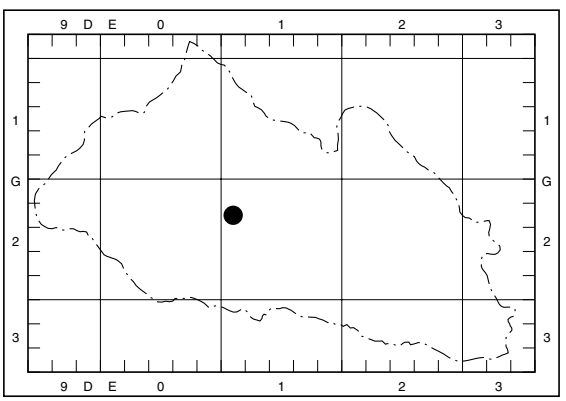
Map 51. *Cosmarium alpestre* J. Roy et Bisset



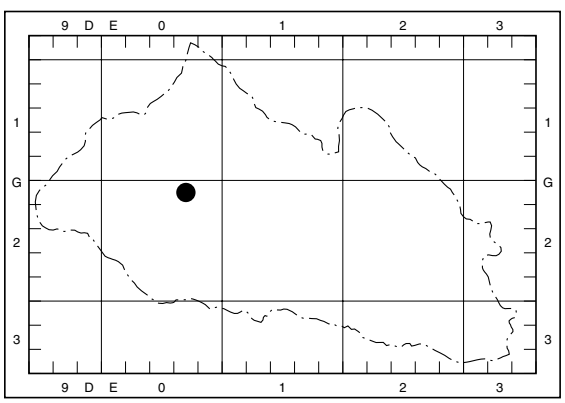
Map 52. *Cosmarium anceps* P. Lundell



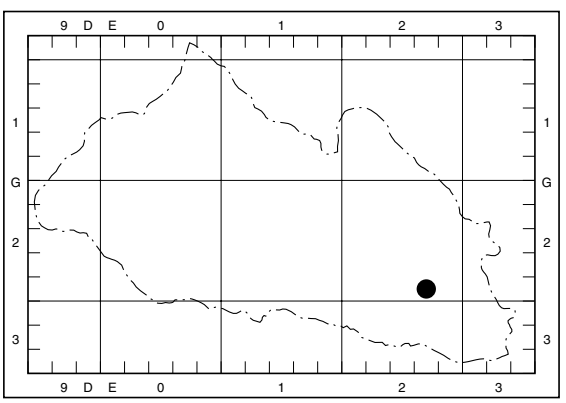
Map 53. *Cosmarium angulosum* Brébisson



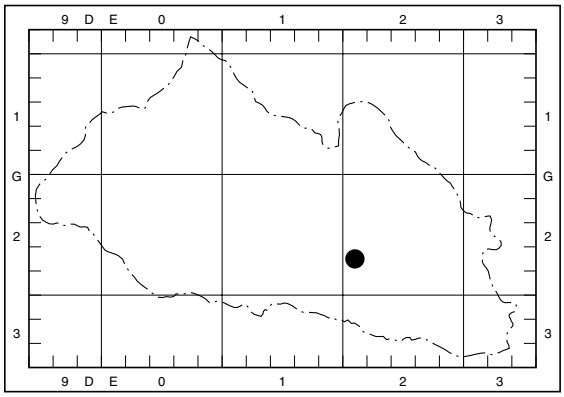
Map 54. *Cosmarium annulatum* (Nägeli) de Bary



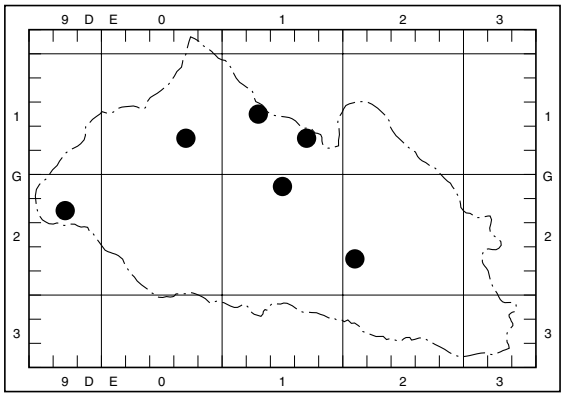
Map 55. *Cosmarium arctoum* Nordstedt



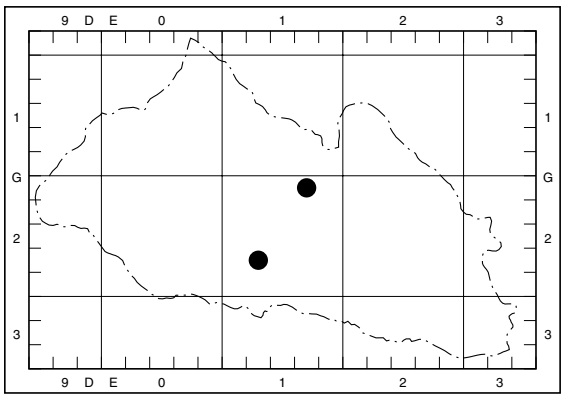
Map 56. *Cosmarium asphaerosporum* Wittrock



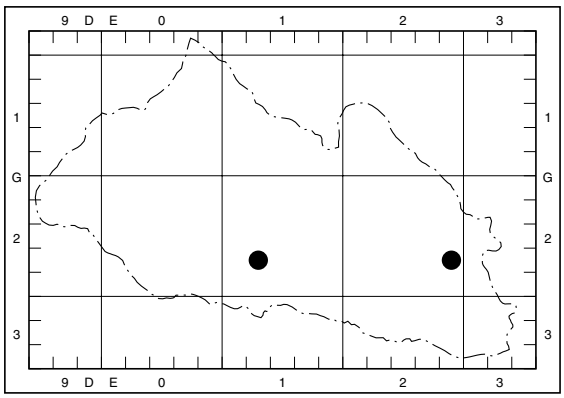
Map 57. *Cosmarium bioculatum* Brébisson ex Ralfs



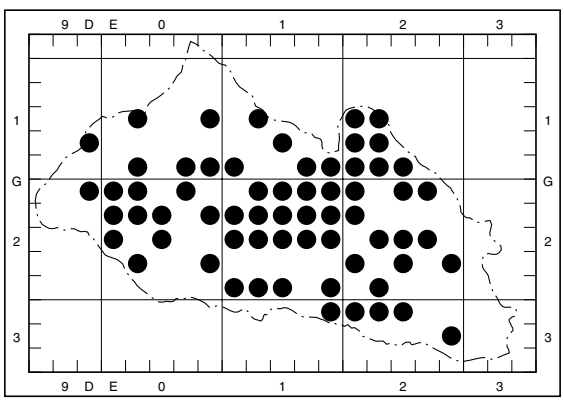
Map 58. *Cosmarium biretum* Brébisson ex Ralfs



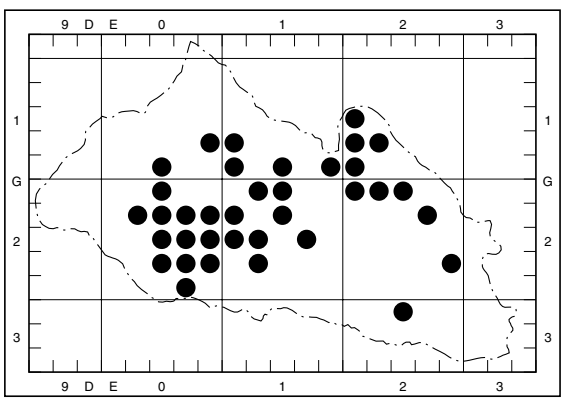
Map 59. *Cosmarium blyttii* Wille



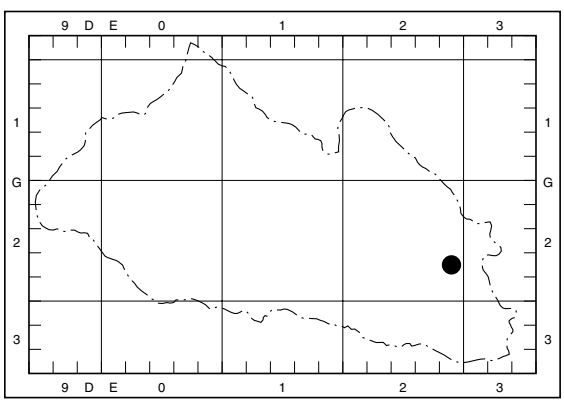
Map 60. *Cosmarium boeckii* Wille



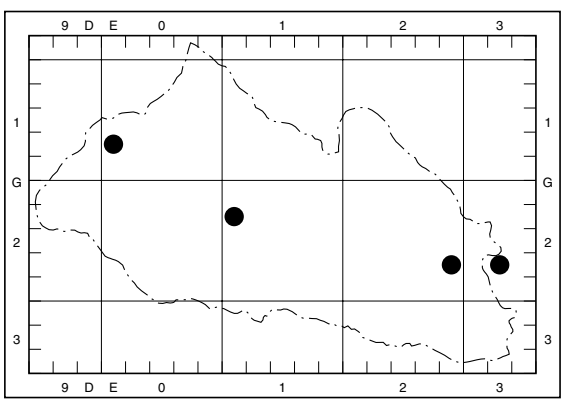
Map 61. *Cosmarium botrytis* (Meneghini ex Ralfs



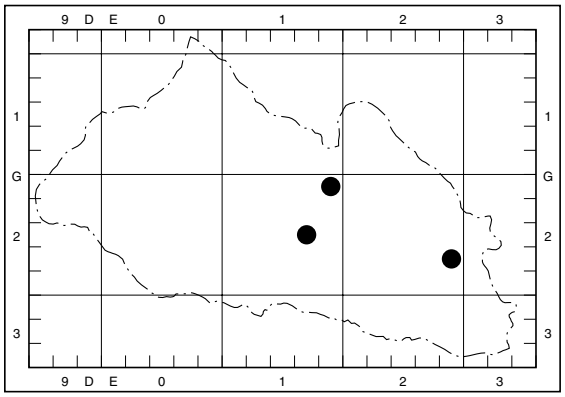
Map 62. *Cosmarium caelatum* Ralfs



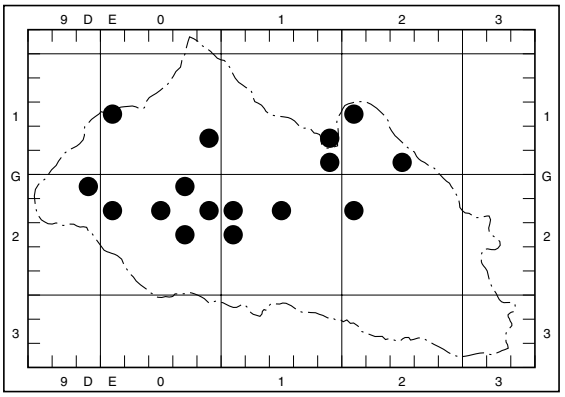
Map 63. *Cosmarium connatum* Brébisson ex Ralfs



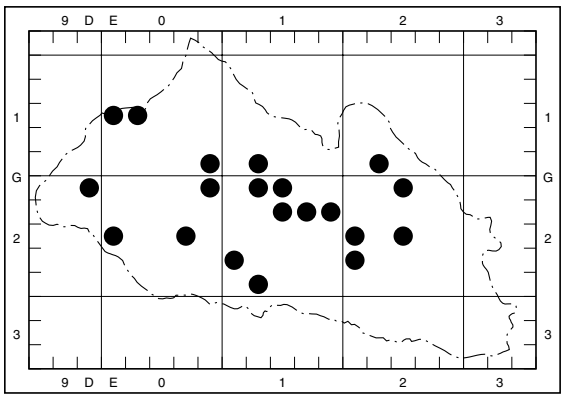
Map 64. *Cosmarium conspersum* Ralfs



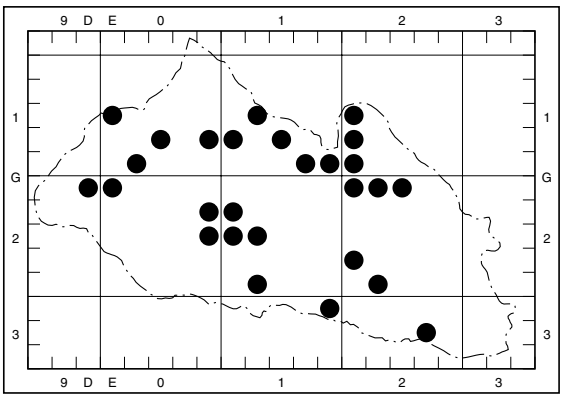
Map 65. *Cosmarium contractum* O. Kirchner



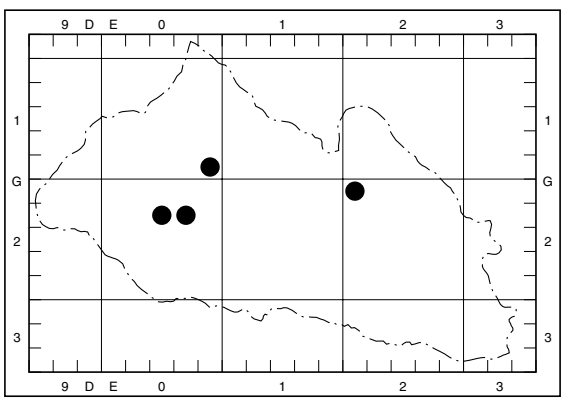
Map 66. *Cosmarium costatum* Nodstedt



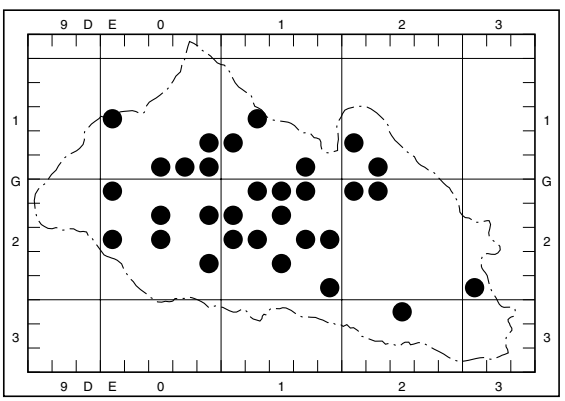
Map 67. *Cosmarium crenatum* Ralfs ex Ralfs



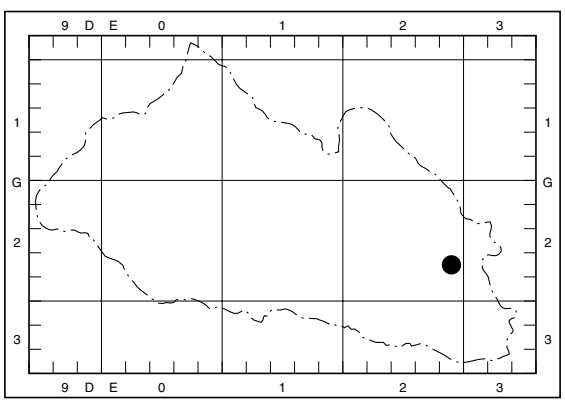
Map 68. *Cosmarium cyclicum* P. Lundell



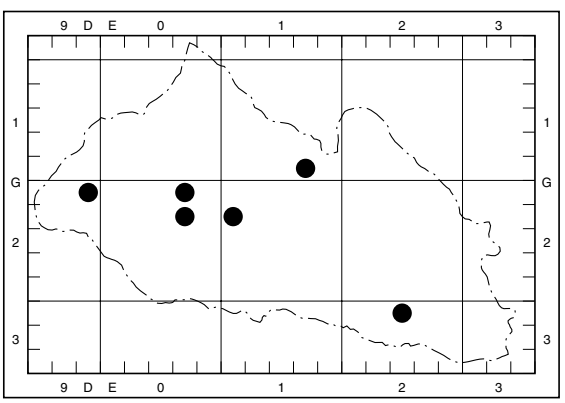
Map 69. *Cosmarium cymatopleurum* Nordstedt



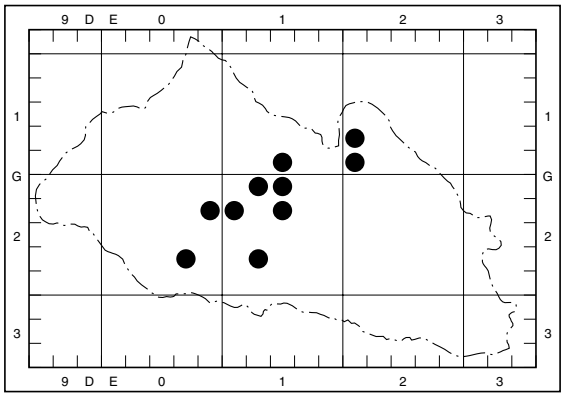
Map 70. *Cosmarium davidsonii* R. Roy et Bisset



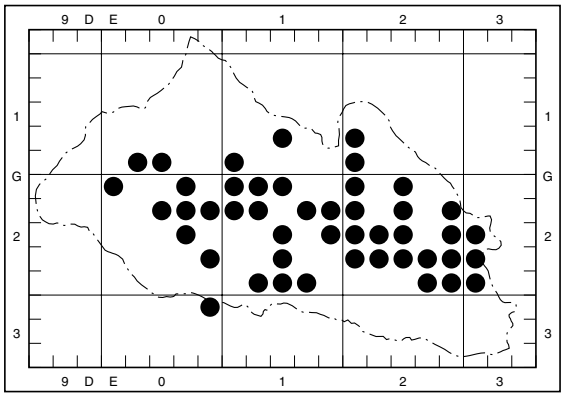
Map 71. *Cosmarium debaryi* W. Archer



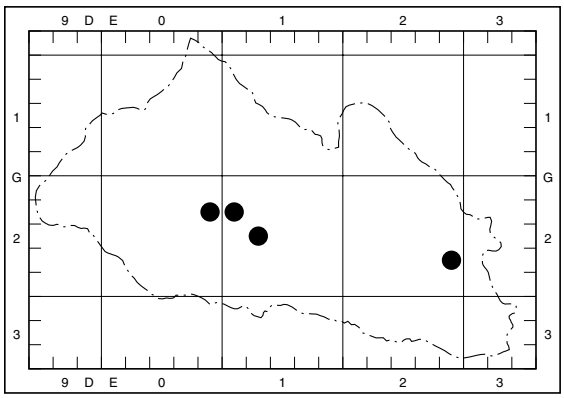
Map 72. *Cosmarium decedens* (Reinsch) Raciborski



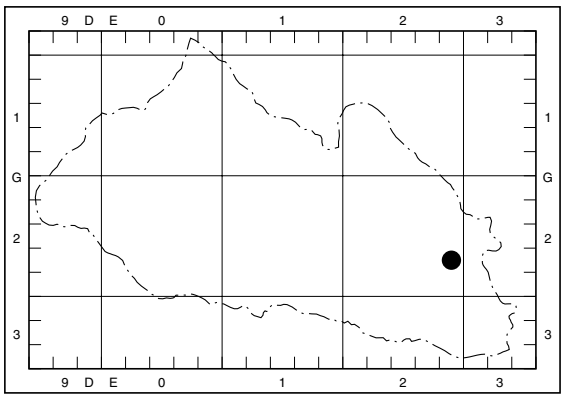
Map 73. *Cosmarium dentiferum* Corda ex Nordstedt



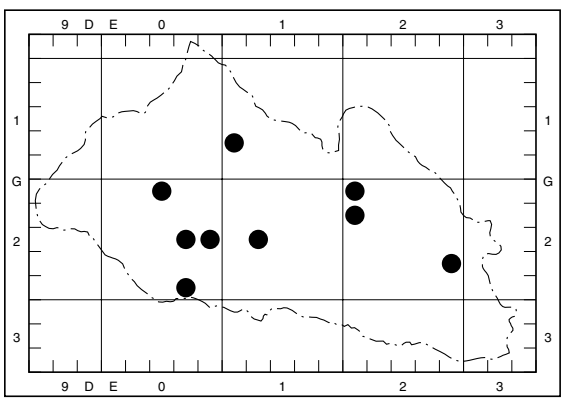
Map 74. *Cosmarium didymochondrum* Nordstedt



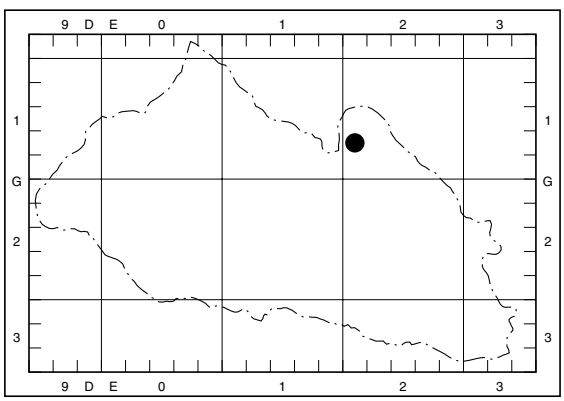
Map 75. *Cosmarium difficile* Lütkemüller



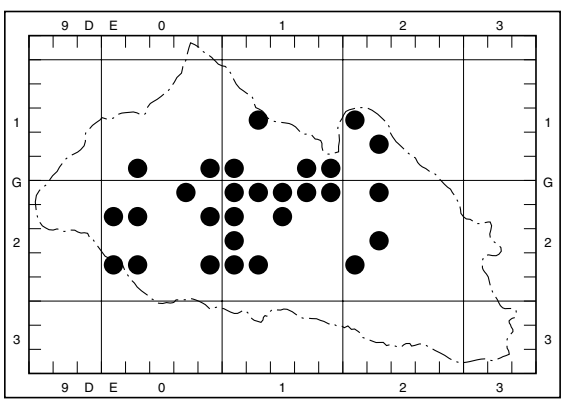
Map 76. *Cosmarium dispersum* L. N. Johnson



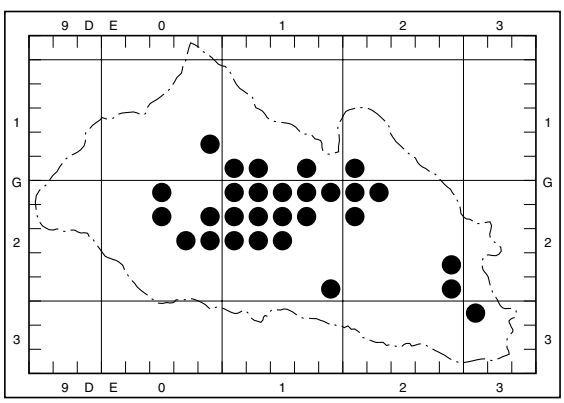
Map 77. *Cosmarium elegantissimum* P. Lundell



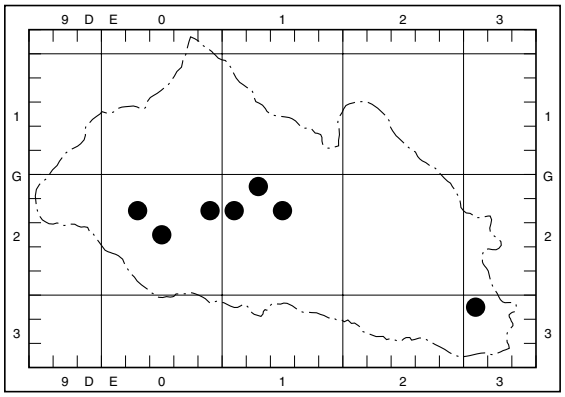
Map 78. *Cosmarium exiguum* W. Archer



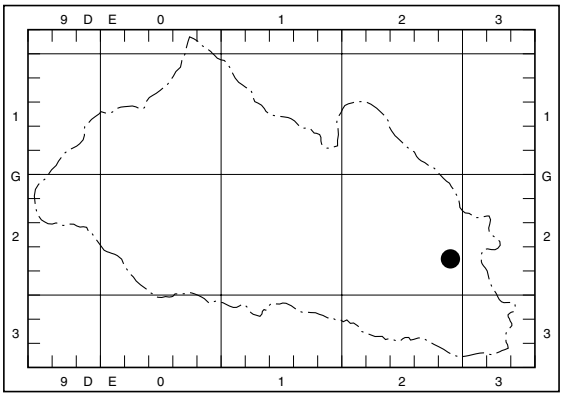
Map 79. *Cosmarium formosulum* Hoff



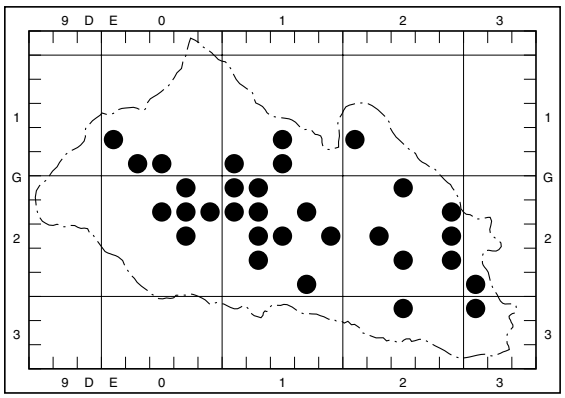
Map 80. *Cosmarium galeritum* Nordstedt



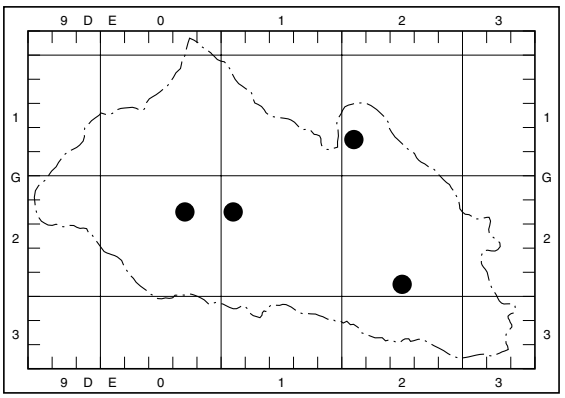
Map 81. *Cosmarium garrolense* J. Roy et Bisset



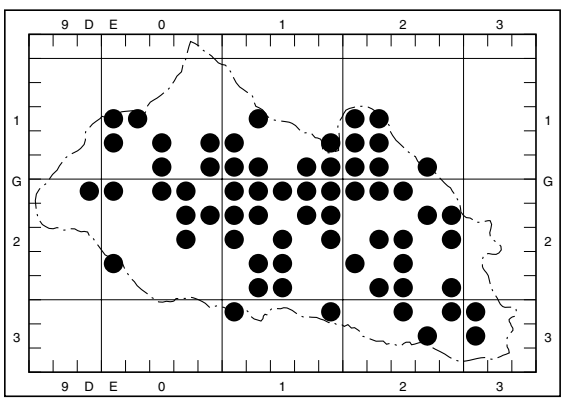
Map 82. *Cosmarium gonioides* West. et G. S. West



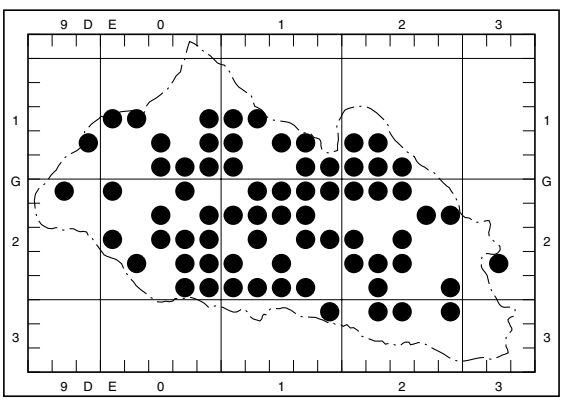
Map 83. *Cosmarium granatum* Brébisson. ex Ralfs



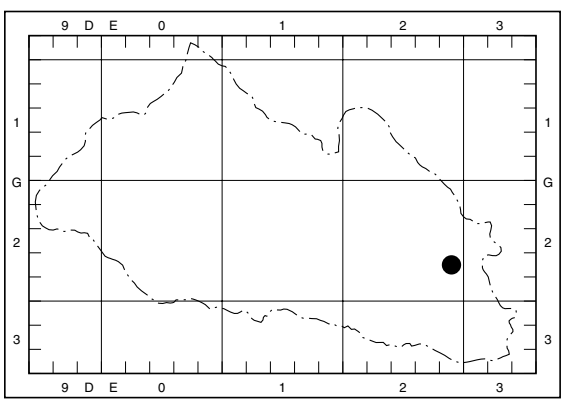
Map 84. *Cosmarium hammeri* Reinsch



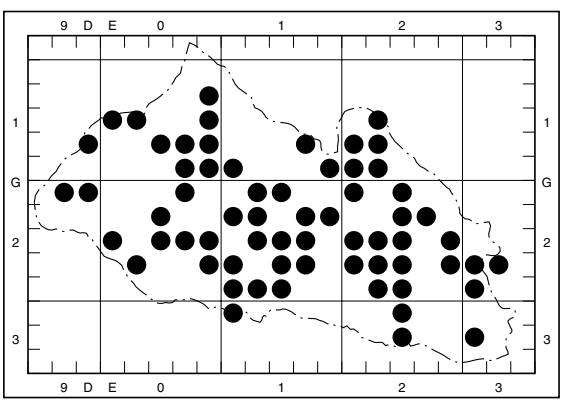
Map 85. *Cosmarium holmiense* P. Lundell



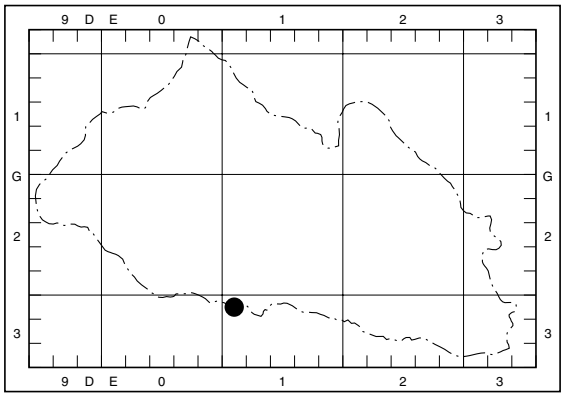
Map 86. *Cosmarium hornavanense* Gutwiński



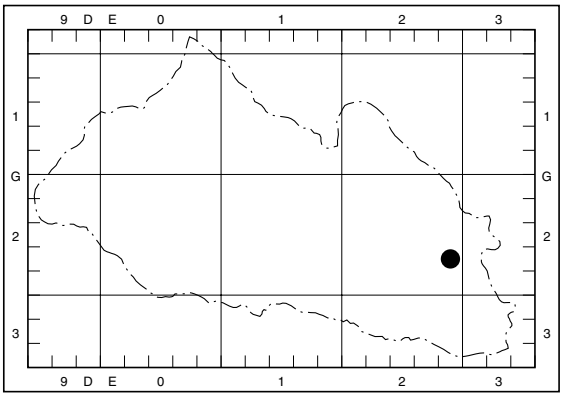
Map 87. *Cosmarium humile* Nordstedt in De Toni



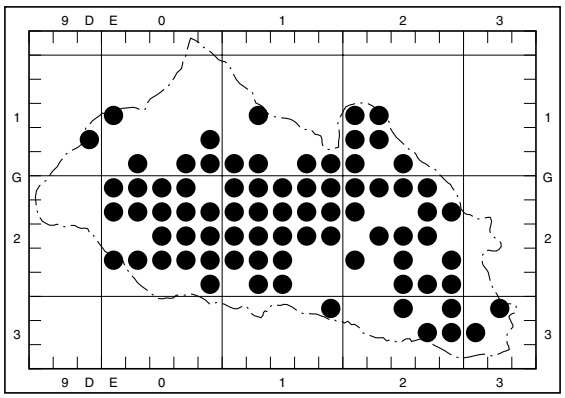
Map 88. *Cosmarium impressulum* Elfving



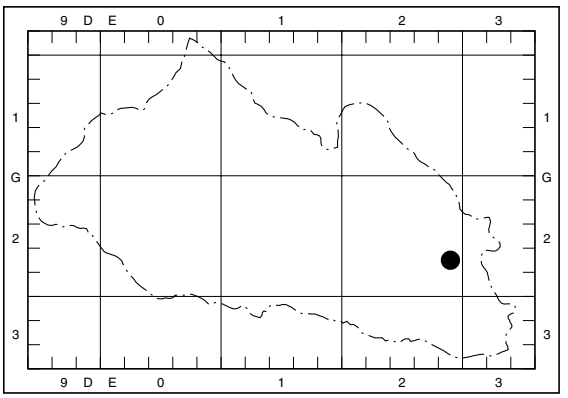
Map 89. *Cosmarium impressulum* var. *crenulatum* (Nägeli) Willi Krieger & Gerloff



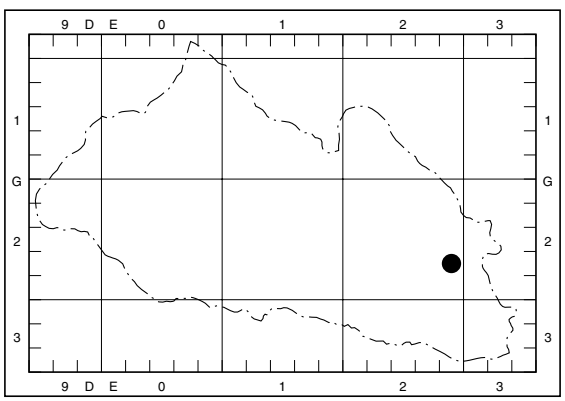
Map 90. *Cosmarium jenisejense* Boldt



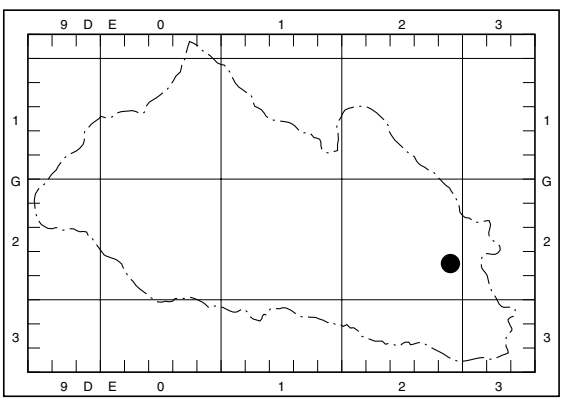
Map 91. *Cosmarium laeve* Rabenhorst



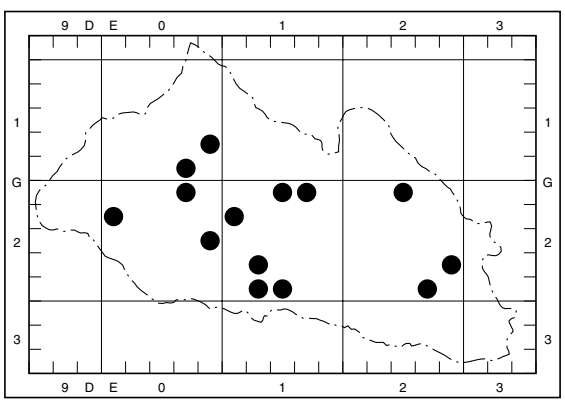
Map 92. *Cosmarium limnophilum* Schmidle



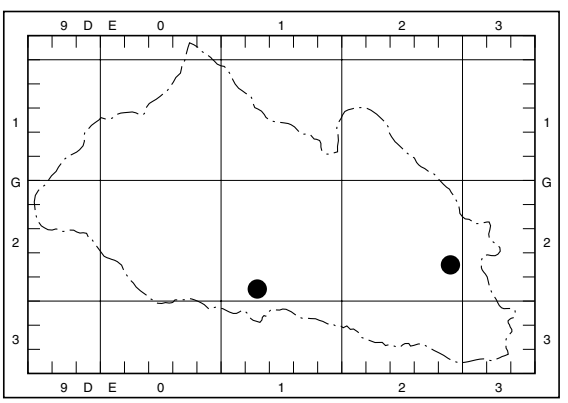
Map 93. *Cosmarium majae* Strøm



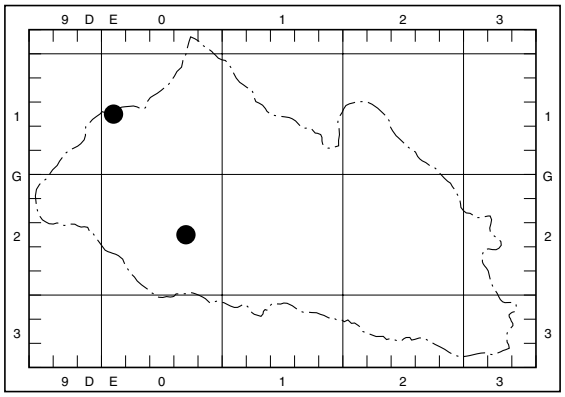
Map 94. *Cosmarium margaritatum* (P. Lundell) J. Roy et Bisset



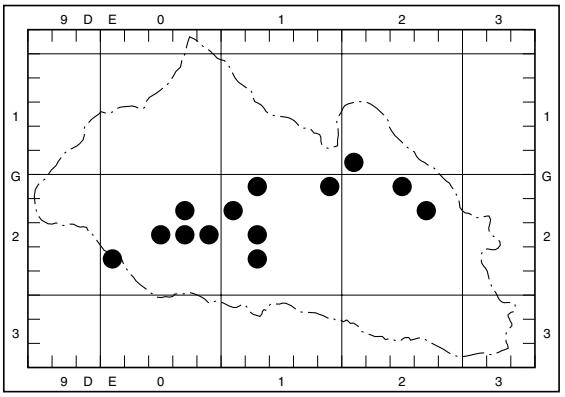
Map 95. *Cosmarium margaritiferum* Meneghini ex Ralfs



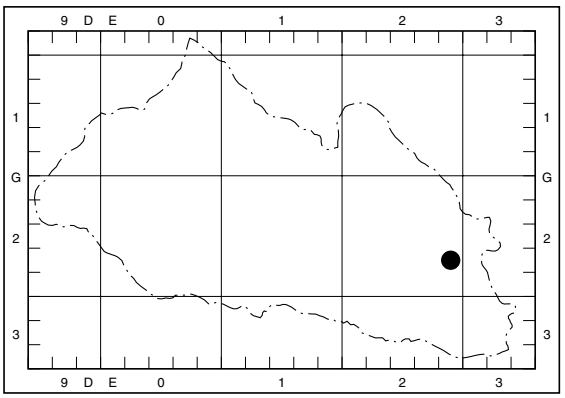
Map 96. *Cosmarium meneghinii* Brébisson ex Ralfs



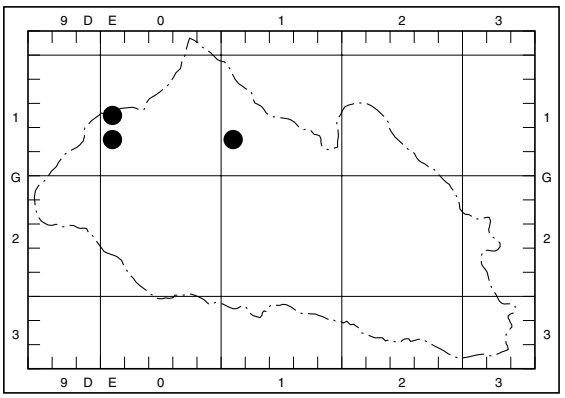
Map 97. *Cosmarium microsphinctum* Nordstedt



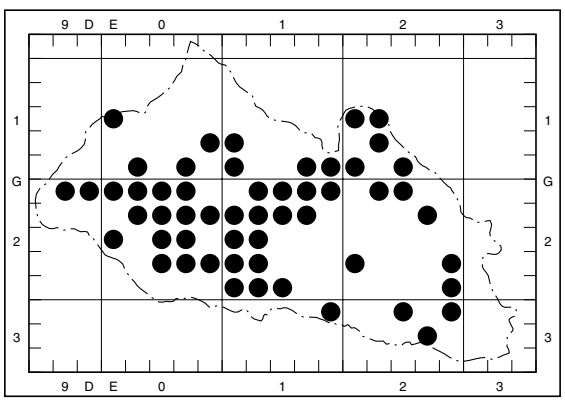
Map 98. *Cosmarium nasutum* Nordstedt



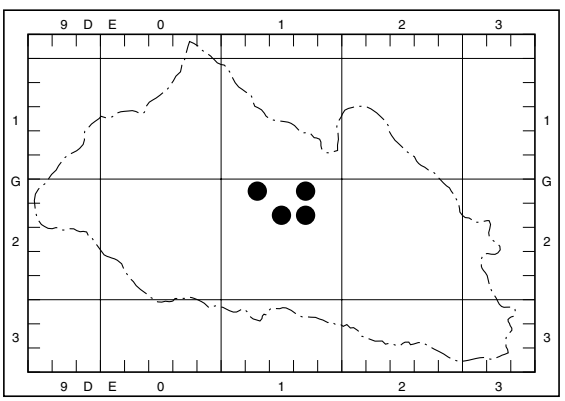
Map 99. *Cosmarium neodepressum* G.J.P.Ramos & C.W.N.Moura



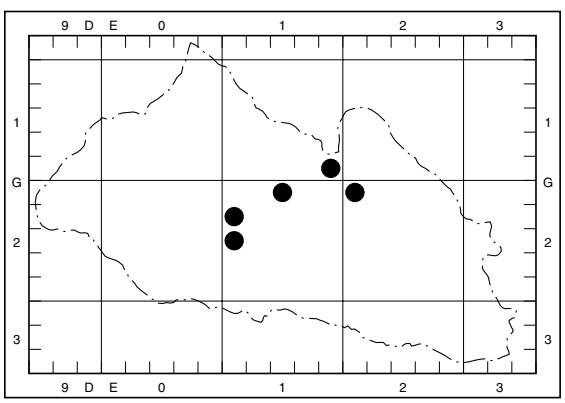
Map 100. *Cosmarium nitidulum* De Notaris



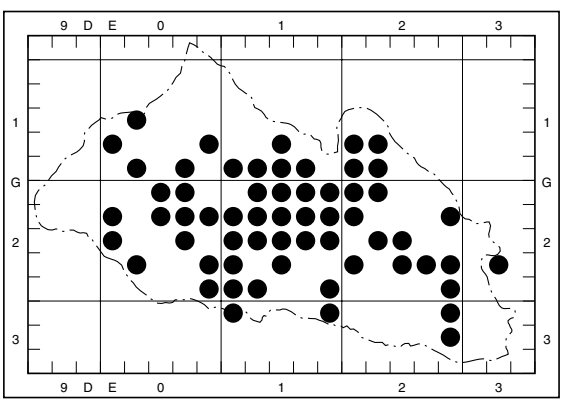
Map 101. *Cosmarium notabile* Brébisson



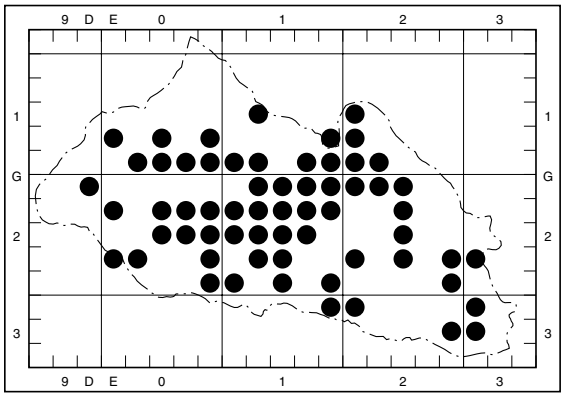
Map 102. *Cosmarium novae-semliae* Wille



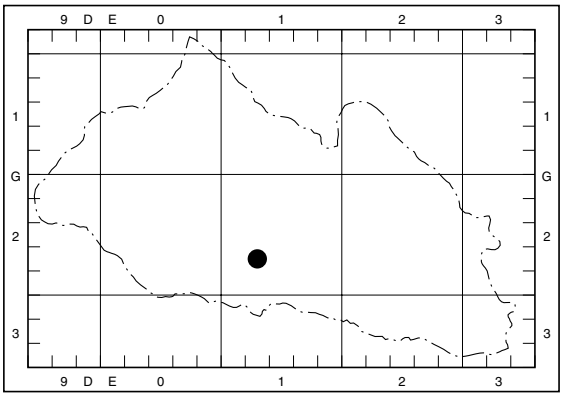
Map 103. *Cosmarium obliquum* Nordstedt



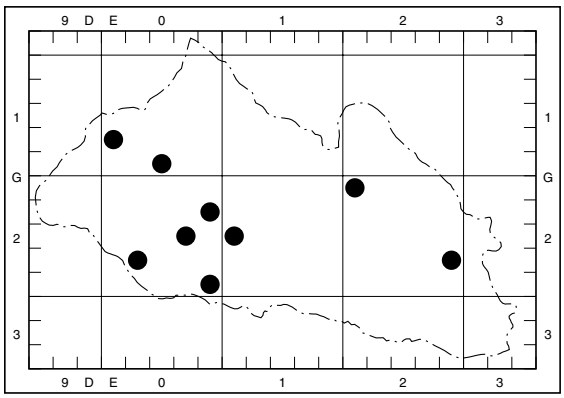
Map 104. *Cosmarium obtusatum* (Schmidle) Schmidle



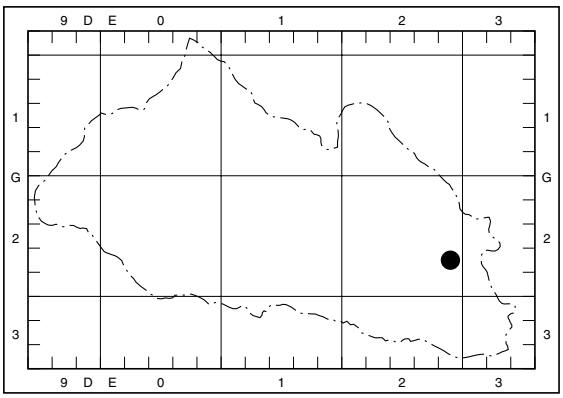
Map 105. *Cosmarium ochthodes* Nordstedt



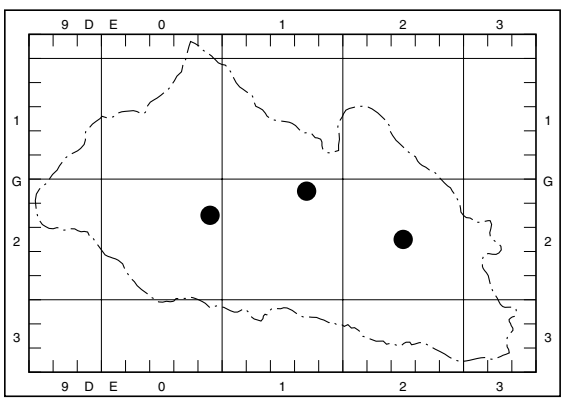
Map 106. *Cosmarium ornatum* Ralfs ex Ralfs



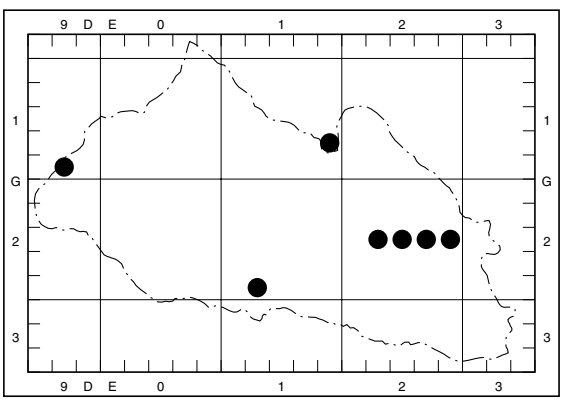
Map 107. *Cosmarium pachydermum* P. Lundell



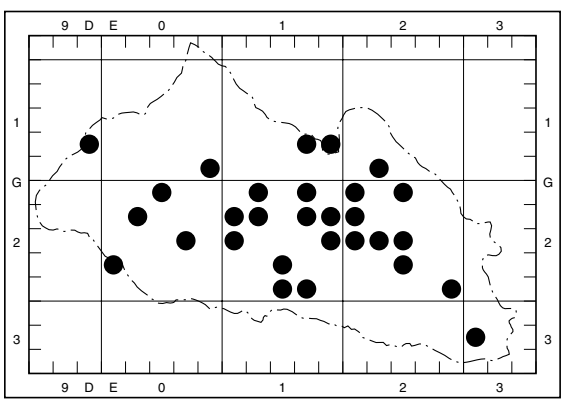
Map 108. *Cosmarium paragranatoides* Skuja



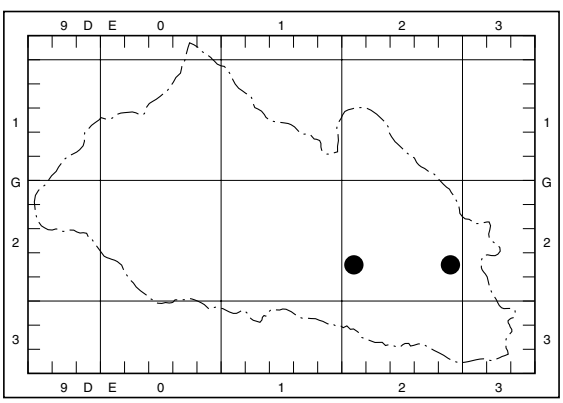
Map 109. *Cosmarium parvulum* Brébisson



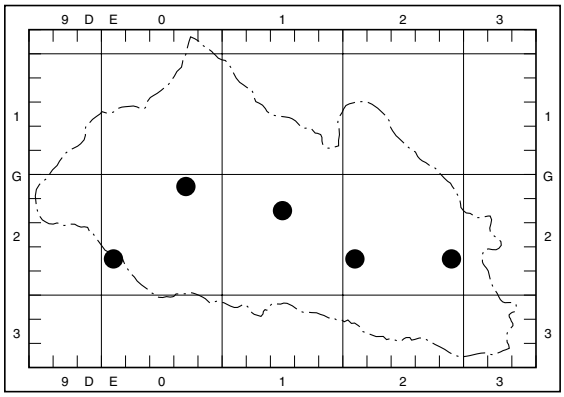
Map 110. *Cosmarium pericymatium* Nordstedt



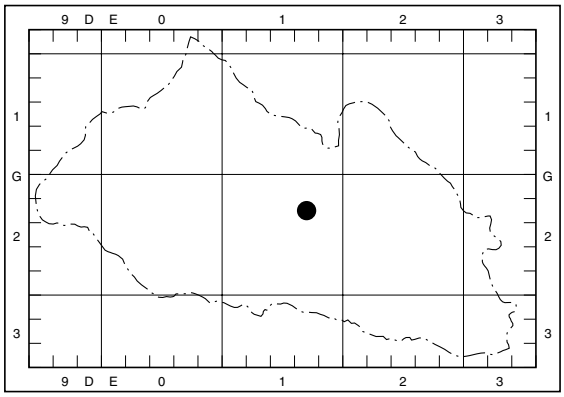
Map 111. *Cosmarium pokornyanum* (Grunow) West. et G. S. West



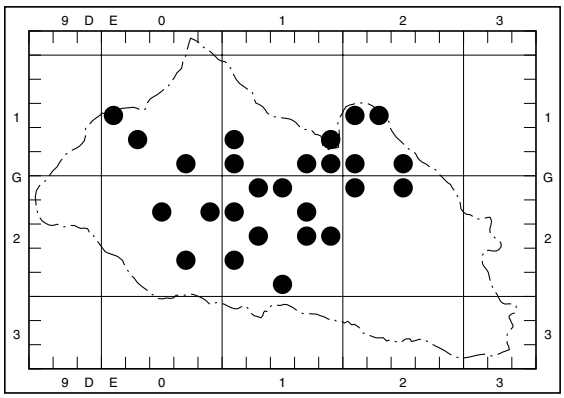
Map 112. *Cosmarium porteanum* W. Archer



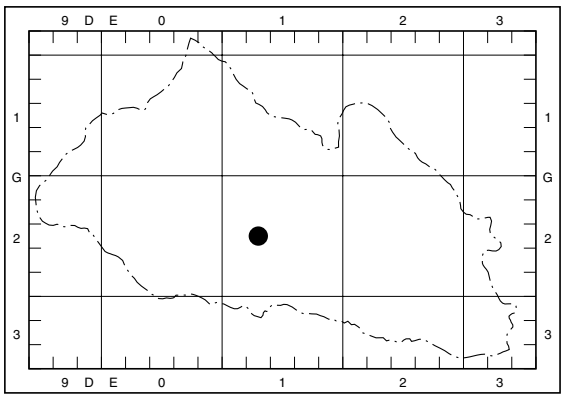
Map 113. *Cosmarium praemorsum* Brébisson



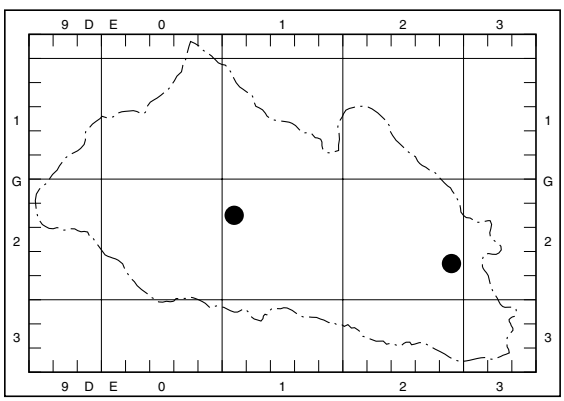
Map 114. *Cosmarium pseudoexiguum* Raciborski



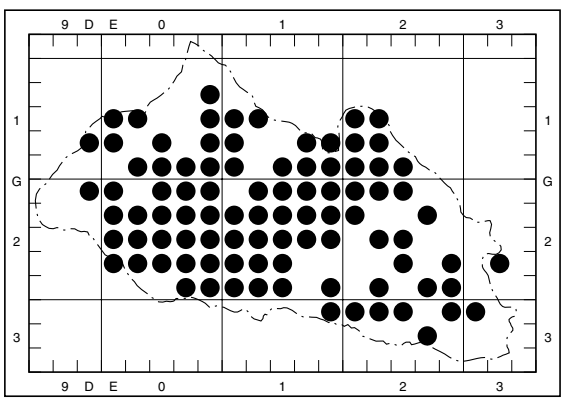
Map 115. *Cosmarium pseudopyramidatum* P. Lundell



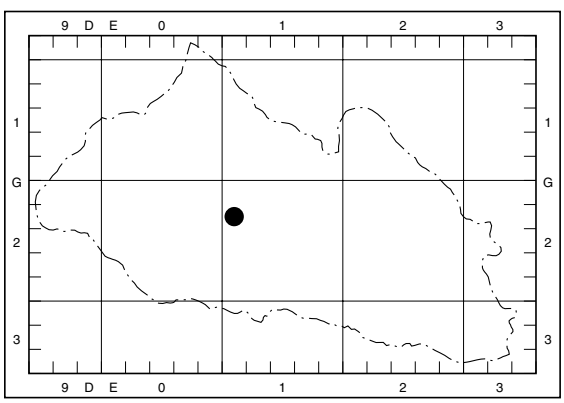
Map 116. *Cosmarium pulcherrimum* Nordstedt



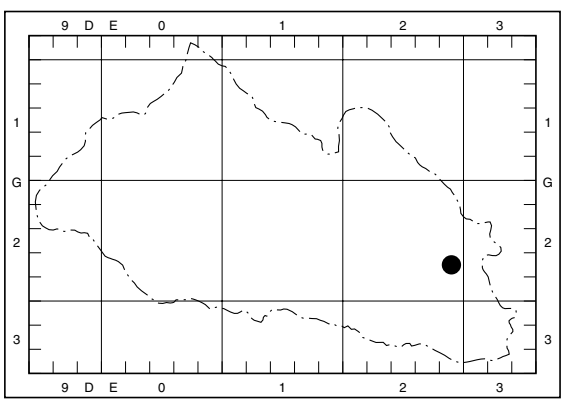
Map 117. *Cosmarium pyramidatum* Brébisson ex Ralfs



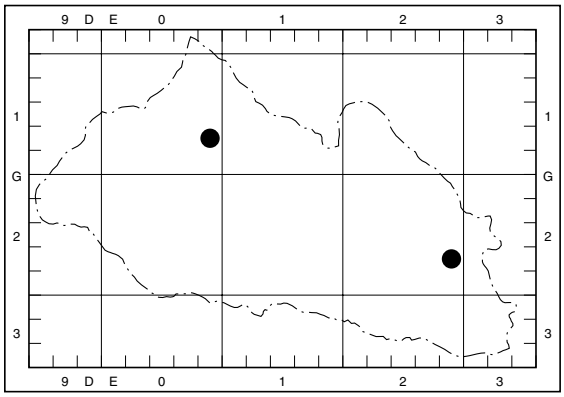
Map 118. *Cosmarium quadratulum* (F. Gay) De Toni



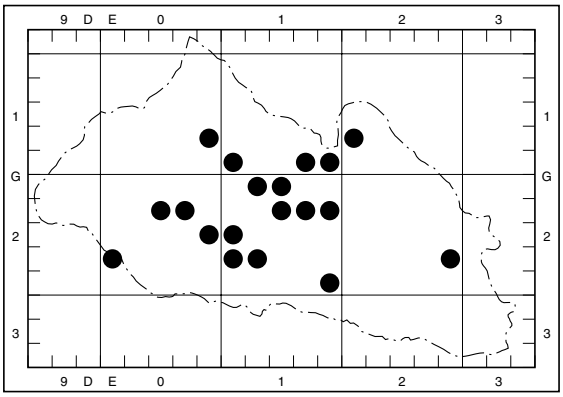
Map 119. *Cosmarium quadratum* Ralfs ex Ralfs



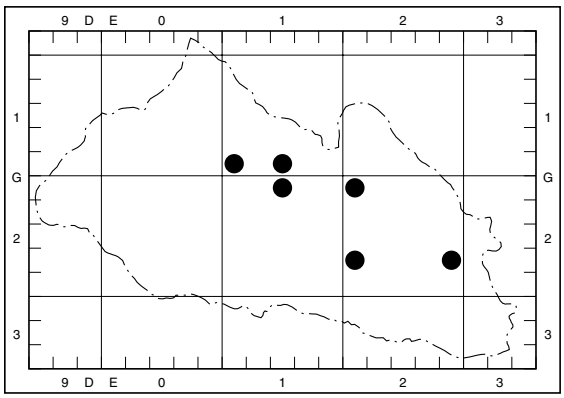
Map 120. *Cosmarium quadrum* P. Lundell



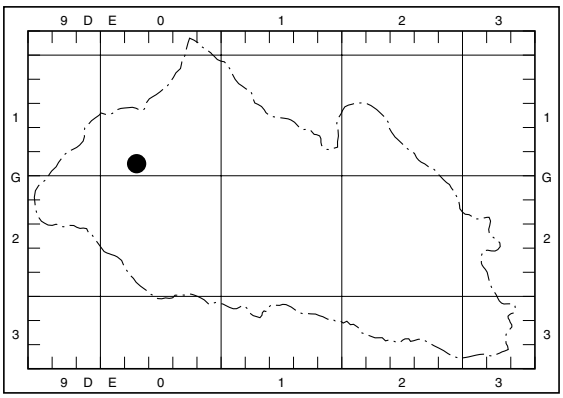
Map 121. *Cosmarium rectangulare* Grunow



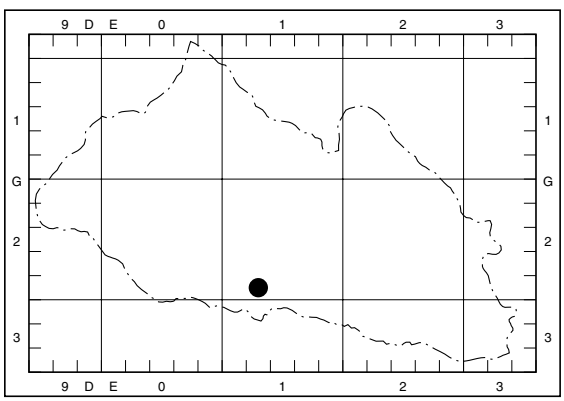
Map 122. *Cosmarium regnellii* Wille



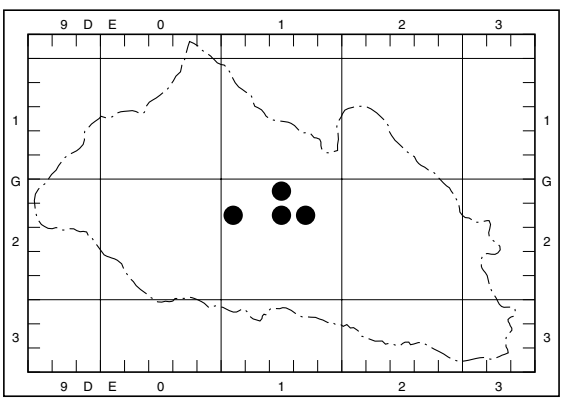
Map 123. *Cosmarium reniforme* (Ralfs) W. Archer



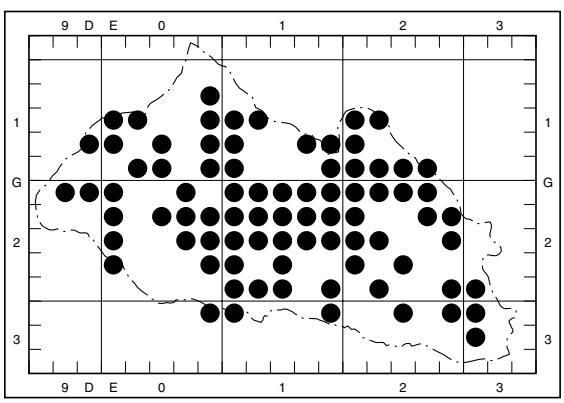
Map 124. *Cosmarium saxicola* Kaiser



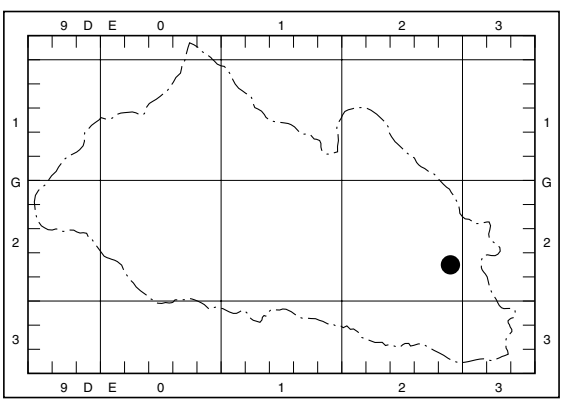
Map 125. *Cosmarium sexangulare* P. Lundell



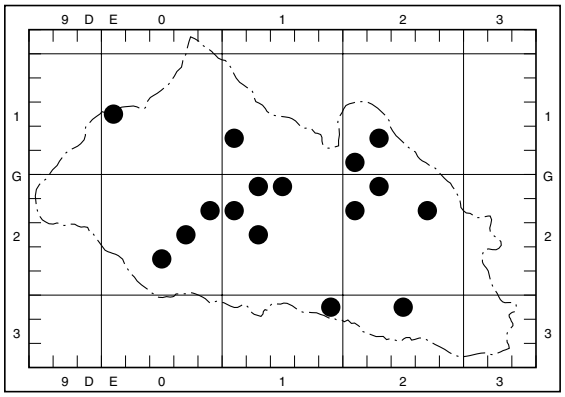
Map 126. *Cosmarium sexnotatum* Gutwiński



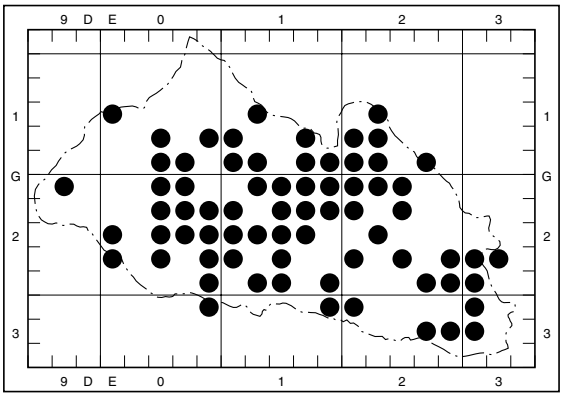
Map 127. *Cosmarium speciosum* P. Lundell



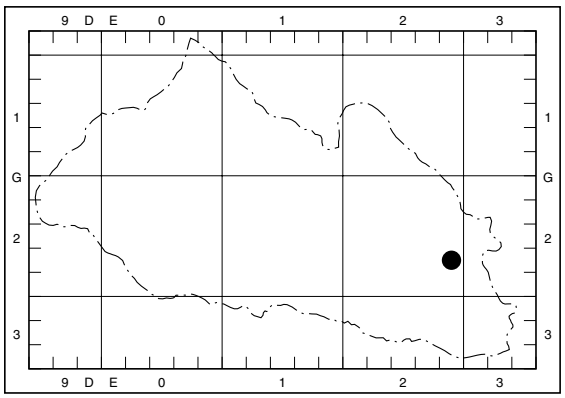
Map 128. *Cosmarium sphagnicola* West. et G. S. West



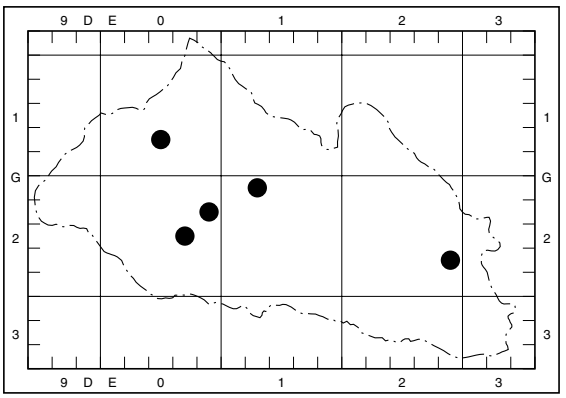
Map 129. *Cosmarium sphalerostichum* Nordstedt



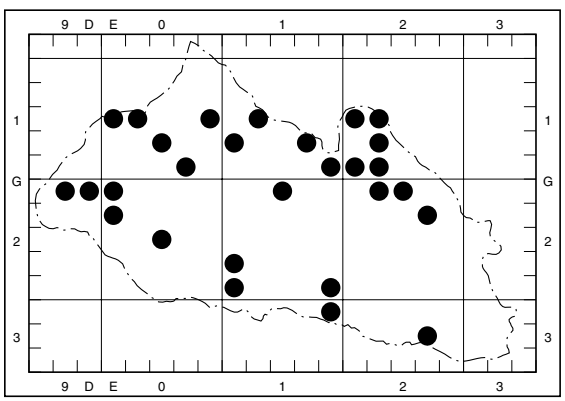
Map 130. *Cosmarium sportella* Brébisson ex Kützing



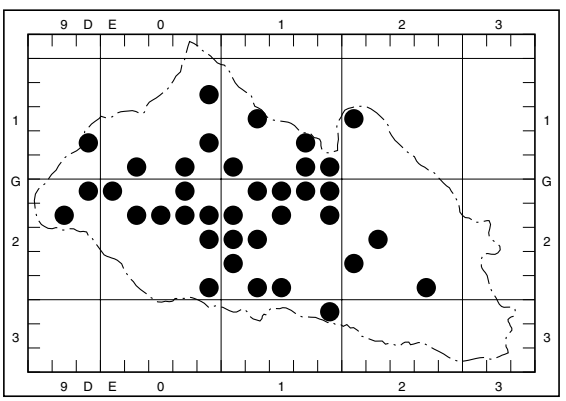
Map 131. *Cosmarium staurastroides* Eichler et Gutwiński



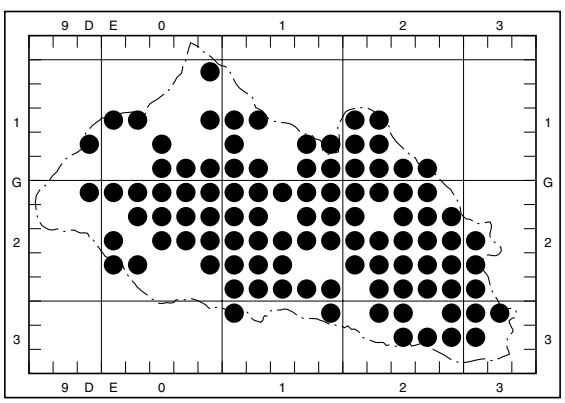
Map 132. *Cosmarium subarctoum* (Lagerheim) Raciborski



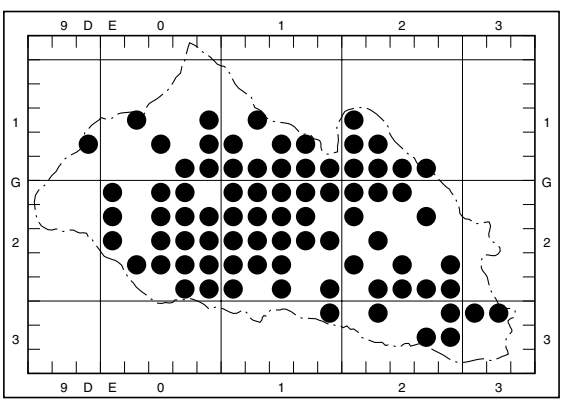
Map 133. *Cosmarium subbroomei* Schmidle



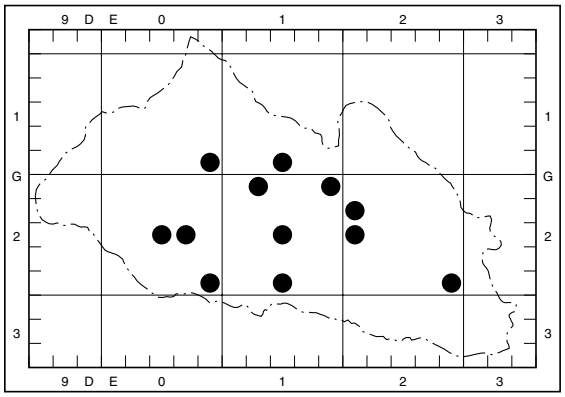
Map 134. *Cosmarium subcostatum* Nordstedt



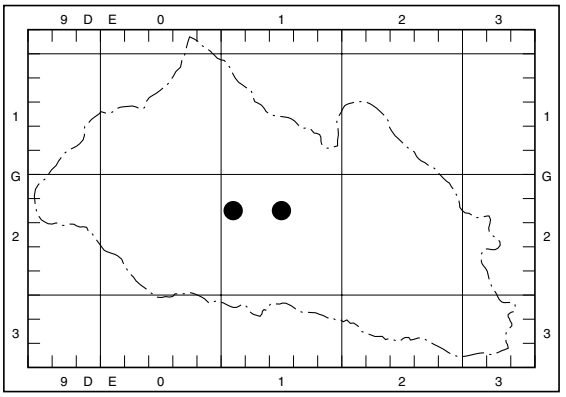
Map 135. *Cosmarium subcrenatum* Hantzsch



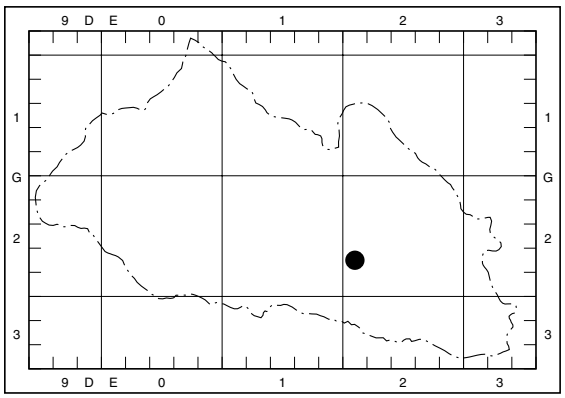
Map 136. *Cosmarium subcucumis* Schmidle



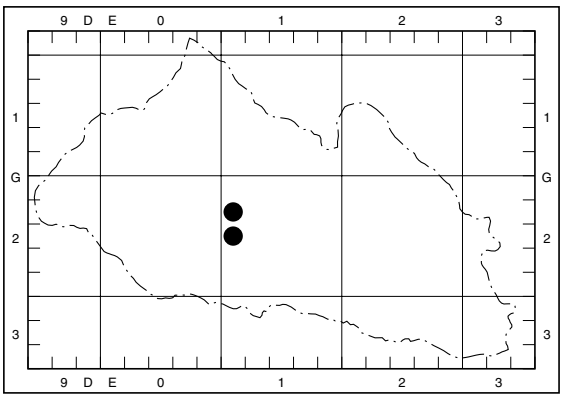
Map 137. *Cosmarium subgranatum* (Nordstedt) Lütkemüller



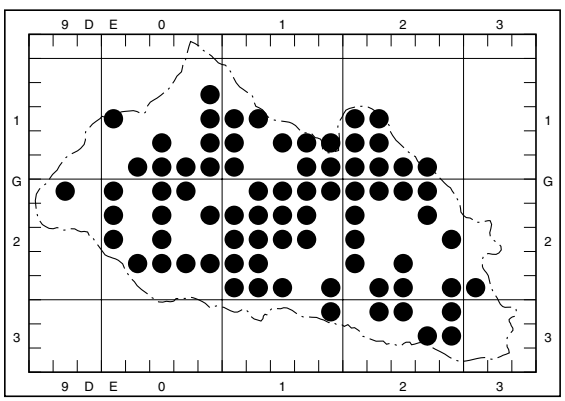
Map 138. *Cosmarium subnotabile* Wille



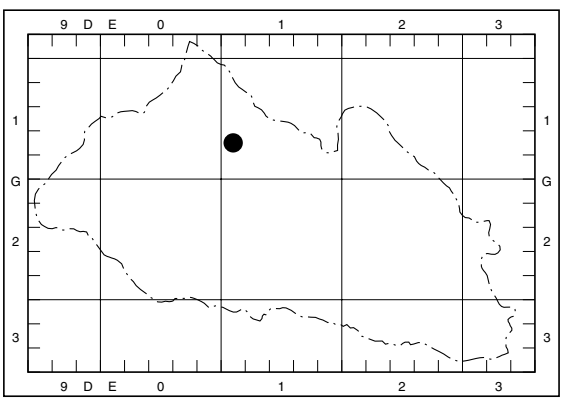
Map 139. *Cosmarium subprotumidum* Nordstedt



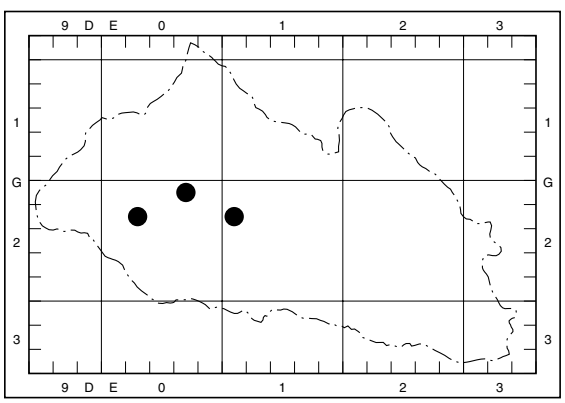
Map 140. *Cosmarium subquadratum* Nordstedt



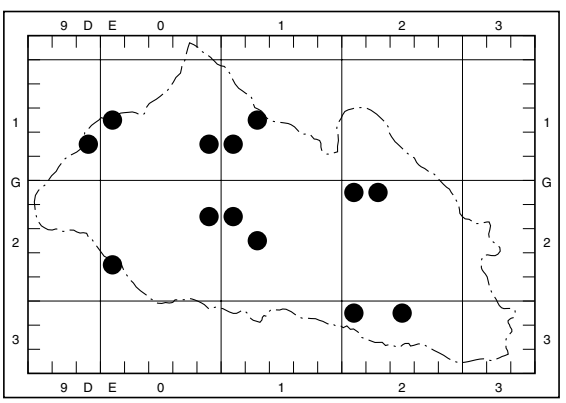
Map 141. *Cosmarium subspeciosum* Nodstedt



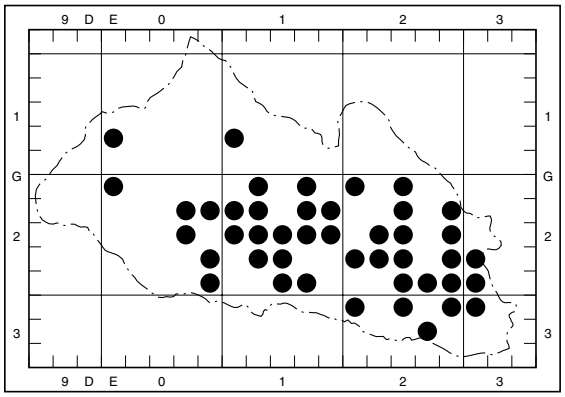
Map 142. *Cosmarium subtumidum* Nordstedt



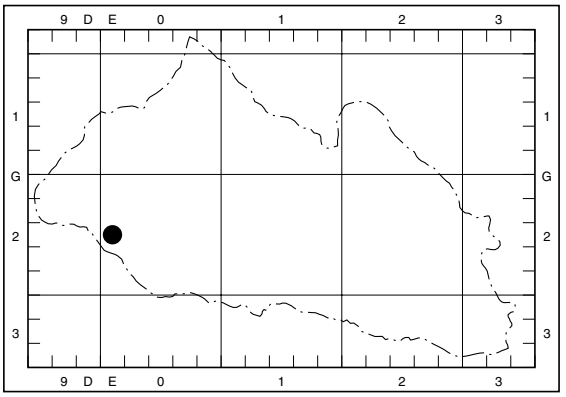
Map 143. *Cosmarium tatricum* Raciborski



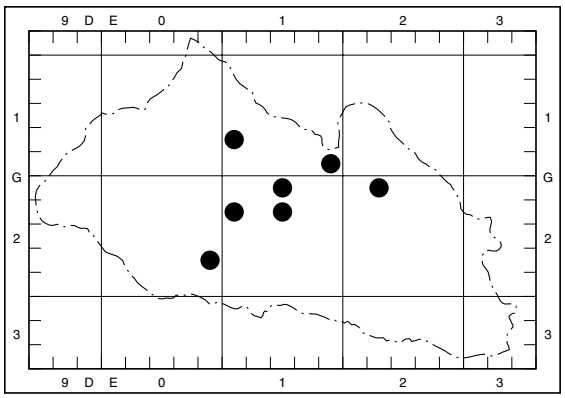
Map 144. *Cosmarium tetragonum* (Nägeli) W. Archer



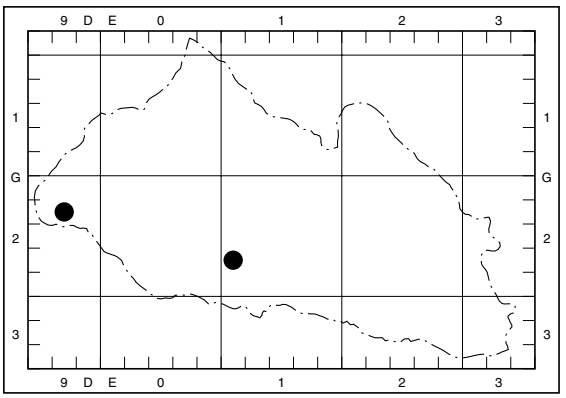
Map 145. *Cosmarium tetraophthalmum* Brébisson ex Ralfs



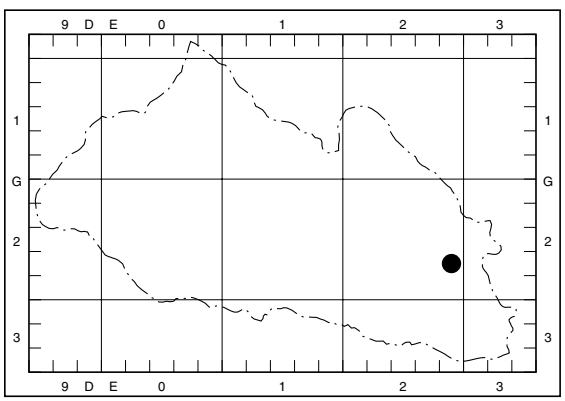
Map 146. *Cosmarium thwaitesii* Ralfs



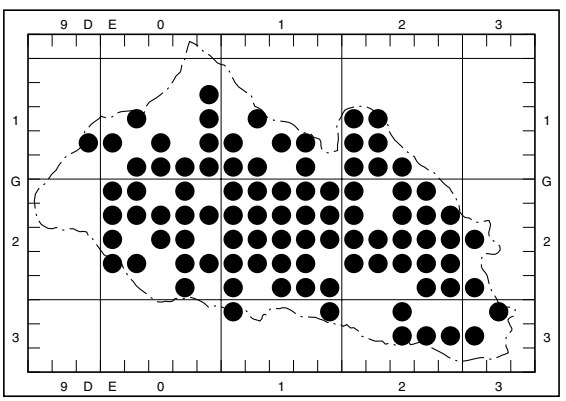
Map 147. *Cosmarium tinctum* Ralfs



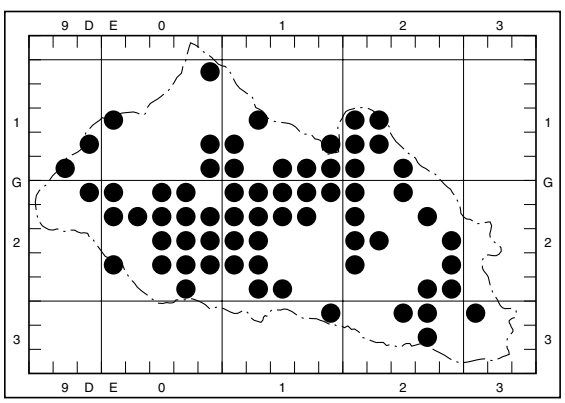
Map 148. *Cosmarium turpinii* Brébisson



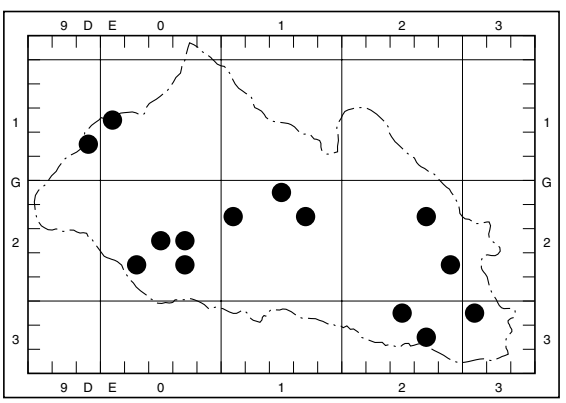
Map 149. *Cosmarium venustum* (Brébisson) W. Archer



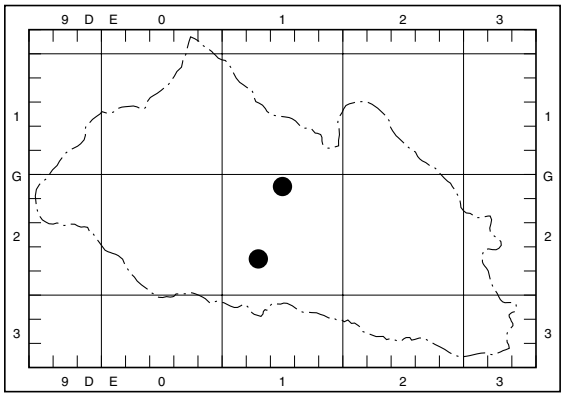
Map 150. *Cosmarium vexatum* West



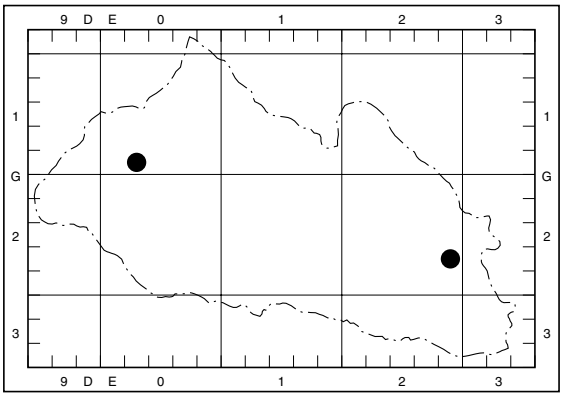
Map 151. *Cylindrocystis brebissonii* (Ralfs) de Bary



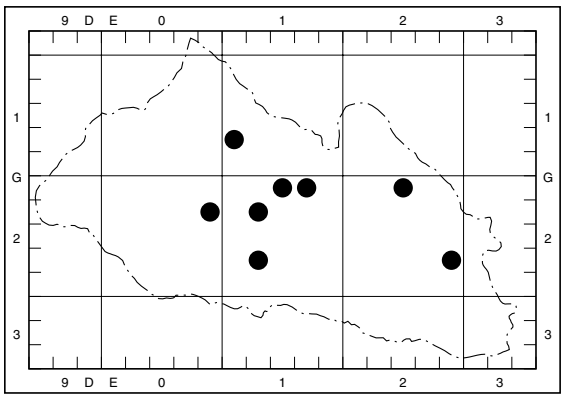
Map 152. *Cylindrocystis crassa* de Bary



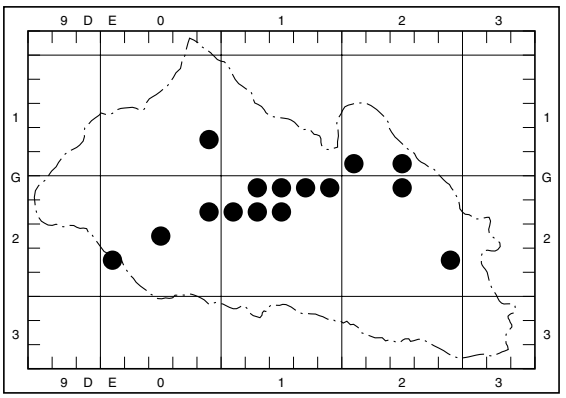
Map 153. *Desmidium grevillei* (Kützing ex Ralfs) de Bary



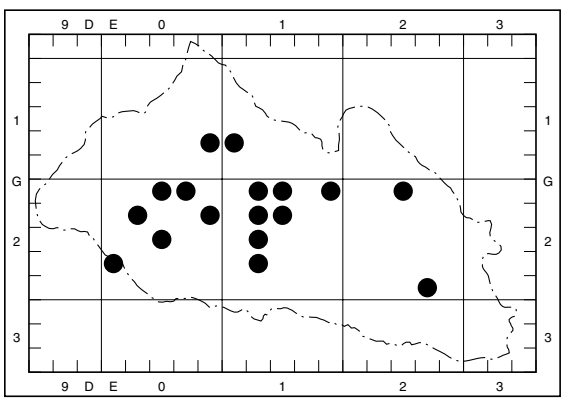
Map 154. *Desmidium swartzii* C. Agardh ex Ralfs



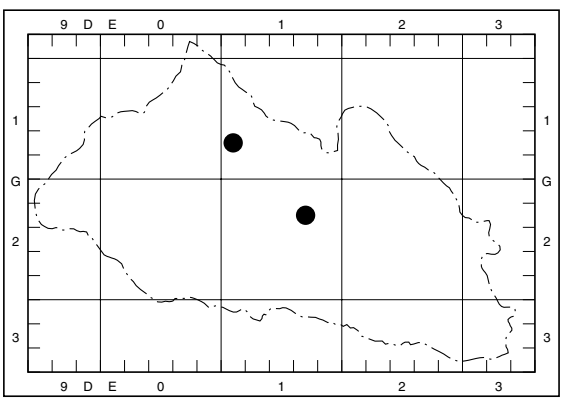
Map 155. *Euastrum ansatum* Ehrenberg ex Ralfs



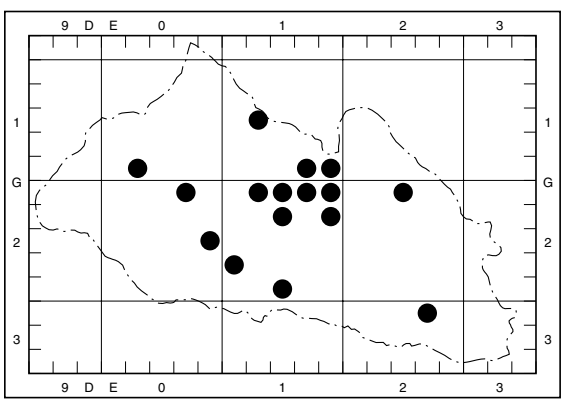
Map 156. *Euastrum bidentatum* Nägeli



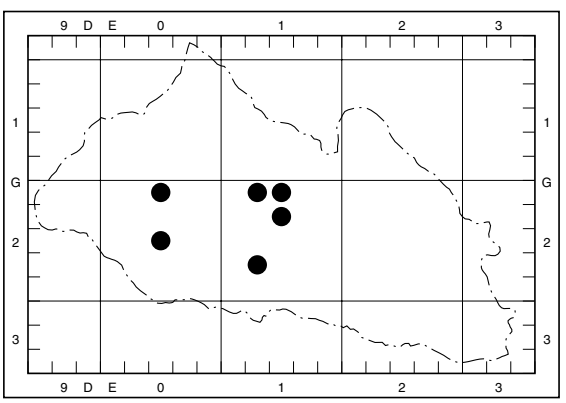
Map 157. *Euastrum binale* Ehrenberg. ex Ralfs



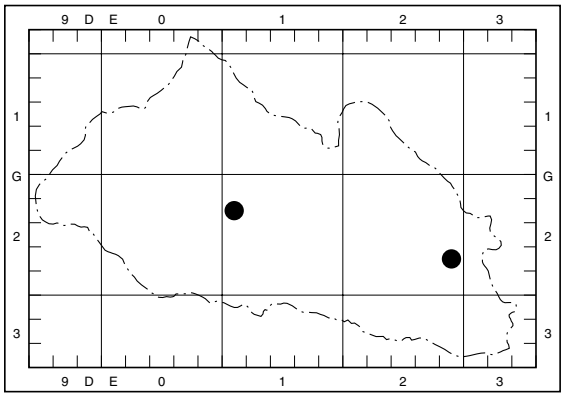
Map 158. *Euastrum crassicolle* P. Lundell



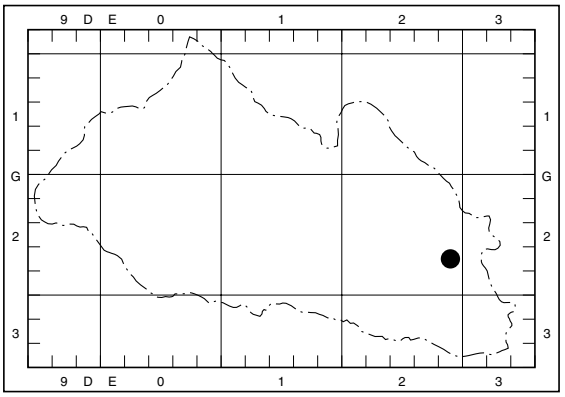
Map 159. *Euastrum denticulatum* F. Gay



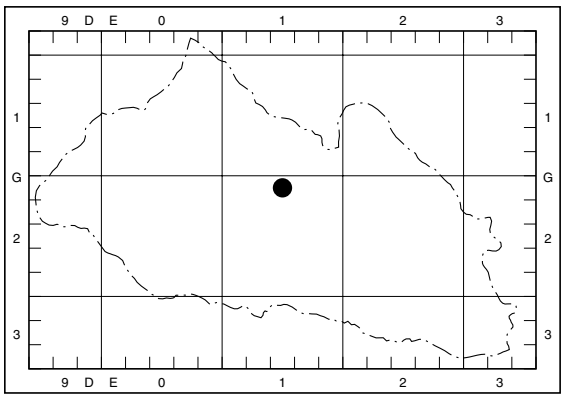
Map 160. *Euastrum didelta* Ralfs



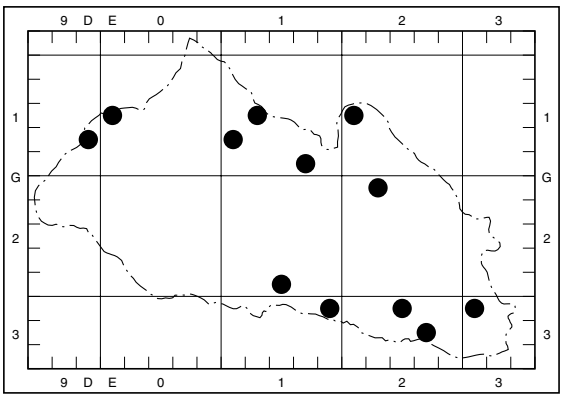
Map 161. *Euastrum dissimile* (Nordstedt) Schmidle



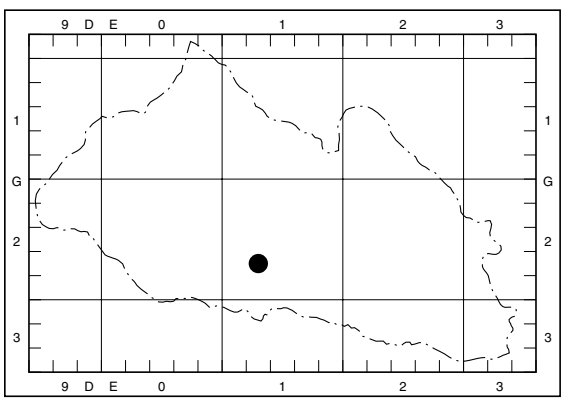
Map 162. *Euastrum dubium* Nägeli



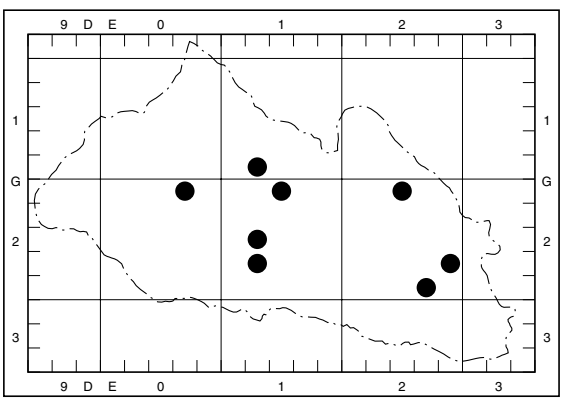
Map 163. *Euastrum elegans* Ralfs



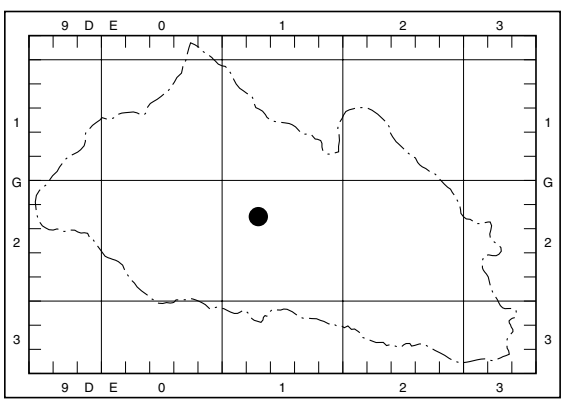
Map 164. *Euastrum erosum* P. Lundell



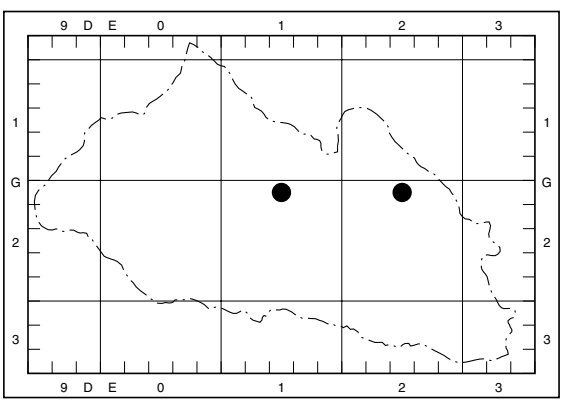
Map 165. *Euastrum gayanum* De Toni



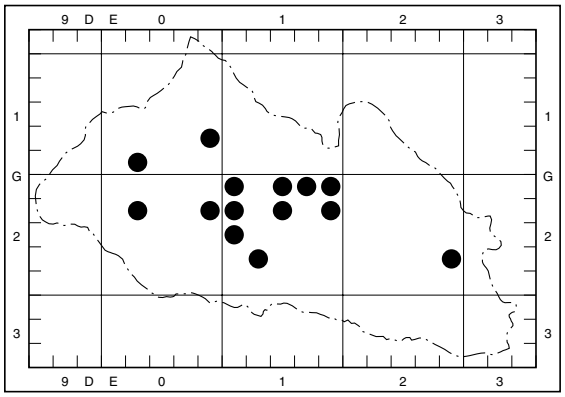
Map 166. *Euastrum humerosum* Ralfs



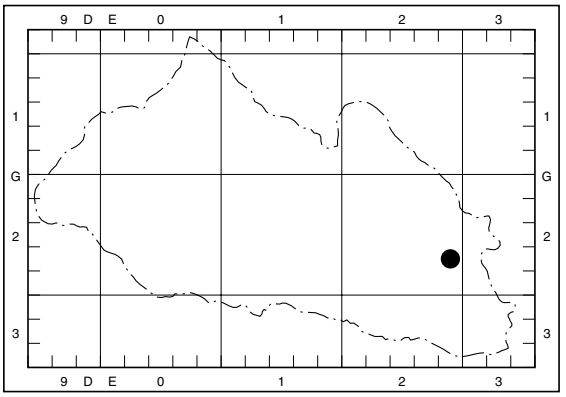
Map 167. *Euastrum insigne* Hassall ex Ralfs



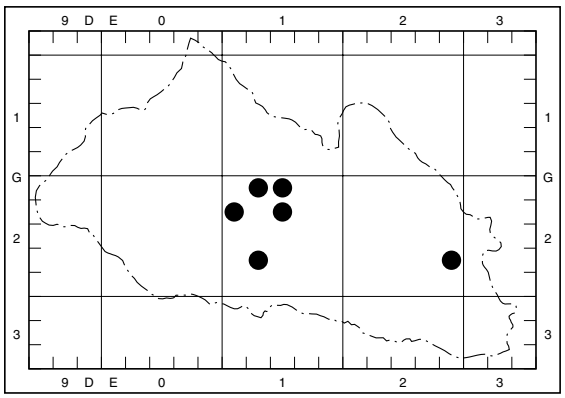
Map 168. *Euastrum montanum* West. et G. S. West



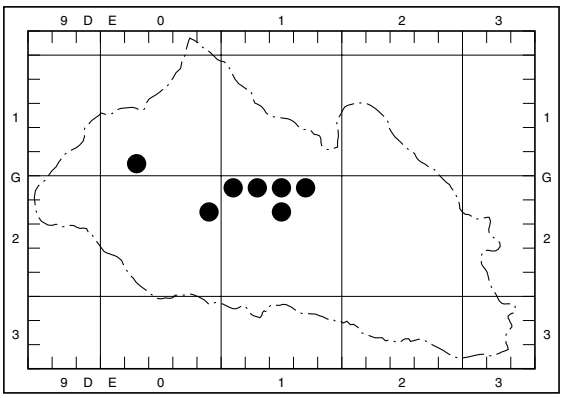
Map 169. *Euastrum oblongum* Ralfs



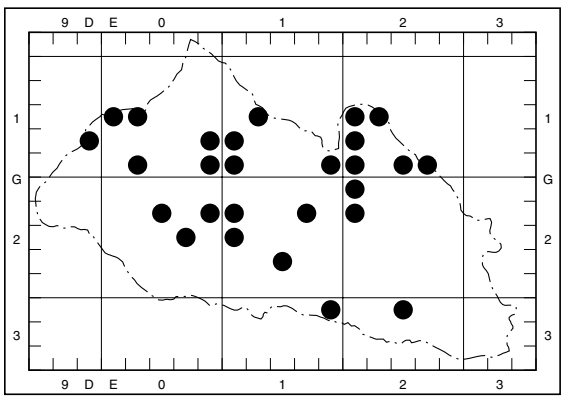
Map 170. *Euastrum pulchellum* Brébisson



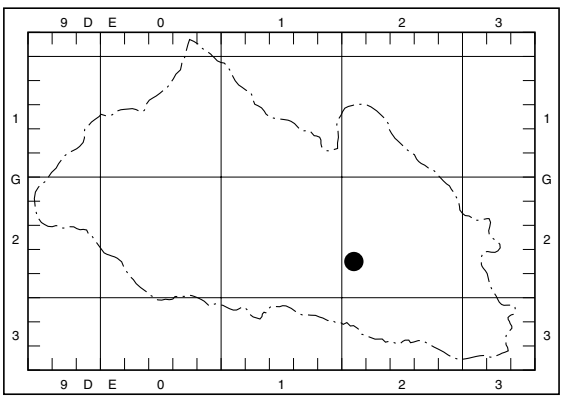
Map 171. *Euastrum subalpinum* Messikommer



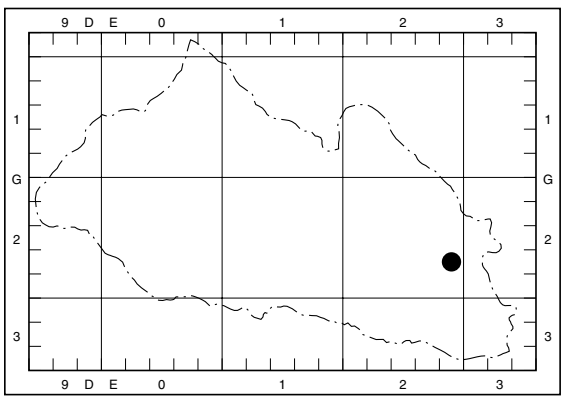
Map 172. *Euastrum verrucosum* Ehrenberg ex Ralfs



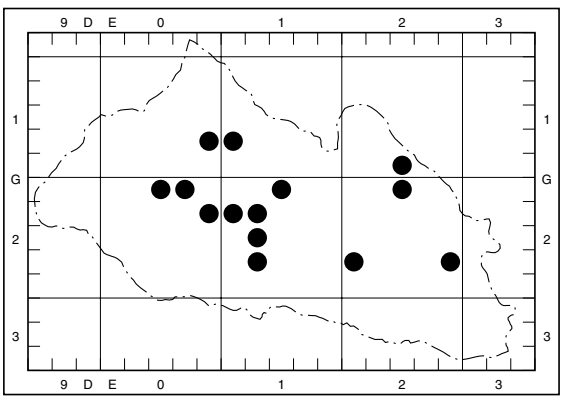
Map 173. *Gonatozygon brebissonii* de Bary



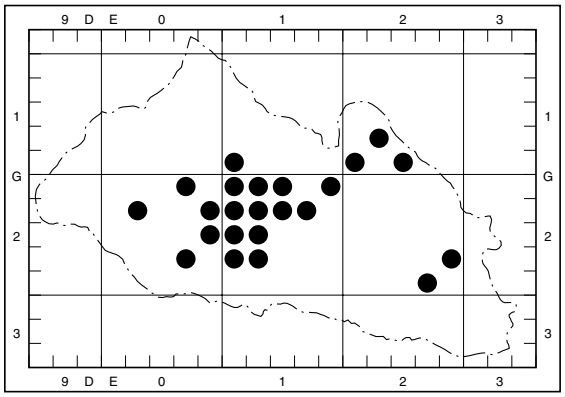
Map 174. *Gonatozygon monotaenium* de Bary



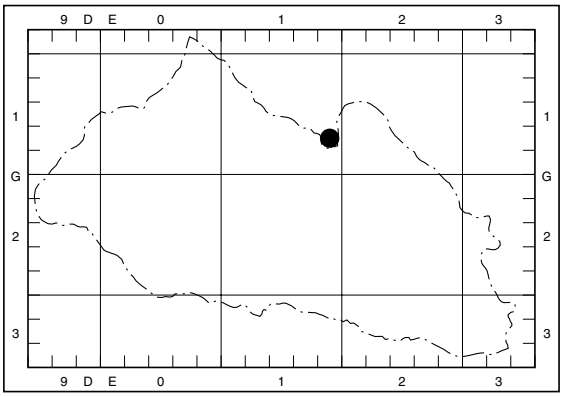
Map 175. *Haplotaenium rectum* (Delponte) Bando



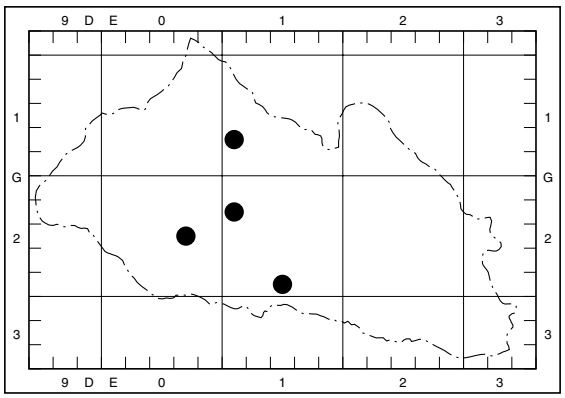
Map 176. *Hyalotheca dissiliens* Brébisson ex Ralfs



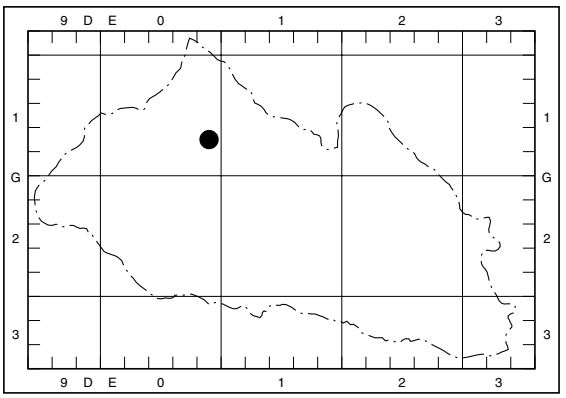
Map 177. *Mesotaenium degreyi* W. B. Turner



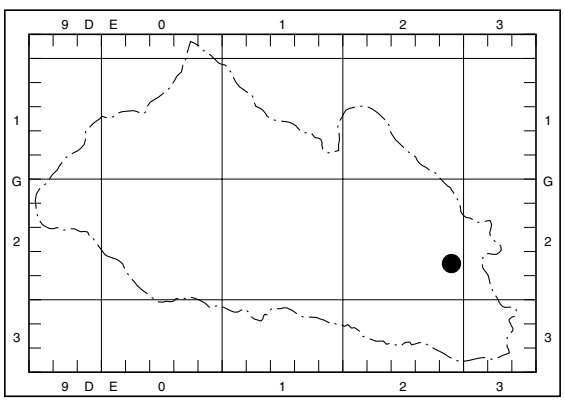
Map 178. *Mesotaenium endlicherianum* Nägeli



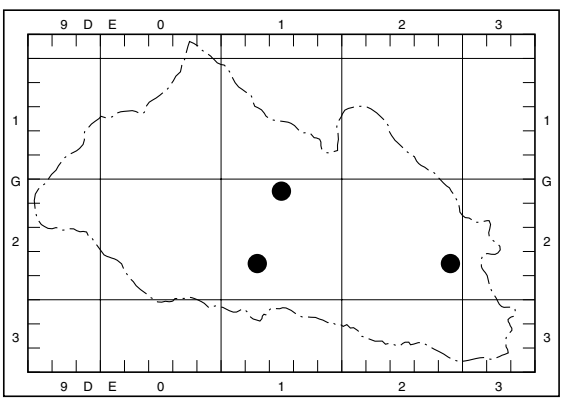
Map 179. *Mesotaenium macrococcum* (Kützing ex Kützing) R. Roy et Bisset



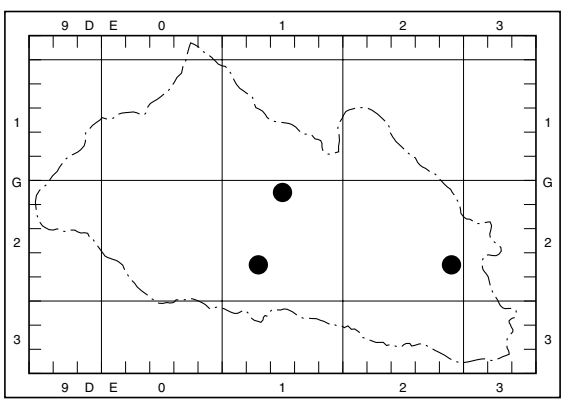
Map 180. *Micrasterias americana* Ehrenberg ex Ralfs



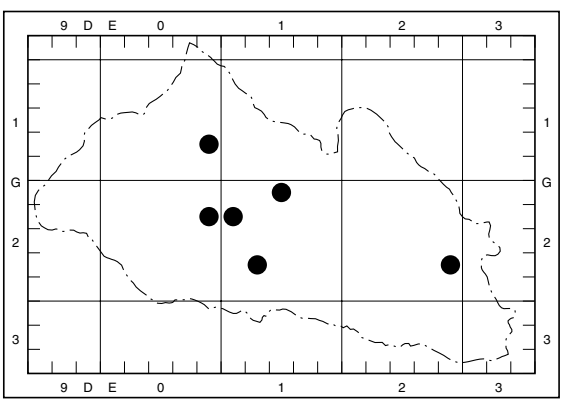
Map 181. ***Micrasterias dickiei*** (Ralfs) Škaloud, Nemjová, Veselá, Černá & Neustupa



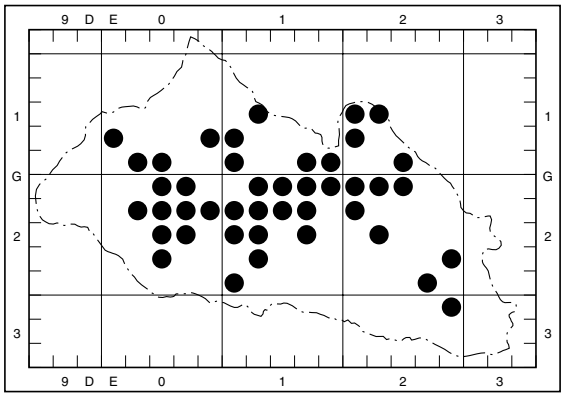
Map 182. *Micrasterias papillifera* Brébisson ex Ralfs



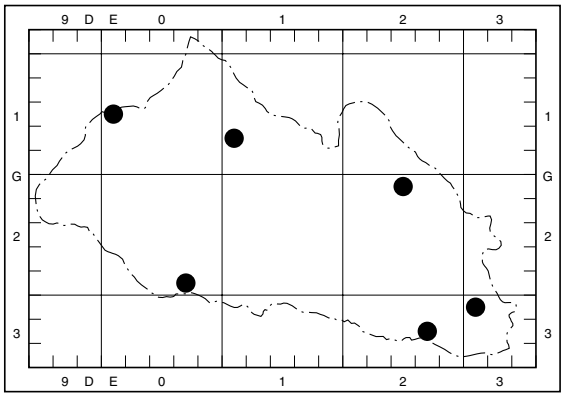
Map 183. *Micrasterias rotata* Ralfs



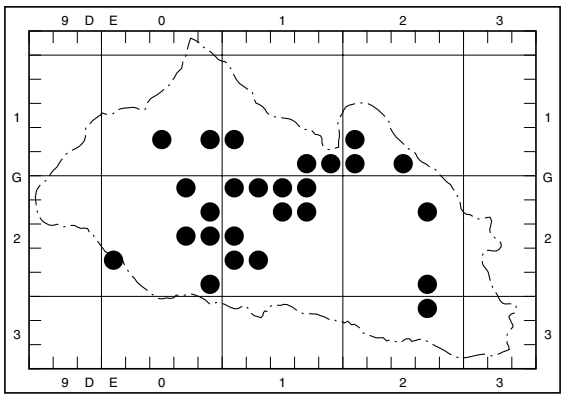
Map 184. *Micrasterias truncata* Brebisson ex Ralfs



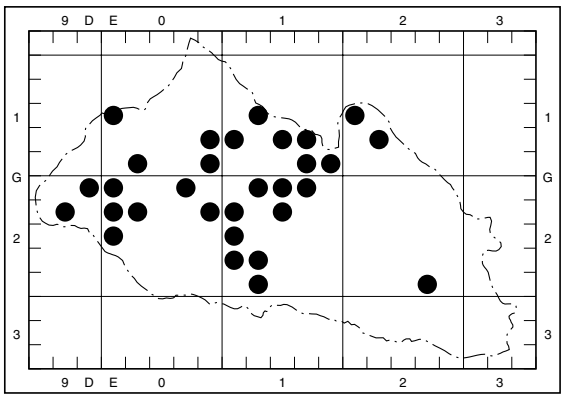
Map 185. *Netrium digitus* (Brébisson ex Ralfs) Itzigsohn et Rothe



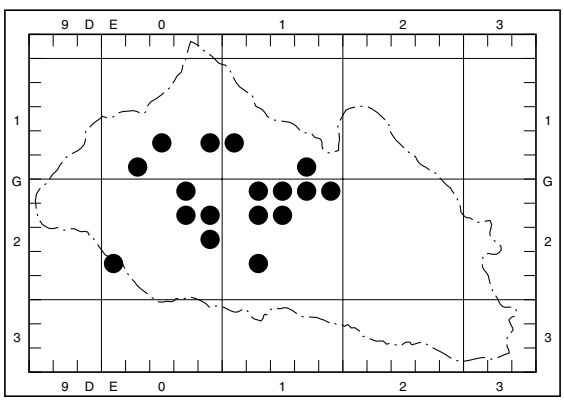
Map 186. *Netrium oblongum* (de Bary) Lütkemüller



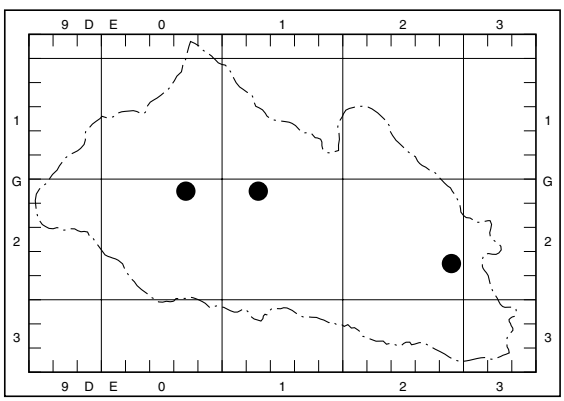
Map 187. *Penium cylindrus* Brébisson ex Ralfs



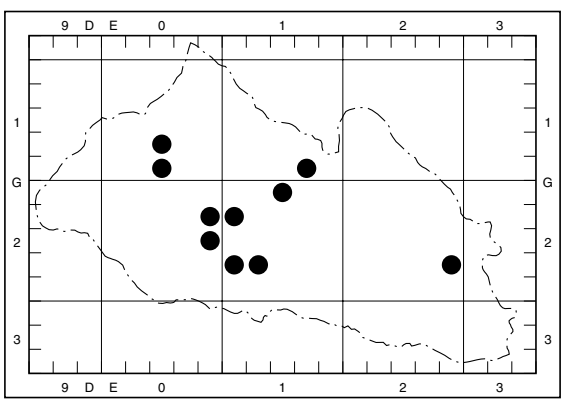
Map 188. *Penium margaritaceum* (Ehrenberg) Brébisson



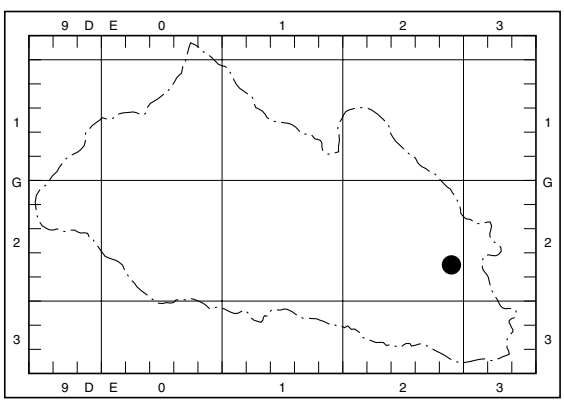
Map 189. *Penium spirostriolatum* J. Barker



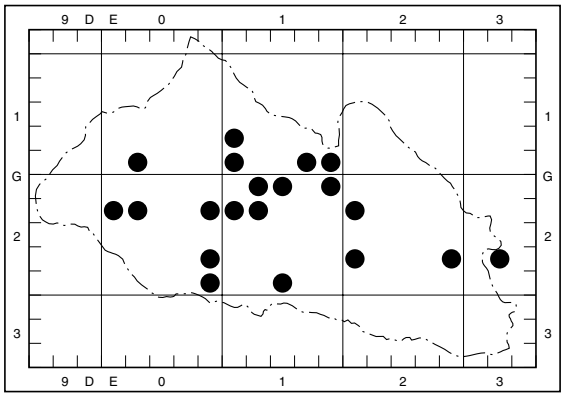
Map 190. *Planotaenium interruptum* (Ohtani) Petlovany et Palamar-Mordvintseva



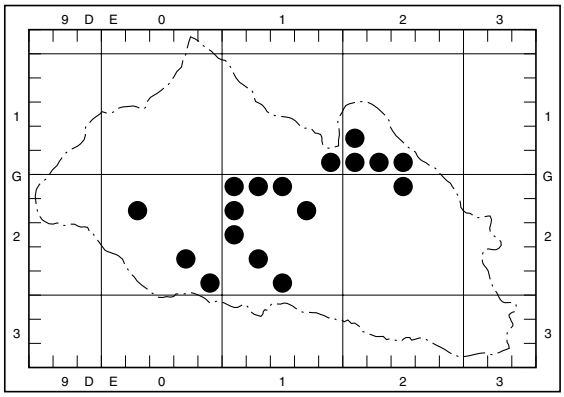
Map 191. *Pleurotaenium crenulatum* (Ehrenberg ex Ralfs) Rabenhorst



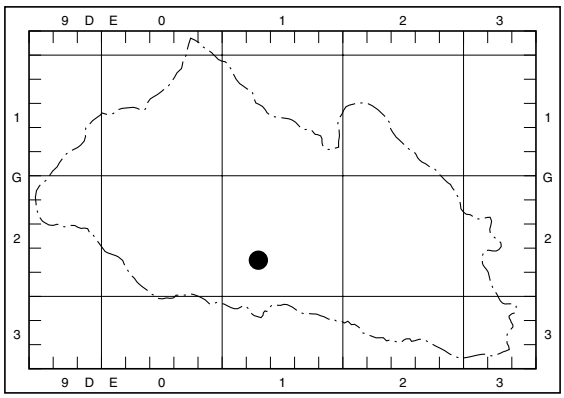
Map 192. *Pleurotaenium ehrenbergii* (Ralfs) Delponte



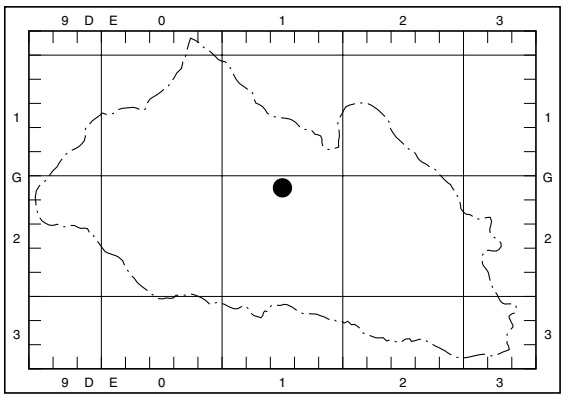
Map 193. *Pleurotaenium trabecula* Nägeli



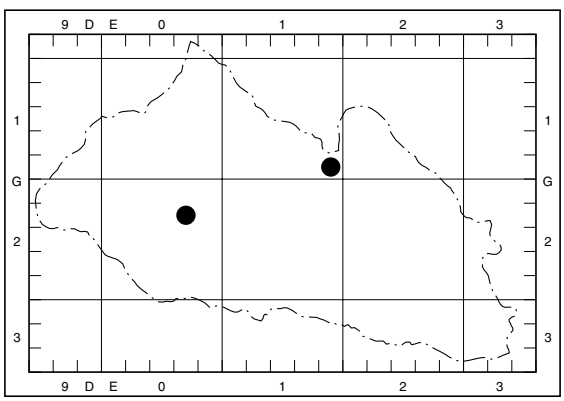
Map 194. *Roya obtusa* (Brébisson) West et G. S. West



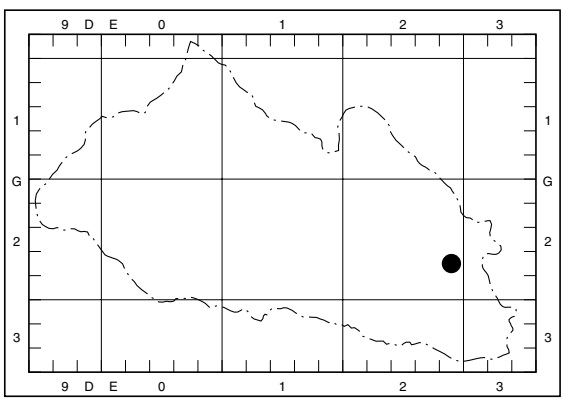
Map 195. *Spirotaenia condensata* Brébisson



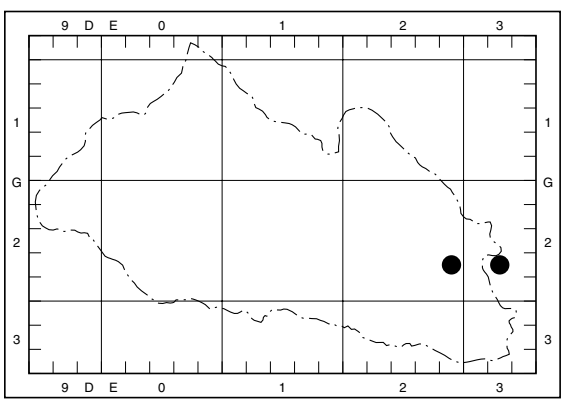
Map 196. *Spirotaenia obscura* Ralfs



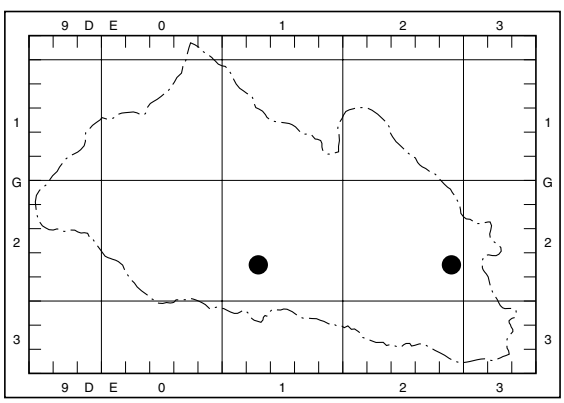
Map 197. *Spondylosium pulchellum* (W. Archer) W. Archer



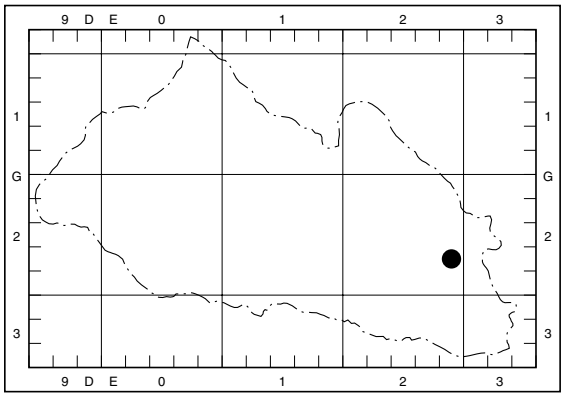
Map 198. *Staurastrum aculeatum* Meneghini ex Ralfs



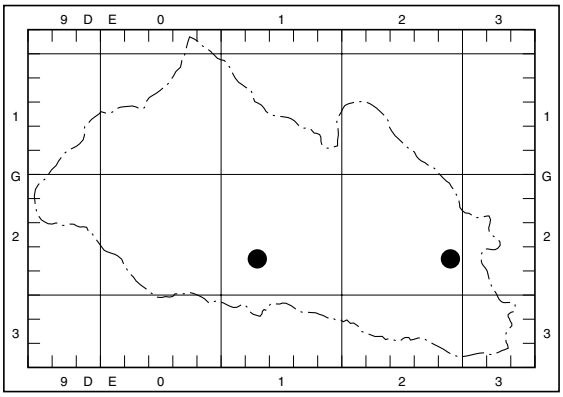
Map 199. ***Staurastrum acutum*** var. *varians* (Raciborski) Coesel & Meesters



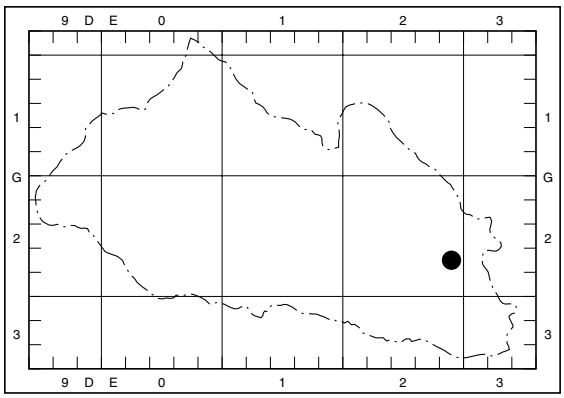
Map 200. *Staurastrum alternans* Brébisson



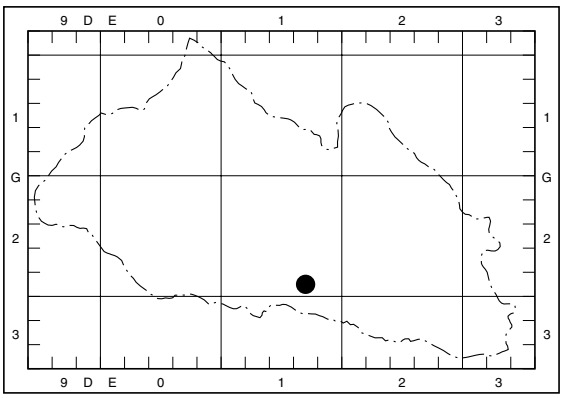
Map 201. *Staurastrum arcuatum* Nordstedt



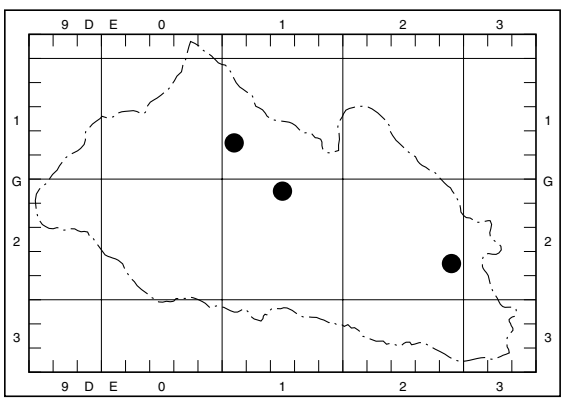
Map 202. *Staurastrum avicula* Brébisson



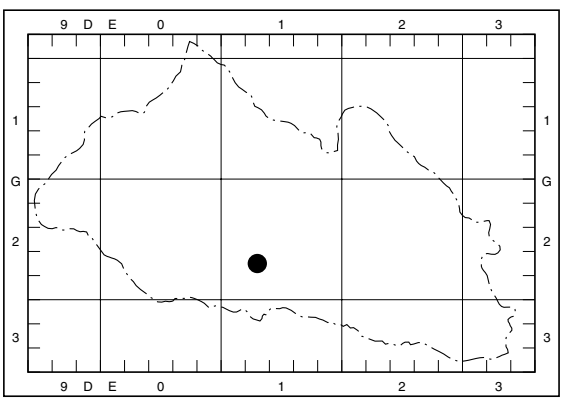
Map 203. *Staurastrum bieneanum* Rabenhorst



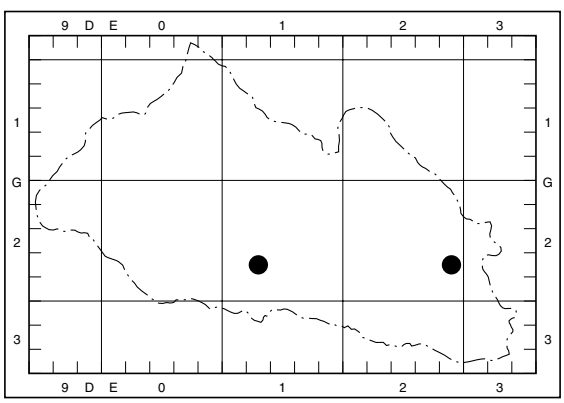
Map 204. *Staurastrum botrophilum* Wolle



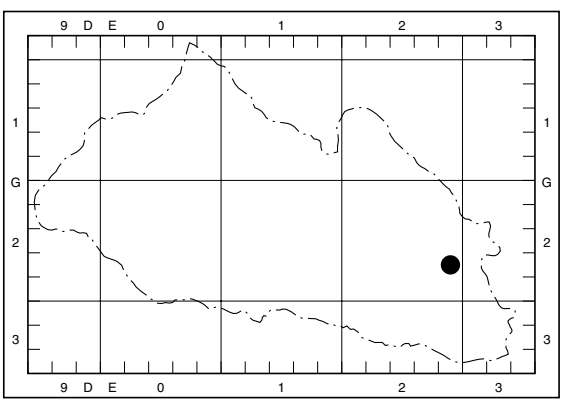
Map 205. *Staurastrum capitulum* Brébisson



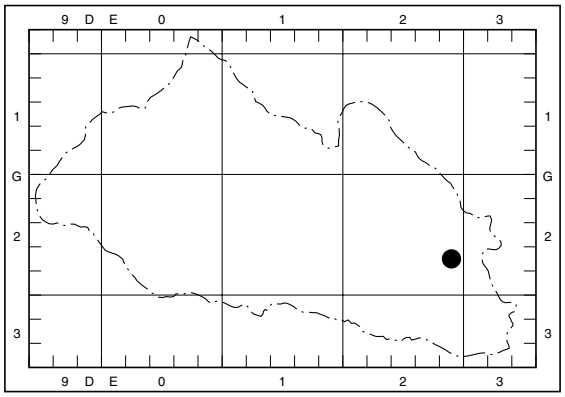
Map 206. *Staurastrum controversum* Brébisson



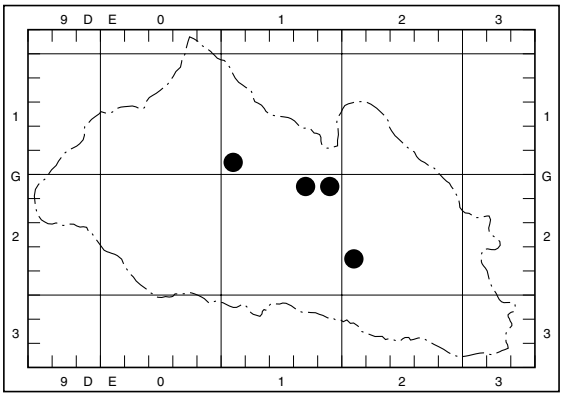
Map 207. *Staurastrum cyrtocerum* var. *inflexum* (Brébisson) Coesel & Meesters



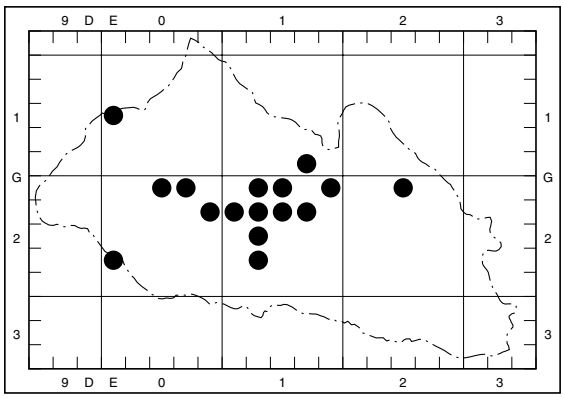
Map 208. *Staurastrum dispar* Brébisson



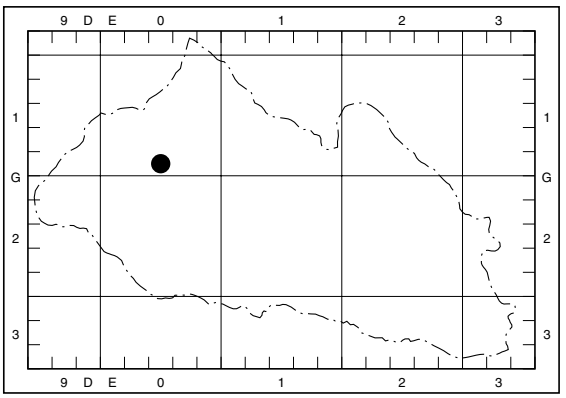
Map 209. *Staurastrum furcatum* Brébisson



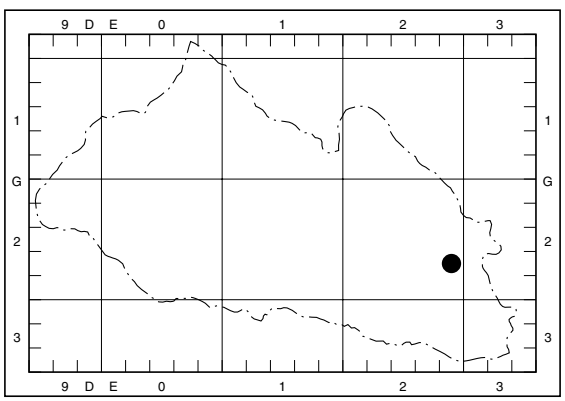
Map 210. *Staurastrum hexacerum* Wittrock



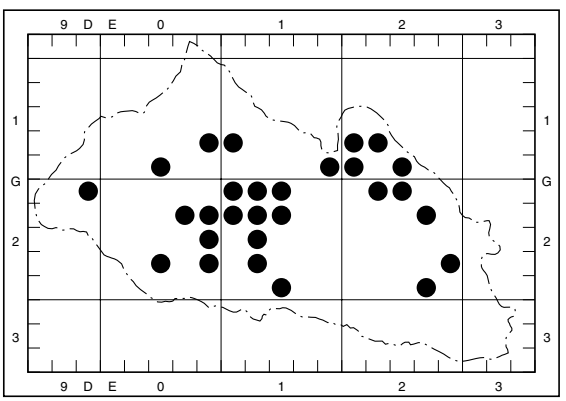
Map 211. *Staurastrum hirsutum* Ehrenberg ex Ralfs



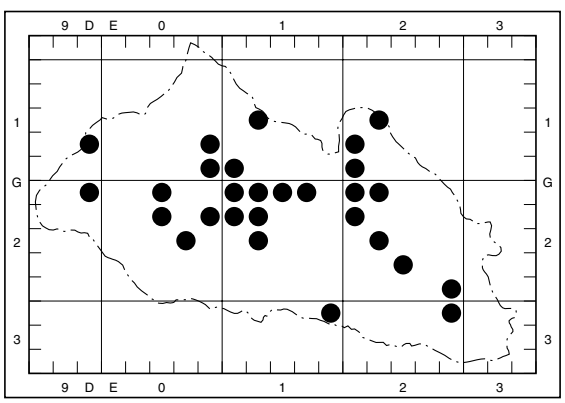
Map 212. *Staurastrum lapponicum* (Schmidle) Grönblad



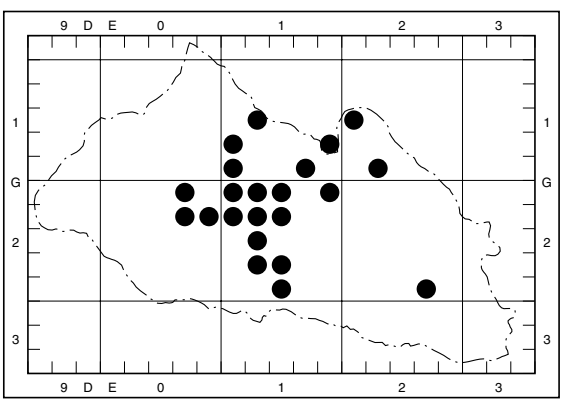
Map 213. *Staurastrum lunatum* Ralfs



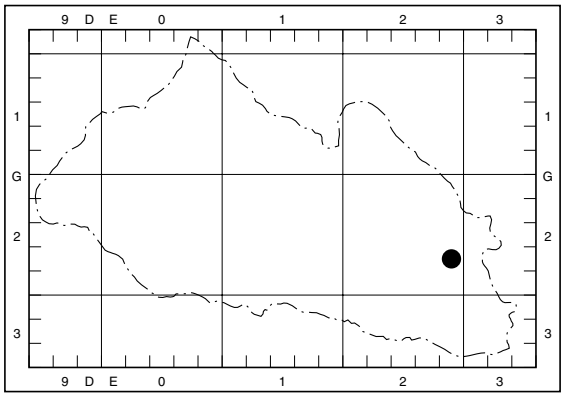
Map 214. *Staurastrum margaritaceum* Meneghini ex Ralfs



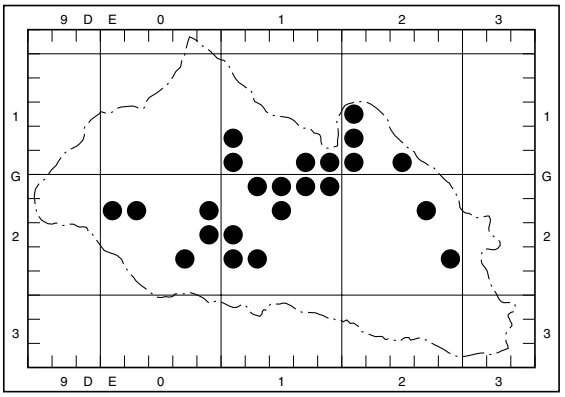
Map 215. *Staurastrum merianii* Reinsch



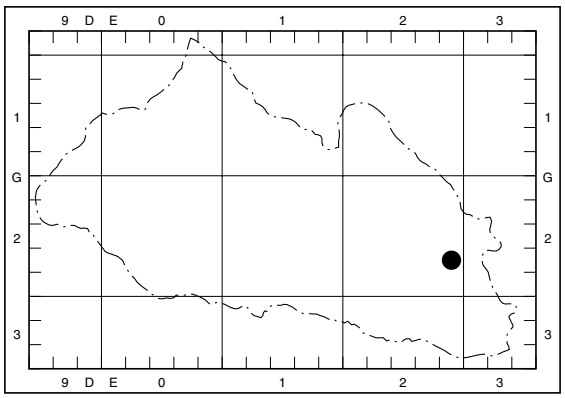
Map 216. *Staurastrum muricatum* Brébisson ex Ralfs



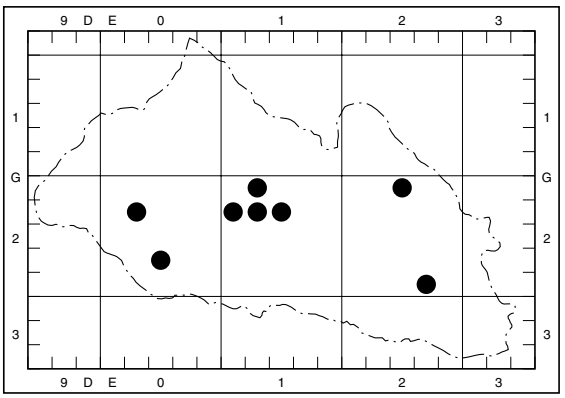
Map 217. *Staurastrum muticum* Brébisson ex Ralfs



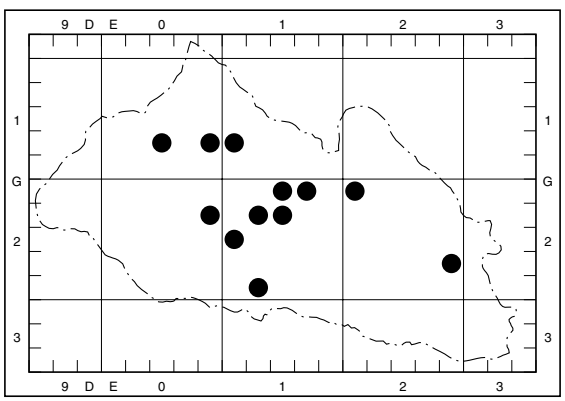
Map 218. *Staurastrum orbiculare* Meneghinii ex Ralfs



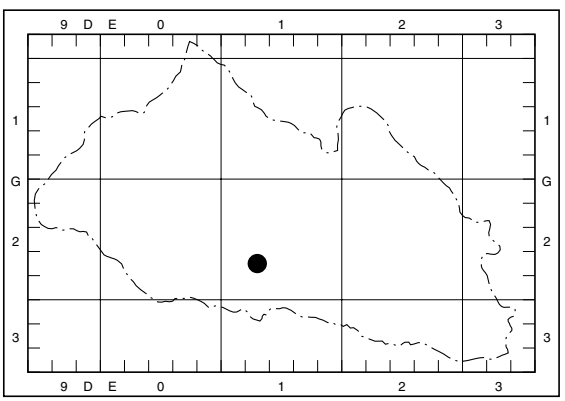
Map 219. *Staurastrum oxyacanthum* W. Archer



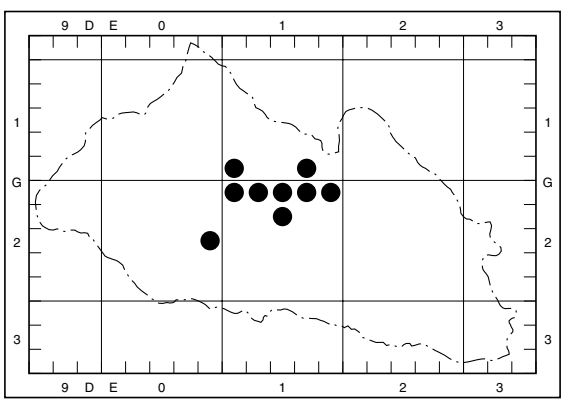
Map 220. *Staurastrum pileolatum* Brébisson



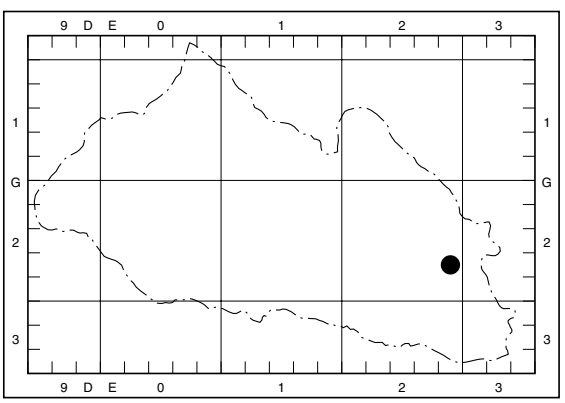
Map 221. *Staurastrum pilosum* Brébisson



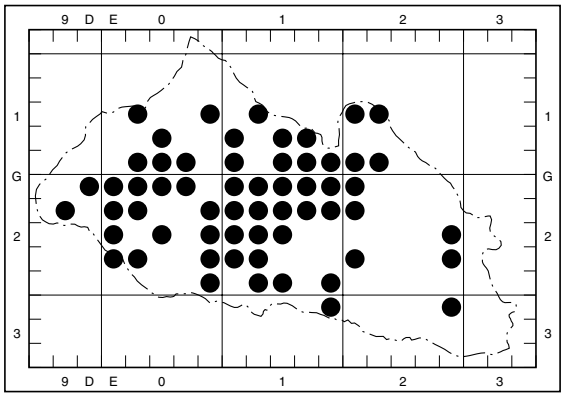
Map 222. *Staurastrum polymorphum* Brébisson



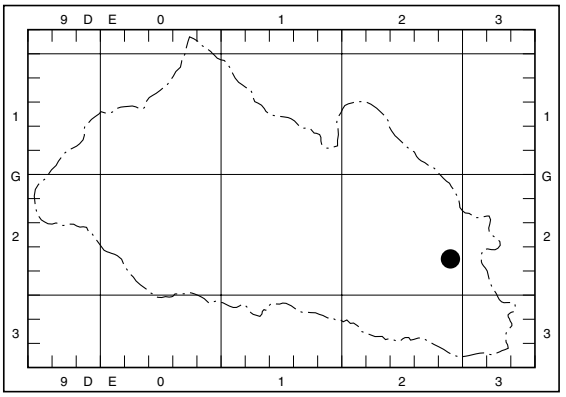
Map 223. *Staurastrum polytrichum* (Perty) Rabenhorst



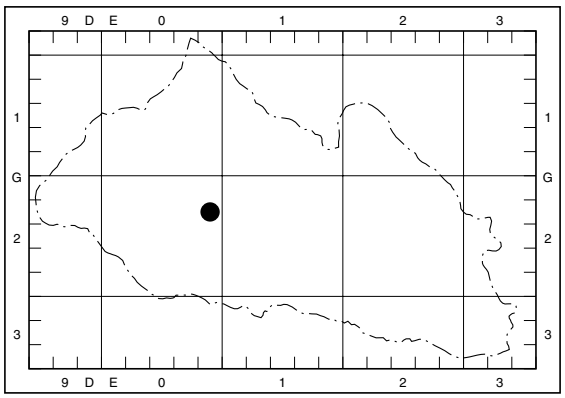
Map 224. *Staurastrum proboscideum* (Brébisson) W. Archer



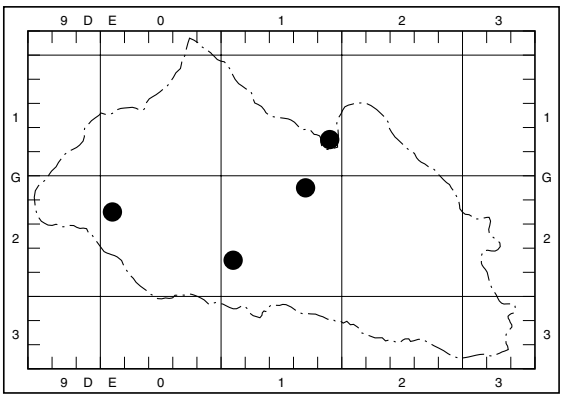
Map 225. *Staurastrum punctulatum* Brébisson



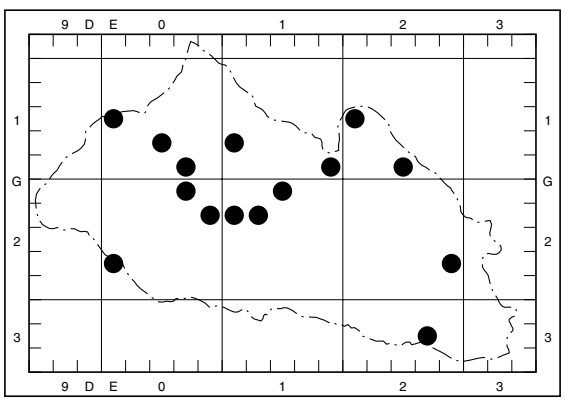
Map 226. *Staurastrum pungens* Brébisson



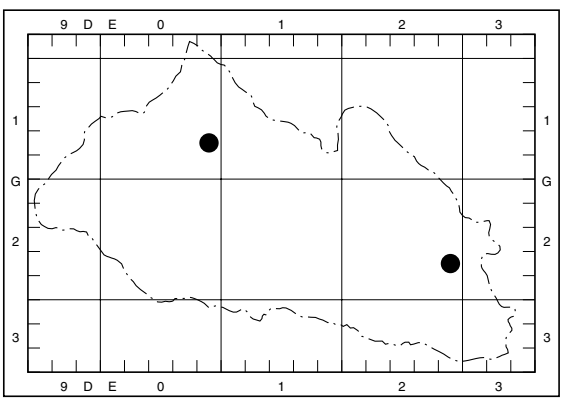
Map 227. *Staurastrum pyramidatum* West



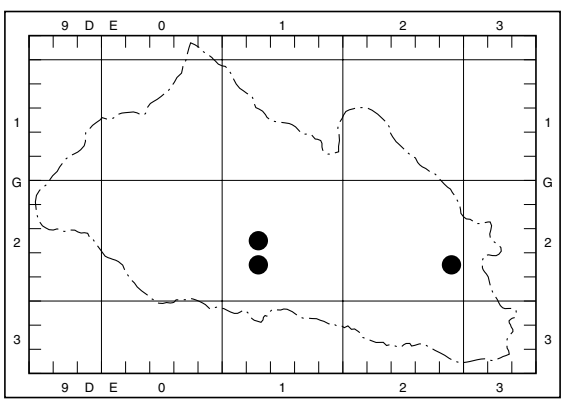
Map 228. *Staurastrum scabrum* Brébisson



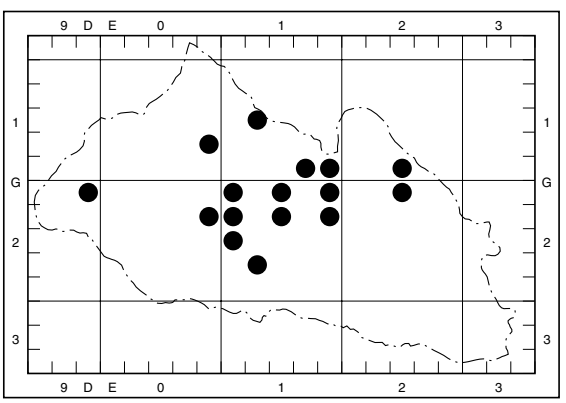
Map 229. *Staurastrum sexcostatum* Brébisson ex Ralfs



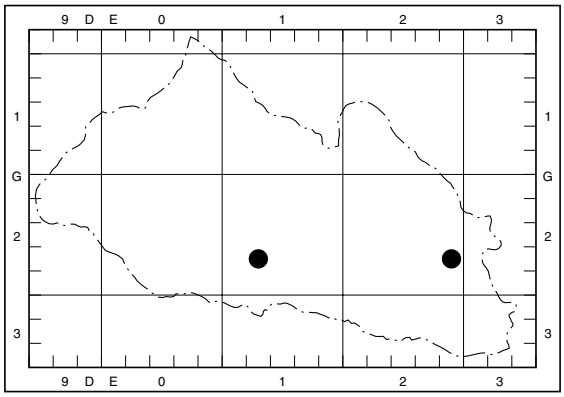
Map 230. *Staurastrum spongiosum* Brébisson ex Ralfs



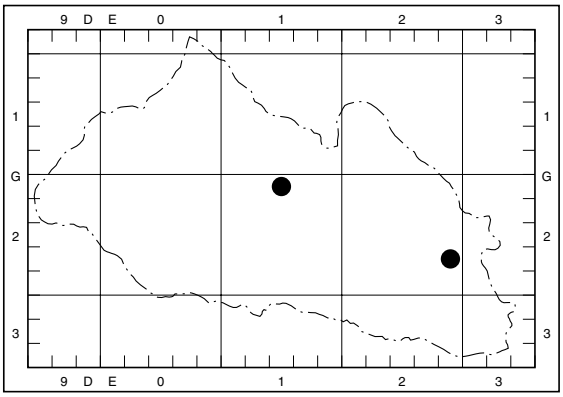
Map 231. *Staurastrum subavicula* (West) West. et G. S. West



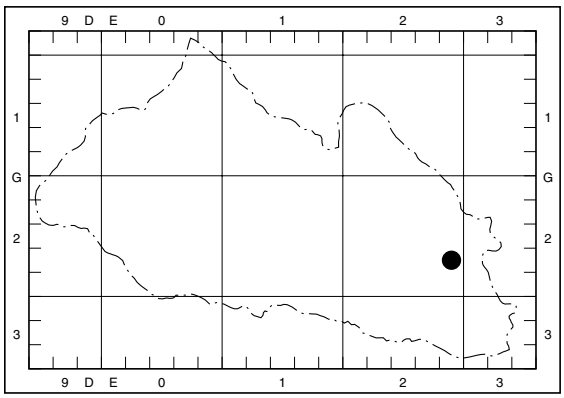
Map 232. *Staurastrum subbrebissonii* Schmidle



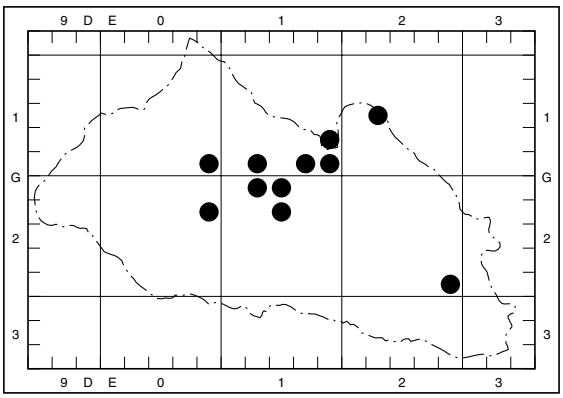
Map 233. *Staurastrum teliferum* Ralfs



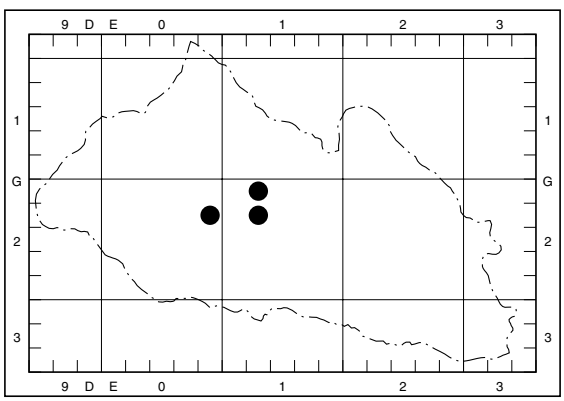
Map 234. *Staurastrum teliferum* var. *gladiosum* (W.B.Turner) Coesel & Meesters.



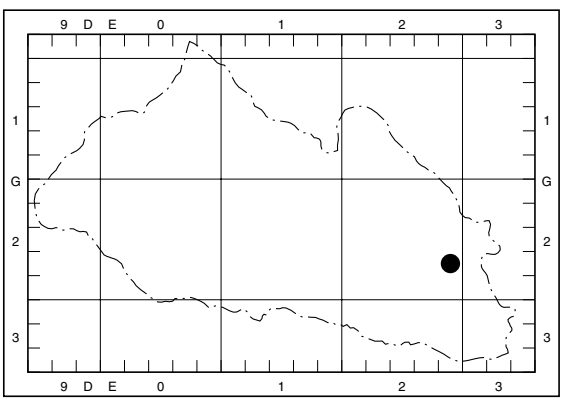
Map 235. *Staurastrum tetracerum* Ralfs ex Ralfs



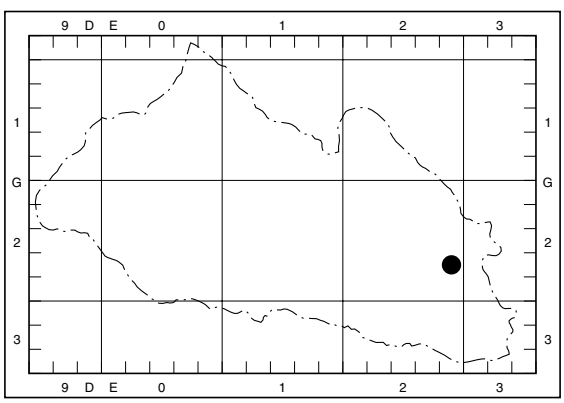
Map 236. *Staurastrum turgescens* De Notaris



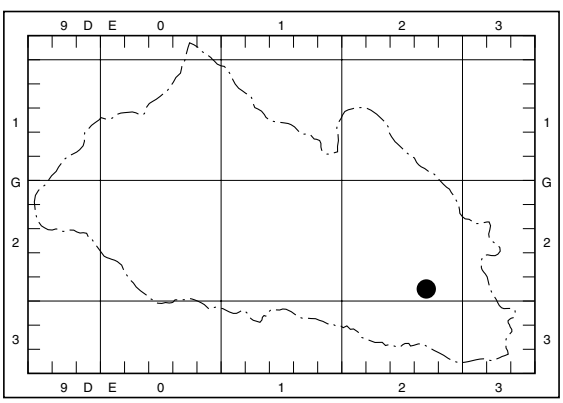
Map 237. *Staurodesmus controversus* West. et G. S. West) Teiling



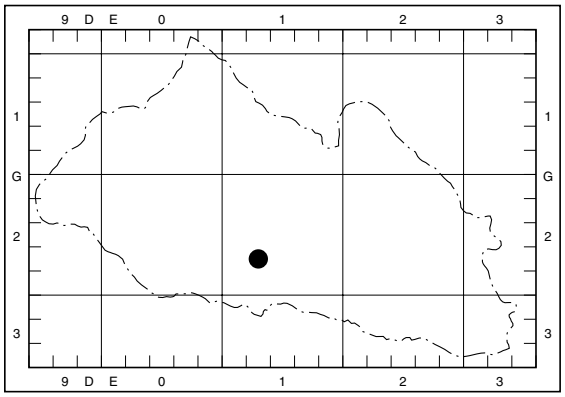
Map 238. *Staurodesmus convergens* (Ehrenberg ex Ralfs) Teiling



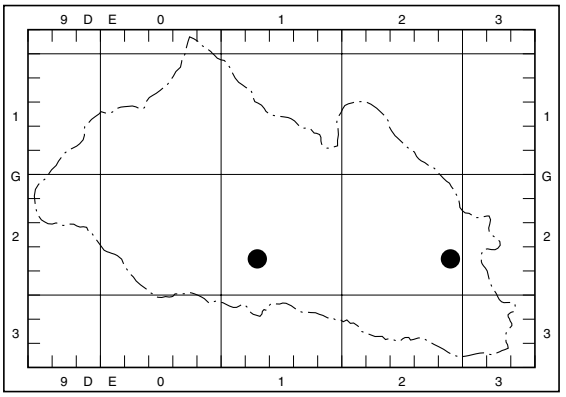
Map 239. *Staurodesmus cuspidatus* (Brébisson) Teiling



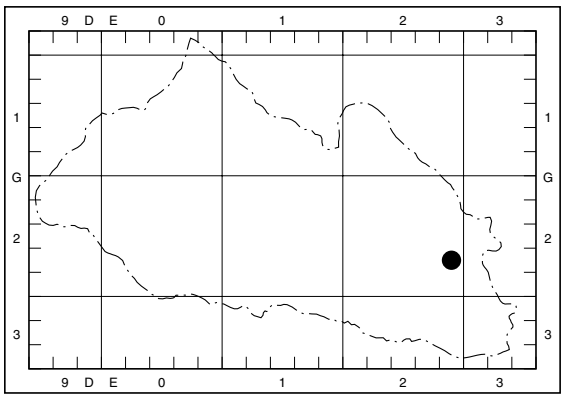
Map 240. *Staurodesmus extensus* (O.F. Andersson) Teiling



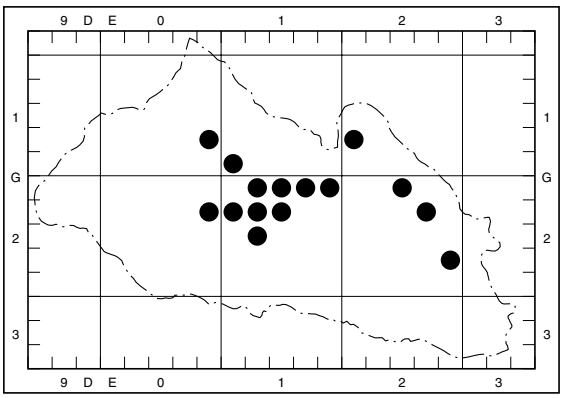
Map 241. *Staurodesmus glaber* (Ralfs) Teiling



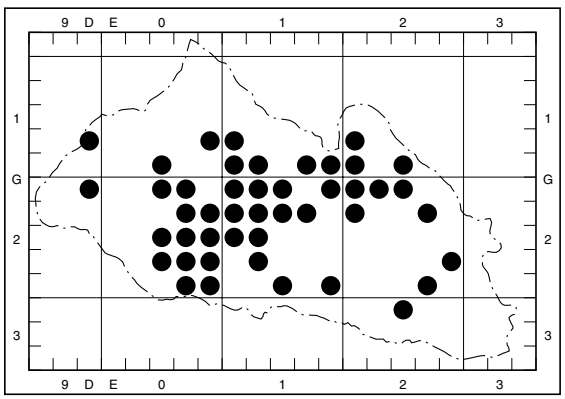
Map 242. *Staurodesmus patens* (Nordstedt) Croasdale



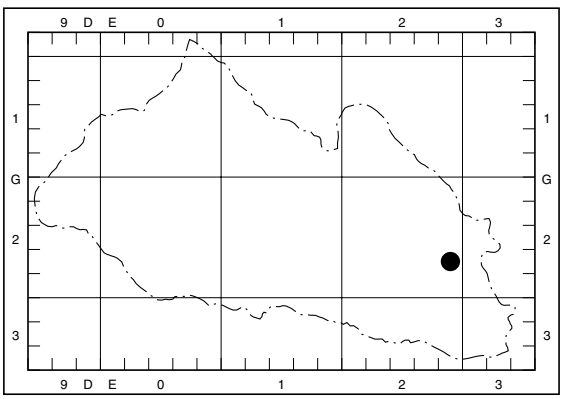
Map 243. *Teilingia granulata* (R. Roy et Bisset) Bourrelly



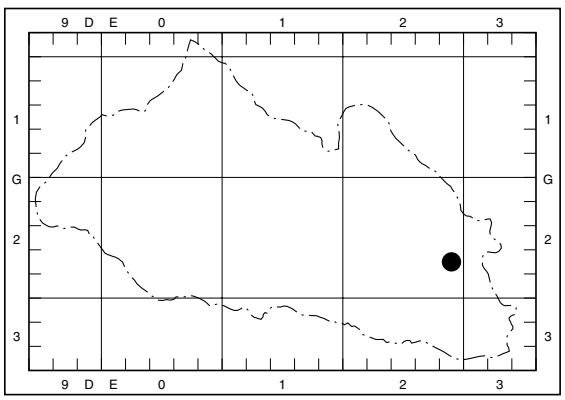
Map 244. *Tetmemorus granulatus* Brébisson ex Ralfs



Map 245. *Tetmemorus laevis* Ralfs ex Ralfs



Map 246. *Xanthidium antilopaeum* Kützing



Map 247. *Xanthidium cristatum* Brébisson ex Ralfs