Konrad WOŁOWSKI

TAXONOMIC AND ENVIRONMENTAL STUDIES ON EUGLENOPHYTES OF THE KRAKÓW-CZĘSTOCHOWA UPLAND (SOUTHERN POLAND)

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Accredited with the International Association for Plant Taxonomy for the purpose of registration of all new plant names

W. Szafer Institute of Botany, Polish Academy of Sciences

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Editorial Office
W. Szafer Institute of Botany, Polish Academy of Sciences
Lubicz 46, PL–31–512 Kraków, Poland
tel. (012) 421 51 44 fax. (012) 421 97 90 e-mail: ed-office@ib-pan.krakow.pl

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ABSTRACT: The work complements and develops investigations on the euglenophytes of the Kraków-Częstochowa Upland (Wyżyna Krakowsko-Częstochowska), Southern Poland. The Upland is built of upper Jurassic limestones forming rocky walls up to 60 m in height with picturesque stream ravines and groups of rocks and mogotes as single rocks on the outcrops.

The paper gives information on taxonomy, occurrence and environmental characteristics of euglenophytes occurring in various types of water body: karstic village and field ponds, fishponds, springs, streams ditches, puddles and damp soil.

206 euglenophyte taxa were identified, among them 161 taxa new for this area, and 69 taxa new to Poland. All the taxa are briefly described and illustrated using original drawings and photographs (LM and SEM).

Five taxa: *Euglena truncata*, *Trachelomonas botanica var. borealis, T. decorata*, *T. hirta var. duplex,* and *Phacus acuminatus* var. *indica,* are new to the European flora. Very rare taxa occurring as either single or scarce specimens and known only in Europe are: *Euglena slavjanskiensis, E. sima*, *E. hirudo*, *Trachelomonas ovoides*, *T. guttata T. sarmatica*, *T. lomnickii* and *T. gregussii* var. *danubialis*.

The results of annual observations of euglenophyte populations occurring in four chosen karstic ponds – together with physico-chemical characteristics of the water – are also given.

KEYS WORDS: Euglenophyta, taxonomy, environmental studies, Kraków-Częstochowa Upland, Southern Poland

K. Wołowski, Department of Phycology, W. Szafer Institute of Botany, Polish Academy of Sciences, ul. Lubicz 46, PL-31–512 Kraków, Poland; E-mail: Wolowski@ib-pan.Krakow.pl

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Introduction

Unlike other taxonomic groups of algae euglenophytes are rarely the subject of monographic studies in a chosen geographical region. There are only a few exceptions to this in the world literature. In the temperate climatic zone Skuja gave precise original information on all euglenophytes (and other species of algae as well) together with perfect iconographical documentation for Uppland (Skuja 1948), from various waters (Skuja 1956) and Lappland (Skuja 1964) in Sweden. In tropical regions similar work has been done by Bourrelly and Couté (1982) from French Guiana, and Thérésien (1989) from the Amazonian system in Bolivia. Special studies on *Euglena* were made in Poland (Zakryś 1986), the U.S.A. (Gojdics 1953; Zakryś & Walne 1994), Argentina (Tell & Conforti 1986), and on *Trachelomonas* in Bolivia (Couté & Thérézien 1985).

There are also a few monographs, partly compilations, in which one can find information about different regions. Popova (1966), Popova and Safonova (1976) are the authors of splendid works on the flora of the former Soviet Union for which material collected in Western Siberia was used. Vetrova (1980, 1986, 1993) gathered information about colourless euglenophytes and green *Eutreptia, Euglena, Strombomonas, and Trachelomonas* from Ukrainian continental waters.

Older compilations which served as the keys to identification of algae contain some information about euglenophytes in Czech Republic (Hansgirg 1886), and in the waters of Germany (Lemmermann 1910, 1913). The works of Huber-Pestalozzi (1955) and Starmach (1983) compiling species from almost the whole globe have lately been of great value. These monographs have greatly contributed to this taxonomic group being taken into consideration in phycological and hydrobiological papers.

In Poland, as in many other countries, the main sources of information about the group have been references obtained while investigating various taxonomic groups of algae, but the majority of them contain neither iconographical or descriptive documentation, excluding the possibility of checking the identification. They mostly concern common taxa, and a few which can be identified from the preserved material.

We can be proud, however, of a Polish specialist Roman Dreżepolski, whose scientific output was not only connected with the present Polish territory, but who also described several new taxa (Dreżepolski 1921–1922, 1925, 1948) later found in other parts of the world.

One of the most interesting regions of Poland for euglenophyte taxa is the Kraków-Częstochowa Upland (Wyżyna Krakowsko-Częstochowska), Southern Poland.

Information about euglenophytes of the Upland area can be found in 20 papers which comprise data concerning 63 taxa: *Euglena* (23), *Trachelomonas* (13), *Strombomonas* (1), *Lepocinclis* (7), *Phacus* (12), and colourless: *Astasia* (4), *Menoidium* (2), and *Hyalophacus* (1). Only six of these publications contain both graphic and written documentation dealing mainly with euglenophytes (Czosnowski 1948; Bucka 1958; Wołowski 1991c, 1992a, b, 1993). Czosnowski (1948) gave information about 45 taxa of euglenophytes but only 24 of them were found in the Kraków-Częstochowa Upland. Bucka (1958) described the representatives of *Euglena* in isolated portions of river bed left when in Kraków the Vistula was straightened. I was concerned with a very interesting group of colourless euglenophytes found in one of the Wiercica springs in the Parkowe Reserve (Wołowski 1991c). A second paper (Wołowski 1992a) deals with euglenophytes found in the ponds of the Ojców National Park. The two last-mentioned papers described the new taxa *Euglena siemińskiana* and *Euglena ettlii* found in the Kraków-Częstochowa Upland.

Single taxa were occasionally mentioned from the River Vistula (Starmach 1938; Turoboyski 1956; Kyselowa & Kysela 1966; Uherkovich 1970), River Biała Przemsza (Starmach 1938), from the spring section of the River Pilica (Cabejszek 1951; Kadłubowska 1964), the Prądnik stream at Pieskowa Skała (Pudo 1979), the carp ponds at Mydlniki (Engelhorn 1939; Starmach 1939; Szklarczyk-Gazdowa 1965), the purification plant at Aleksandrowice and at Pieskowa Skała (Pudo 1978a, b), and from various water bodies in Kraków (Kukucz 1937; Starmach 1938; Wołowski 1988).

The information from all these papers was summed up when discussing the advancement of phycological studies on the Kraków-Częstochowa Upland (Wołowski 1991a).

The aim of the present work was to carry out a thorough investigation of the taxonomy, occurrence and the effect of environmental factors on the previously little-known euglenophyte flora of various types of water body on the Kraków-Częstochowa Upland.

DESCRIPTION OF THE STUDIED AREA

The Kraków-Częstochowa Upland is a geologically and geographically well identified area (Figs 1–2). The Upland is built of upper Jurassic limestones which form rocky walls up to 60 m in height with picturesque stream ravines and groups of Jurassic limestone rocks and mogotes as single rocks on the outcrops. The area is known as the Kraków-Częstochowa Jura, because of its geology. Various karstic phenomena typical of the region are linked to the presence of limestone rocks. The Jurassic Landscape Park was formed on the most picturesque and biologically interesting area.

The Kraków-Częstochowa Upland is situated at an altitude 500 m and covers an area of 2615 km^2. It stretches from the Warta ravine near Częstochowa in the north to the Vistula valley in the south. Its south-west border runs from Kraków, Trzebienica, Olkusz, Klucze, along the valley of the River Warta up to Częstochowa, while in the north-east the border runs from Mstów, Juljanka, Lelów, Szreniawa, along the Dłubnia valley to Kraków (Czeppe 1972; Kondracki 1988; Michalik 1974).

Various kinds of water body are important landmarks of the Kraków-Częstochowa Upland. Its massif is intersected by rather small rivers (left-bank tributaries of the River Vistula): Biała Przemsza, Szreniawa, Pilica, Dłubnia, Prądnik, and Rudawa, but most of the area suffers from a water shortage. The problem is most acute in the northern part where some tributaries of the Rivers Warta and Pilica begin but most of these are temporary streams present only during the rainy season or when the snow melts. A slightly better situation is found in the middle part of the Upland in the Wolbrom area with its vast dried peatbogs which are the sources of the Rivers Centuria and Biała Przemsza.

Water is most plentiful in the southern part. In deep gorges karstic streams are present characterized by small waterfalls, stony beds and fairly clean and cold water: the Prądnik, Sąspówka, Czubrówka, Szklarka, Bętkówka, Kobylanka, Bolechowicki and Kluczwoda streams. They flow through the so-called “Dolinki Krakowskie” Landscape Park (the small valleys in the vicinity of Kraków). The numerous karstic cold vauclusers which arise from the bed of a basin are very interesting and give rise to streams. These limnocrenic springs make possible trout and bull trout culture in artificially dammed ponds. Warmer and slowly flowing streams run into carp or trout and carp culture ponds.

The permanent karstic ponds, which have no outlet, fill fairly deep land cavities and occur in the southern part of the Upland. Some of them supply villages situated on the outcrop of the Upland with water while others are situated among the fields. In the past, people living in the villages on the outcrop used to fetch drinking water from the springs and streams in the valleys; nowadays, some of these water resources are used by the water-supply service.

The water characteristics are strictly connected with the karstic character of the terrain. Springs and streams, owing to small or fairly moderate changes in their temperature fluctuation, create a specific environment for the flora and fauna.

The Kraków-Częstochowa Upland belongs to the central European climatic zone. The

average precipitation is 700 mm and the heaviest rains are in June, July, and August. Rain in this wet season falls in short, sharp showers. Precipitation varies in different regions, being higher in the south than in the north. The area has low humidity in spite of the period of heavy rain (Czeppe 1972; Michalik 1974; Zinkow 1990).

Material and methods

The study was carried out between 1986–1993, in 1997 and 1998, on samples taken from different types of water body. Water temperature and pH were measured at the same time. To characterize environmental properties of euglenophytes growing in karstic ponds – the most frequently occurring water bodies – observations on euglenophyte development as well as physico-chemical water analyses were made in 4 chosen ponds during one year.

Taxonomic studies on euglenophytes were based on live material centrifuged with a hand hydroextractor. Each sample was investigated until a full list of species was recorded. Occasionally, after the initial observations, material on an object glass was fixed in fumes of crystalline iodine (acting for 10 to 20 seconds) or in 0.5% Lugol's solution or a 0.5% solution of glutaraldehyde to enhance the cellular details, and also to immobilize the cells to facilitate microscopic examination. The colourless euglenophytes and representatives of *Euglena* preserved by these methods were examined for a short time only.

Original drawings were made with the aid of a camera lucida; photographs were taken with a Zeiss and Nicon automatic photographic system. As a rule scale bars of all illustrations are 10 µm. If different the information is given.

All measurements and descriptions were made using Jenaval Zeiss Jena and Optiphot 2 Nikon light microscopes with bright field, and Nomarski optics. The *Trachelomonas* species were studied in the Cambridge Stereoscan, and Tesla 502 SEM. The samples for the investigation using SEM were prepared by the Bozzola and Russell (1995) method.

Abundance of a species, expressed in terms of the number of its specimens, was estimated using a five degree scale as follows:

+ – the species occurred only as a single specimen at least on one slide;
1 – the species occurred as up to 6 specimens, on almost every slide (sparse);
2 – the species occurred on every slide but not on all visible fields (frequent);
3 – the species occurred on every slide and visible field (very frequent);
4 – the species formed a bloom on the surface of the water, visible to the naked eye (in masses).

From most of the sites the samples were taken once, twice or three times a year, also in winter. The investigation of possible seasonal variations was carried out by examination of samples taken once a month from four selected karstic ponds situated in villages Bębło, Jerzmanowice, Paczółtowice, and Sciborzyce.

The samples were taken at the rim of the different water bodies from open water with a plankton net, from the bottom by means of a slime aspirator of 20 ml capacity, and when neuston film was present on the water surface samples were taken with a spoon or directly onto an object glass.

The temperature and pH of the water were measured: pH was measured using a MAT 1202-SM model pH-meter. Levels of oxygen and phosphate, general and carbonate hardness, chlorine, calcium, and nitrate content were investigated with the aid of a set produced by MERC in colorimetric methods.

"Community" is a wide term with various meanings – usually it is reserved for a collection of species which live together and are linked to a particular habitat (Round 1984: 31). The term "euglenophyte community", used in this paper, denotes only a collection of euglenophytes; in this sense it is merely a collective term.

DESCRIPTION OF THE SURVEYED SITES

Samples were taken from 106 localities; but euglenophyte species, were found at only 62 sites. This does not mean that during future investigation no euglenophyes will be found in the other localities. Short descriptions of the sites are given below. They include numbers of sites surveyed (marked on the sketch of the studied area; Fig. 1–2) and dates of sampling. The numbers of the 65 sites where euglenophytes were present are typed in bold letters, numbers of those localities in which no euglenophytes were found are printed in ordinary type.

1. Kraków, Bronowice Wielkie, a puddle near a bus stop, 15.08.1985.

2. Kraków, Botanical Garden of the Jagiellonian University, the main pond, 12.06.1985.

3. Kraków, Botanical Garden of the Jagiellonian University, plastic container by the green house, to the left of the entrance, 12.06.1985.

4. Kraków, the River Vistula, near the Royal Castle on the Wawel Hill, 15.09.1991.

5. Mydlniki, the carp ponds (Jaś, Małgosia, Pstrągowa Łąka, Pokaz, Sportowiec) belonging to the Agricultural Academy, Kraków, 29.07.1986 & 12.08.1995.

6. Kraków, Przegorzały, private property on Jodłowa St., the first garden pond from the entrance, 15.05.1989.

6a. Kraków, Przegorzały, the same private property on Jodłowa St., the second, smaller garden pond, 15.05.1989.

7. Kraków, water-supply plant in Bielany, the dike pond with slow sand filter, 15.05.1989.

8. Modlniczka, karstic pond in the village centre ca 7 m in diameter, 9.09.1986.

9. Modlnica, karstic village pond (by the sports centre) covered with *Phragmites communis* and *Typha latipholia*, 9.09.1986 & 14.01.1989.

10. Modlnica, drainage ditch from the above mentioned pond, 9.10.1986 & 14.01.1989.

11. Wierzchowie, cold vaucluse in the village, 19.12.1987.

11a. Wierzchowie, Kluczwoda stream in the village, 19.12.1987.

12. Żelków, karstic pond in the village centre by a bus stop, 9.09.1986 & 19.12.1987.

12a. Bolechowice, karstic pond by the church, 19.12.1987.

13. Pisary, karstic pond I, by the entrance way to the stone-works, 18.04.1988 & 18.08.1988.

14. Pisary, karstic pond II, by the railway track near the stone-works, 18.04.1988 & 18.08.1988.

15. Pisary, carp pond I, by the entry road from Krzeszowice to Pisary, 18.04.1988 & 18.08.1988.

16. Brzezinka, ditch contaminated with farm sewage, 21.03.1989.

17. Dubie, spring (vaucluse) in a cave on the trout farm estate area, 26.08.1985 & 3.09.1986.

18. Dubie, trout farm, carp-trout ponds behind the buildings, 26.08.1985 & 3.09.1986.

19. Łączki, the second trout pond from "Szaniec" building direction, 12.04.1988.

20. Łączki, outlet from a trout pond by the buildings, 12.04.1988.

21. Łączki, Będkówka stream, above the trout farm, 12.04.1988.

22. Łazy, karstic pond by the village club, 12.04.1988.

23. Będkowice, karstic pond covered by *Phragmites communis* and *Typha latipholia* to the right from the Kraków-Olkusz road, 12.04.1988.

24. Będkowice, concrete fire-control container in the centre of the village, 12.06.1988.

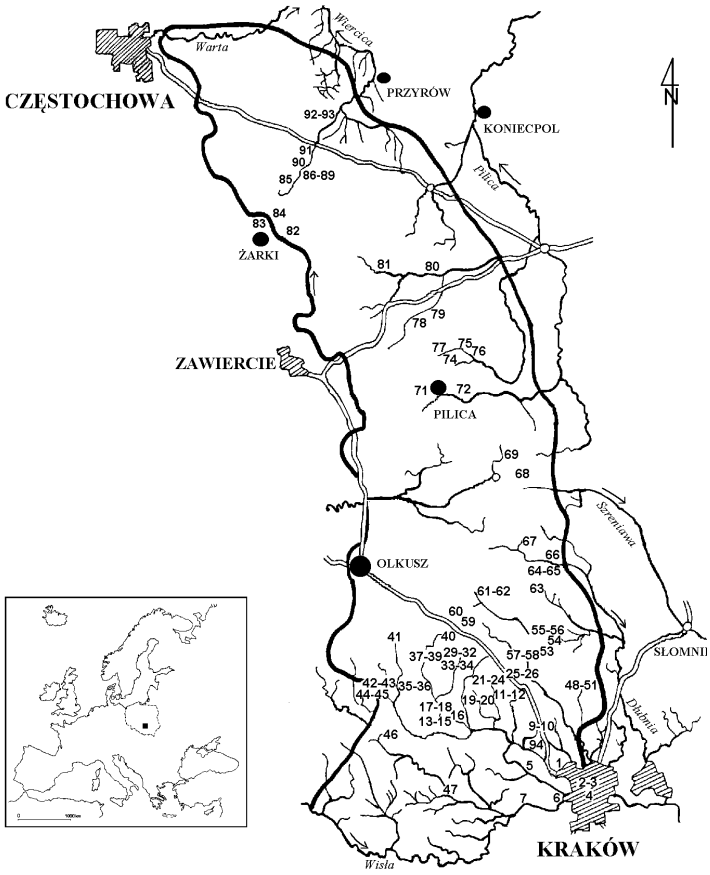
24a. Zielona Mała, Kobylanka stream, lateral channel, mud, 16.09.1993.

25. Bębło, karstic pond I, about 15 m in diameter, covered with *Lemna minor* to the left of the entrance of the road from Kraków to Olkusz at house No 56, 14.01.1989.

25a. Bębło, ditch by the road opposite the pond, 14.01.1989 & 21.03.1989.

26. Bębło, karstic pond II, about 15 m in diameter, near the grocers, 24.07.1989, and monthly observations from January 1990 to January 1991.

27. Jerzmanowice, karstic pond to the left of the main road from Kraków to Olkusz, opposite a bus stop, 26.08.1985, 2.10.1985 & 23.04.1986**,** and from January 1990 to January 1991.



Figs 1–2. Mape of the study area. **1.** Location of the area in Poland. **2.** Distribution of sites in Kraków-Częstochowa Upland. For explanation of site numbers shown on the figure see text.

28. Jerzmanowice, karstic pond in the village, 100 m from the main Kraków to Olkusz road to the left side coming from the south of the road, 26.08.1985, 2.10.1985 & 23.04.1986.

28a. Jerzmanowice, a karstic field pond above the pond situated 100 m off the main road from Kraków-Olkusz, 23.04.1986.

29. Szklary, drainage ditch near house No 47 on the way from Szklary to Dubie, 3.09.1986.

30. Jerzmanowice, hollows filled with water, hoof tracks by the spring of the Szklarka, 3.09.1986.

31. Jerzmanowice-Szklary, Szklarka stream in the valley, 3.09.1986.

32. Jerzmanowice-Szklary, steened vaucluse originating the Szklarka stream, 3.09.1986.

33. Żary, karstic pond by the school, 24.01.1989.

34. Żary, karstic pond by the shop, 24.01.1989.

35. Dębniki, karstic field pond, first right when entering the village from the north on the road from Krzeszowice, 24.01.1989 & 21.03.1989.

36. Dębniki, karstic field pond, II by the quarry, to the right, at the entrance to the village from Krzeszowice in the northern direction 21.03.1989.

37. Racławka valley, Racławka stream at the first bridge by the road from Paczółtowice to Racławice, 19.04.1988.

38. Racławice, puddles near Racławka stream in the village, near bus stop No 2, 19.04.1988.

39. Czubrowice, springs of Racławka stream near purchase centre of dairy products, 19.04.1988.

40. Górki, karstic field pond to the right of the road from Racławice to Przeginia, near a building, 19.04.1988.

41. Paczółtowice, karstic village pond, opposite the church, 10.02.1989, and monthly observations from Jan. 1990 to Jan. 1991.

42. Eliaszówka valley, Eliaszówka stream in forest 19.04.1988.

43. Eliaszówka valley, Eliasz spring, 19.04.1988.

44. Miękinia, karstic village pond at the entrance to the village from Olechówki, 19.04.1988.

45. Miękinia, Miękinka stream, in the village near a bus stop, 19.04.1988.

46. Księża Wieś near Tenczynek, dammed Wroński pond, 16.07.1991.

47. Mników, Popówka valley, from Sanka stream, 16.07.1991.

48. Przybysławice, spring on a private meadow, 18.09.1989.

49. Przybysławice, carp pond I, at the bus terminal, about 6 m in diameter, covered with *Lemna* sp., 18.09.1989.

50. Przybysławice, carp pond II, to the east of the bus stop, in front of a farm, 10 m in diameter, covered with *Lemna* sp., 18.09.1989.

51. Przybysławice, carp pond III, to the east of a bus stop, 20 m in diameter, covered with *Lemna* sp., 18.09.1989.

52. Czajowice, karstic village pond, about 20 m in diameter, to the left from the road Kraków-Olkusz, 26.09.1989.

53. Smardzowice, village pond, near the junction, about 10 m in diameter, 26.09.1989.

53a. Smardzowice, karstic pond by the road to Cianowice, about 10 m wide and 30 m long, covered with *Lemna* sp., 26.09.1989.

54. Cianowice Duże, karstic village pond about 50 m in diameter, with water bloom of blue-green algae, 26.09.1989.

55. Miotełka, small field pond I, behind forester's house, 26.09.1989.

56. Miotełka, karstic field pond near the wood, 26.09.1989.

57. Ojców, Prądnik stream, close to the bridge near the (Brama Krakowska) Kraków Gate, 24.05.1991.

58. Ojców, trout pond (the first of the Sąspówka stream), 24.05.1991.

59. Gotkowice, karstic village pond, about 15 m in diameter, near a shop, 19.04.1988.

60. Przeginia, karstic village pond, partly concreted, by the exit from the Kraków to Olkusz road, 19.04.1988.

61. Pieskowa Skała, lower old fishpond, about 7 m wide and 20 m long, the first from the Kraków Gate direction, 13.09.1989 & 9.11.1991.

62. Pieskowa Skała, upper old fishpond below the castle about 30 m in diameter, to the right when approaching from Ojców, 13.09.1989 & 9.11.1991.

63. Wielmoża near Skała, karstic village pond, about 10 m in diameter, covered with *Potamogeton densus* and *Lemna minor*, 22.08.1988.

64. Ściborzyce, village pond with inflow from spring, 8.11.1989, and monthly observations from Jan. 1990 to Jan. 1991.

65. Ściborzyce, village pond, by the road to the pig farm (former stable), 29.04.1986.

66. Małoszyce, Dłubnia stream by a bus stop, 29.04.1986.

67. Imbramowice, spring (vaucluse) of Dłubnia stream, 29.04.1986.

68. Brzozówka, karstic pond by the cross-roads, with inflow from domestic sewage, 18.09.1989.

69. Wolbrom, reservoir about 100 m in diameter, by the exit from the market in the direction to Pilica, 15.09.1988.

69a. Wolbrom, pond about 4 m in diameter in a garden near the park, post-peat bog area, 27.04.1993.

69b. Wolbrom, a reservoir near a housing quarter, on the dried peat bog, 27.04.1993.

69c. Wolbrom, Pokrzywianka stream, in a park, 27.04.1993.

70. Strzegowa, karstic village pond, covered with *Lemna minor*, in front of a bus stop, to the left when approaching Strzegowa from Wolbrom, 22.09.1988.

71. Pilica, spring of the River Pilica, 15.09.1988.

71a. Pilica, reservoir about 100 m in diameter, approaching the road to the springs of the River Pilica, 15.09.1988.

72. Pilica, River Pilica by the bridge in Wierbka, 18.09.1988.

73. Dzwonowice, karstic village pond, at the bus stop, 18.09.1988.

74. Kidów, karstic village pond by the road from Pilica to Pradła, 15.09.1988.

75. Siadcza, carp pond I, about 70 m in diameter, 15.09.1988.

76. Siadcza, carp pond II, about 30 m in diameter, 15.09.1988.

77. Szyce, carp pond about 40 m in diameter, at building No. 129, 15.09.1988.

78. Pradła, Krztynia stream, near a bus stop, 15.09.1988.

79. Pradła, carp pond, 15.09.1988.

80. Biała Błotna, carp pond, second from the main road from Pradła to Lelów, 15.09.1988.

81. Kostkowie, carp pond, 15.09.1988.

82. Jaworznik, carp pond, at the railway track, 15.09.1988.

83. Żarki, overflow arm of one of the Warta tributaries, on the Żarki/Mostów border, 15.09.1988.

84. Żarki, karstic village pond by the overflow, 15.09.1988.

85. Złoty Potok, "Zygmunt" spring (vaucluse) of Wiercica stream in the Parkowe Reserve, 8.09.1988, 13.04.1989 & 21.02.1990.

86. Złoty Potok, steened "Elżbieta" spring of Wiercica stream, in Parkowe Reserve, 8.09.1988, 13.04.989 & 17.05.1989.

87. Złoty Potok, green coating on wet soil, about 15 m from "Zygmunt" spring on Wiercica in Parkowe Reserve, 8.09.1988, 13.04.1989, 21.02.1990 & 24.07.1990.

88. Złoty Potok, Wiercica stream, in Parkowe Reserve about 30 m below "Zygmunt" spring, 8.09.1988, 13.04.1989 & 21.02.1990.

89. Złoty Potok, carp pond in Parkowe Reserve, 8.09.1988, 13.04.1989 & 21.02.1990.

90. Złoty Potok, trout pond near Parkowe Reserve, 24.07.1990.

91. Złoty Potok, trout pond, private property in the centre of village, 24.07.1990.

92. Dziadówki, forester's lodge, carp pond I, near Janów by the road from Janów to Sieraków, 22.08.1988.

92a. Dziadówki, forester's lodge, carp pond II, about 100 m in diameter, by the road from Janów to Sieraków, Budostal recreational centre, 22.08.1988.

92b. Dziadówki, forester's lodge, carp pond III near Budostal recreational centre by the road from Janów to Sieraków, overgrown with *Plantago* sp., 22.08.1988.

93. Dziadówki, forester's lodge, carp pond near Janów by the road Janów to Sieraków, 22.08.1988.

94. Budzyń at Modlniczka village, north-west of Kraków, peat bog, 5.02.1998.

TAXONOMY, OCCURRENCE, ENVIRONMENTAL CHARACTERISTICS

The Latin name of each genus and species is given, together with the authority of the first description. The monograph or detailed source used for the identification of each species is indicated in parenthesis. If no such citation is given, then the original authority cited was used for identification of the taxon.

The general taxonomic system followed is that according to Leedale (1967) using the six orders (Eutreptiales, Euglenales, Rhabdomonadales, Sphenomonadales, Heteronematales, and Euglenamorphales) of class Euglenophyta as constructed by Ross in Leedale (1967: 204). The taxonomic system for the genus *Euglena* is according to Pringsheim (1956), for *Phacus* according to Pochmann (1941) modified by Bourrelly (1985), for *Trachelomonas* according to Deflandre (1926), for *Lepocinclis* according to Perty in Conrad (1935). The taxonomic system of colourless genera is according to Leedale (1967).

The collection site numbers (in bold) are given, together with the information on habitats (p – plankton,

n – neuston, m – bottom mud, s – damp soil), and abundance (+ – single, 1 – sparse, 2 – frequent, 3 – very frequent, 4 – in masses, forming bloom; for details see Material & Methods).

Species new to Europe are indicated with three asterisks (***); new to the Polish flora with two asterisks (**); species new to the Kraków-Częstochowa Upland with one (*) asterisk. For all the taxa mentioned the cell shape and dimensions are given and accompanied by original drawings and in several cases also by light and scanning photomicrographs. Taxa new for the Polish flora are briefly described.

Information on earlier reports of the occurrence of each species in the Kraków-Częstochowa Upland and in Poland is provided. In the case of cosmopolitan species the stands in Poland are cited only when less then five. Data on the world distribution of species and their habitats were obtained from cited monographs and papers and also from the *Iconotheca of Algae* of Department of Phycology, W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.

EUTREPTIALES

DISTIGMA Holland 1942

*****Distigma curvatum*** Pringsheim 1936 (Figs 3–5)

Cells 15.1–22.5 µm long, 4.8–8.0 µm wide, slightly-elliptical, irregularly bent. Two flagella: one is longer than the cell length and the other about 1/2 the length of the cell. Pellicle finely densely striated. Paramylon grains numerous, shortly cylindrical. Nucleus small, at the posterior part of the cell. Found in site – **86**: m(+); pH 6.8.

General distribution – EUROPE: Latvia (Skuja 1939), Czech Republic (Cyrus & Sladeček 1973), Norway, Russia, Sweden (Popova & Safonova 1976), Hungary (Nemeth 1997), Ukraine (Vetrova 1980), Romania (Péterfi 1986); ASIA: Western Siberia (Popova & Safonova 1976); SOUTH AMERICA: Brazil (Menezes 1993).

Habitats – The banks of lakes, ponds, puddles, sewage treatment plants. Saprobity – α-polysaprobic (Cyrus & Sladeček 1973), α-mesosaprobic (Vetrova 1980).

****Distigma proteus*** Ehrenberg (Starmach 1983) (Figs 6–7; Plate I: 1–3)

Cells 44.5–83.5 µm long, 9.5–15.0 µm wide, long fusiform; each cell tapering towards the truncate anterior end, and narrowing to the posterior end. Found in site – **86**: m(1–2); **26**: p(+); pH 6.8–7.5.

Distribution in Poland – Previously recorded in Mazurian Lakes (Sosnowska 1974) and in a peat bog in the Karkonosze Mts (Matuła 1980).

General distribution – Cosmopolitan.

Habitats – Swamps, peat bogs, overgrown ponds and ditches, sewage. Occurred also in settling basin for radioactive waste (Lackey 1958). Saprobity – Catarobic-mesosaprobic (Lemmermann 1913), β-α-mesosaprobic (Cyrus & Sladeček 1973; Vetrova 1980).

EUGLENALES

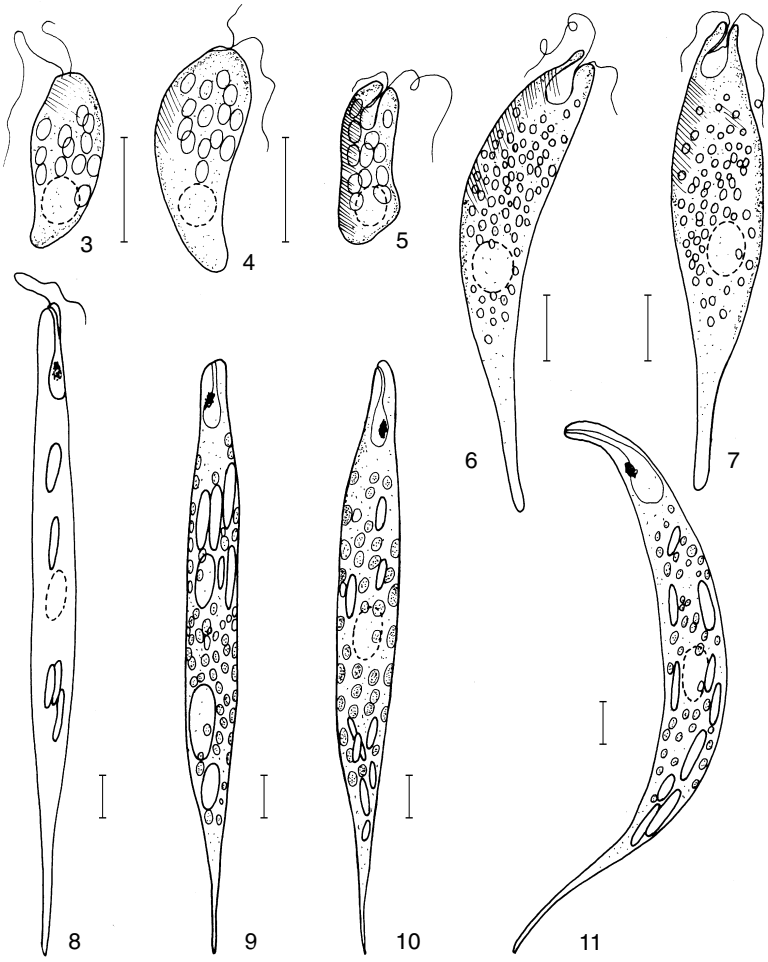
EUGLENA Ehrenberg 1830

Subgenus **Rigidae** Pringsheim 1956

Euglena acus Ehrenberg var. ***acus*** (Starmach 1983) (Figs 8–11; Plate II: 1–5)

Syn.: *E. acus* var. *rigida* Hübner, *E. acus* var. *minor* Hansgirg, *E. accutissima* Lemmermann, *E. acus* var. *lata* Swirenko, *E. acus* var. *longissima* Deflandre

Cells 120.0–176.0 µm long, 13.5–15.0 µm wide, long fusiform, broadly acicular; each cell slightly narrowing at the anterior end, gradually tapering to long, sharp hyaline tail at



Figs 3–11. 3–5. *Distigma curvatum* Pringsheim; **6–7.** *D. proteus* Ehrenberg; **8–11.** *Euglena acus* Ehrenberg var. *acus*.

the posterior end. Found in site – **6**: p(1); **27**: p(+–2); **28**: p(3); **36**: p(1); **50**: p(1); **51**: p(3); **69a**: p(+); pH 7.2–8.4.

Distribution in Poland – Very common.

General distribution – Cosmopolitan.

Habitats – Fresh water, rarely from saline waters, planktonic, in small water bodies, rice-fields, swamps, village ponds, fish- and field ponds. In salt water of Panama Canal (Prescott 1955). According to Popova (1966) amplitude of pH is 5.8–8.9, according to Palmer (1959) resistant to chromium. Saprobity – β-mesosaprobic (Kolkwitz & Marson 1908; Lemmermann 1913), β-α-mesosaprobic (Zelinka & Marvan 1961), saprophilous (Fjerdingstad 1964, 1965), α-mesosaprobic (Cyrus & Sladeček 1973).

Euglena gasterosteus Skuja 1948 (Figs 12–13; Plate III: 1–2)

Cells 41.2–49.0 µm long, 7.5–13.5 µm wide, fusiform; each cell obliquely truncate at the anterior end and terminating in a sharp hyaline tail-piece at the posterior end. Found in site – **70**: p(+); pH 7.5.

Distribution in Poland – Previously recorded in the complex of the Konin Lakes (Burchardt 1976), from Dębina Reservoir in Wielkopolska region (Dąmbska 1976), phytoplankton of Lake Pątnowskie (Burchardt 1977), reservoirs in Pawłowice near Poznań (Burchardt *et al.* 1979), phytoplankton of the lakes of the Mazurian Landscape Park (Chudyba 1979).

General distribution – EUROPE: Sweden (Skuja 1948), Latvia (Popova 1966), Ukraine (Asaul 1975), Hungary (Uherkovich 1979, 1982), Czech Republic (Wołowski 1992c).

Habitats – Reservoirs, lakes, puddles and ponds.

****Euglena limnophila*** Lemmermann 1913 var. ***limnophila*** (Figs 14–16; Plate III: 8)

Cells 50.5–66.0 µm long, 10.0–12.9 µm wide, fusiform, cylindrical fusiform, slightly flattened; each cell truncate at the anterior end, posterior end with a straight tail-piece. Found in site – **23**: p(1); **26**: p(+); pH 7.0–8.0.

Distribution in Poland – Common.

General distribution – Cosmopolitan.

Habitats – Small water bodies, ditches, ponds, small rivers with slow currents, fishponds and village ponds. Saprobity – Catarobic (Lemmermann 1913), oligo-β-mesosaprobic (Cyrus & Sladeček 1973).

****Euglena limnophila*** var. ***swirenkoi*** Popova 1955 (Figs 17–19; Plate III: 7)

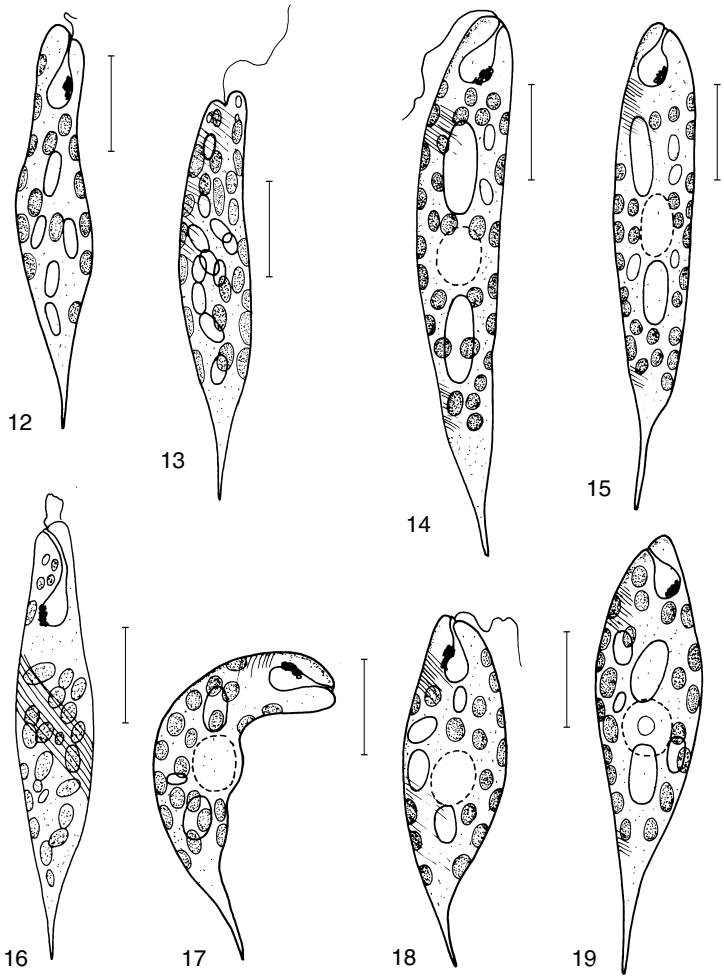
Syn.: *E. swirenkoi* Arnoldi 1922, *E. limnophila* var. *minor* Drežepolski 1925

Cells 28.1–47.5 µm long, 10.0–16.5 µm wide, fusiform, slightly bent; each cell with a curved, sharp tail-piece at the posterior end. Found in site – **9**: p(1); **10**: p(1); **14**: p(1–3); **15**: p(+); **25**: p(2); **26**: p(+); pH 7.2–8.4.

Distribution in Poland – Previously recorded in Lake Rusałka by Kotlińska (1976).

General distribution – EUROPE: Russia (Popova 1966), Romania (Péterfi 1962, Iordan 1966), Austria, Hungary (Popova 1966), Ukraine (Asaul 1975), Czech Republic (Wołowski 1992c); ASIA: Uzbekistan (Vetrova 1993), Western Siberia (Popova 1966).

Habitats – Small water bodies: ponds, banks of lakes, rivers and sewage ditches.



Figs 12–19. 12–13. *Euglena gasterosteus* Skuja; **14–16.** *E. limnophila* Lemmermann var. *limnophila*; **17–19.** *E. limnophila* Lemmermann var. *swirenkoi* Popova.

Euglena oxyuris Schmarda fo. ***oxyuris*** (Popova 1966) (Figs 20–21; Plate III: 9–10)

Cells 126.0–140.0 µm long, 11.0–24.5 µm wide, longitudinally cylindrical, slightly twisted; each cell rounded at the anterior end, posterior end with sharp tail-piece. Found in site – **2**: p(2); **9**: p(1); **27**: p(+); **28**: p(1); **41**: p(1); **64**: p(+); pH 7.0–8.4.

Distribution in Poland – Very common.

General distribution – Cosmopolitan.

Habitats – Small freshwater bodies, rarely in salt water (Prescott 1955), and waters rich in organic matter, fishponds, rice-fields, village and garden ponds; according to Matuła (1995) also in peat bogs with pH 3.5–5.0. Occurred in a settling basin for radioactive waste (Lackey 1958);

resistant to chromium (Palmer 1959). Saprobity – Mesosaprobic (Kolkwitz & Marsson 1908), catarobic-mesosaprobic (Lemmermann 1910), β-α-mesosaprobic (Zelinka & Marvan 1961), saprophilous (Fjerdingstad 1964), β-mesosaprobic (Popova 1966), oligosaprobic to β-mesosaprobic (Cyrus & Sladeček 1973).

****Euglena oxyuris*** Schmarda fo. ***maior*** Popova 1966 (Fig. 24)

Syn.: *E. oxyuris* var. *gracillima* Playfair 1921, *E. gigas* Drežepolski 1925

Cells 280–300 μm long, 30–35.0 μm wide, longitudinally cylindrical, slightly twisted at the posterior end. Found in site – **9**: p(+); **26**: p(1); **41**: p(1); pH 7.2–8.0.

Distribution in Poland – Previously recorded by Drežepolski (1925) without information about sites.

General distribution – EUROPE: Russia (Popova 1966), Ukraine (Asaul 1975); ASIA: Kazakhstan, Uzbekhistan (Vetrova 1993), Western Siberia, China (Popova 1966); AUSTRALIA (Playfair 1921); NORTH AMERICA: U.S.A. & SOUTH AMERICA (Popova 1966).

Habitats – Benthic and planktonic, small water bodies, lakes, rivers and village ponds.

*****Euglena oxyuris*** Schmarda fo. ***skvortzovii*** Popova 1966 (Figs 22–23)

Syn.: *E. oxyuris* Schm. var. *skvortzovii* Popova 1947, *E. oxyuris* fo. *minima* Bourrelly 1949

Cells 32.0–38.0 μm long, 8.5–12.5 μm wide, cylindrical. Found in site – **2**: p(1); pH 6.7.

General distribution – EUROPE: France (Bourrelly 1949), Latvia, Lithuania, Russia, Romania, Hungary (Popova 1966), Ukraine (Asaul 1975); AFRICA: Senegal (Compère 1991); ASIA: China (Vetrova 1993); NORTH AMERICA (Vetrova 1993).

Habitats – Planktonic, in slow flowing water, rivers, swamps, fishponds, and garden ponds. Saprobity – β-mesosaprobic.

Euglena spathirhyncha Skuja 1948 (Figs 25–27)

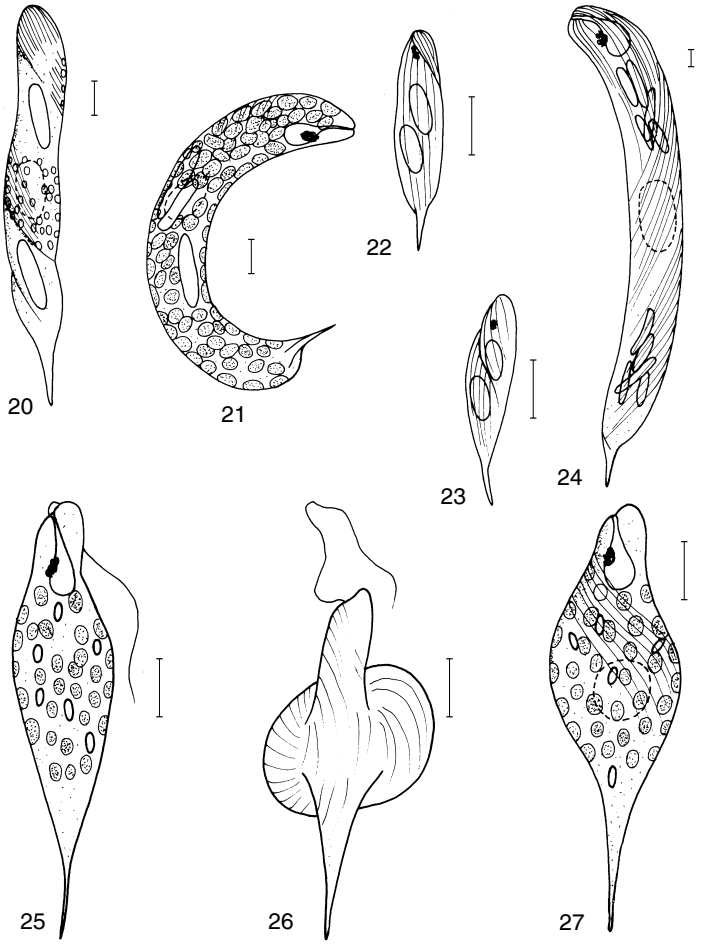
Cells 66.5–72.5 μm long, 12.0–12.6 μm wide, fusiform; each cell truncate at the anterior end, tapering and passing into a thin, sharp tail-piece at the posterior end. Found in site – **23**: p(1); pH 8.0.

Distribution in Poland – Recorded in the Kraków-Częstochowa Upland by Bucka (1958) from post-regulation ponds at the banks of the River Vistula in Kraków and by Kotlińska (1976) from Lakes Malta and Rusałka in Poznań.

General distribution – EUROPE: Sweden (Skuja 1948), Romania (Péterfi 1962; Iordan 1966), Latvia, Russia (Popova 1966), Ukraine (Asaul 1975), Hungary (Uherkovich 1977); ASIA: Western Siberia (Popova 1966), India (Naidu 1966), Uzbekistan (Vetrova 1993); SOUTH AMERICA: Argentina (Tell & Conforti 1986).

Habitats – Planktonic, lakes, small rivers, ditches, rice-fields, and village ponds. Saprobity – Saprobiontic (Fjerdingstad 1964).

Notes – According to Pringsheim (1956) related to *E. proxima*.



Figs 20–27. 20–21. *Euglena oxyuris* Schmarda fo. *oxyuris*; **22–23.** *E. oxyuris* fo. *skvortzovii* Popova; **24.** *E. oxyuris* fo. *maior* Popova; **25–27.** *E. spathirhyncha* Skuja.

Euglena spirogyra Ehrenberg var. ***spirogyra*** (Starmach 1983)

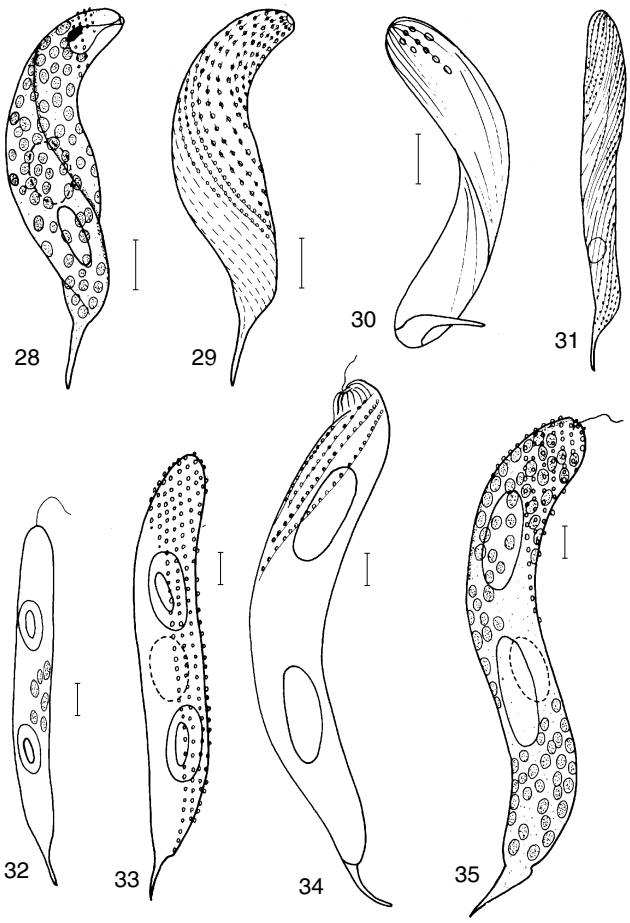
(Figs 28–32; Plate III: 3–6)

Cells 77.0–120.0 µm long, 11.0–18.8 µm wide; each cell longitudinally cylindrical, slightly narrowing and rounded at the anterior end, tapering at the posterior end into sharp, short tail-piece. Found in site – **9**: p(1); **27**: p(+); **28**: p(1); **41**: p(+–1); **59**: p(1); **61**: p(1); **62**: p(2); **64**: p(+–1); **65**: p(1); pH 7.0–8.5.

Distribution in Poland – Recorded in the Kraków-Częstochowa Upland (Bucka 1958) from post-regulation ponds at the banks of the River Vistula in Kraków.

General distribution – Cosmopolitan, very common.

Habitats – Small water bodies, swamps, ditches, pools, lakes, fish and field ponds. In salt



Figs 28–35. 28–32. *Euglena spirogyra* Ehrenberg var. *spirogyra*; **33.** *E. spirogyra* var. *fusca* Klebs; **34–35.** *E. spirogyra* var. *lacticlavius* Hübner.

water of Panama Canal (Prescott 1955). According to Lackey (1958) occurred in a settling basin for radioactive waste. Saprobity – Mesosaprobic (Kolkwitz & Marson 1908), oligo-mesosaprobic (Lemmermann 1910), β-α-mesosaprobic (Zelinka, Marvan 1961), saprophilous (Fjerdingstad 1964), oligosaprobic-α-mesosaprobic (Cyrus & Sladeček 1973).

Euglena spirogyra var. ***fusca*** Klebs 1883 (Fig. 33)

Syn.: *E. fusca* (Klebs) Lemmermann 1910, 1913

Cells 138.0–155.0 μm long, 18.0 μm wide, cylindrical, strongly flattened. Found in site – **9**: p(1); **10**: p(1); **56**: p(1); pH 6.5–7.2.

Distribution in Poland – Recorded in the Kraków-Częstochowa Upland in Kraków by Czosnowski (1948); common in Poland.

General distribution – EUROPE: Germany (Klebs 1883; Lemmermann 1910), Russia (Popova

1951), France (Bourrelly 1961a), Ukraine (Asaul 1975); ASIA: Western Siberia, Azerbaijan, Georgia (Popova 1966), Tadzhikistan, Turkmenistan (Vetrova 1993); NORTH AMERICA: U.S.A. (Gojdics 1953); SOUTH AMERICA: Venezuela (Deflandre 1928), Guyana (Bourrelly & Couté 1982), Brazil (Menenez 1989; Menenez & Fernandes 1987; Xavier 1994), Argentina (Tracana 1985, Tell & Conforti 1986); AFRICA: Ivory Coast (Bourrelly 1961b), Chad (Compère 1975; Péterfi & Coman 1987), Mozambique (Bourrelly *et al.* 1976).

Habitats – Swamps, puddles, humic water, ditches. According to Lackey (1958) occurred in a settling basin for radioactive waste. Saprobity – Catarobic-mesosaprobic (Lemmmermann 1910), saprophilous (Fjerdingstad 1964).

****Euglena spirogyra*** var. ***lacticlavius*** Hübner (Starmach 1983) (Figs 34–35; Plate III: 11)

Cells 131–170 µm long, 18.1–26.5 µm wide, cylindrical; each cell with sharply pointed projection at the posterior end. Found in site – **92**: p(1); **56**: p(1); pH 6.5–6.8.

Distribution in Poland – Previously recorded by Luer-Jeziorańska (1939) in the River Jeziorka, and by Półtoracka (1968) in a lake warmed by wastewater from a thermoelectric plant and lakes with a normal water temperature at Konin.

General distribution – EUROPE: France, Germany (Lemmermann 1913), Spain (Margalef 1948), Lithuania, Russia, Ukraine (Popova 1955), Bulgaria, Denmark, Czech Republic, Romania (Popova 1966), Hungary (Neméth 1997), Ukraine (Asaul 1975; Vetrova 1993); ASIA: Western Siberia, Eastern Arctic (Popova 1966); SOUTH AMERICA: Brazil (Tell & Conforti 1986); NORTH AMERICA: U.S.A. (Gojdics 1953).

Habitats – Small water bodies, forest pools, ditches, field ponds and fishponds. Saprobity – Catarobic-oligosaprobic.

Notes – According to Zakryś (1986) *E. spirogyra* var. *fusca* and *E. spirogyra* var. *lacticlavius* are synonymous with *E. spirogyra* var. *spirogyra.*

Euglena tripteris (Dujardin) Klebs 1883 var. ***tripteris*** (Figs 37–39)

Syn.: *Phacus tripteris* Dujardin 1841, according to Popova 1966 also *E. torta* Stokes, and *E. pseudospiroides* Swirenko

Cells 71.5–145.5 µm long, 8.5–24.0 µm wide, fusiform in outline, band shape, regularly twisted; each cell slightly narrowing at the anterior end, at the posterior end tapering into sharp hyaline tail-piece. Found in site – **27**: p(+); **28**: p(1); **41**: p(+); **50**: p(1); **51**: p(+–1); **64**: p(1); **65**: p(1); pH 7.0–7.8.

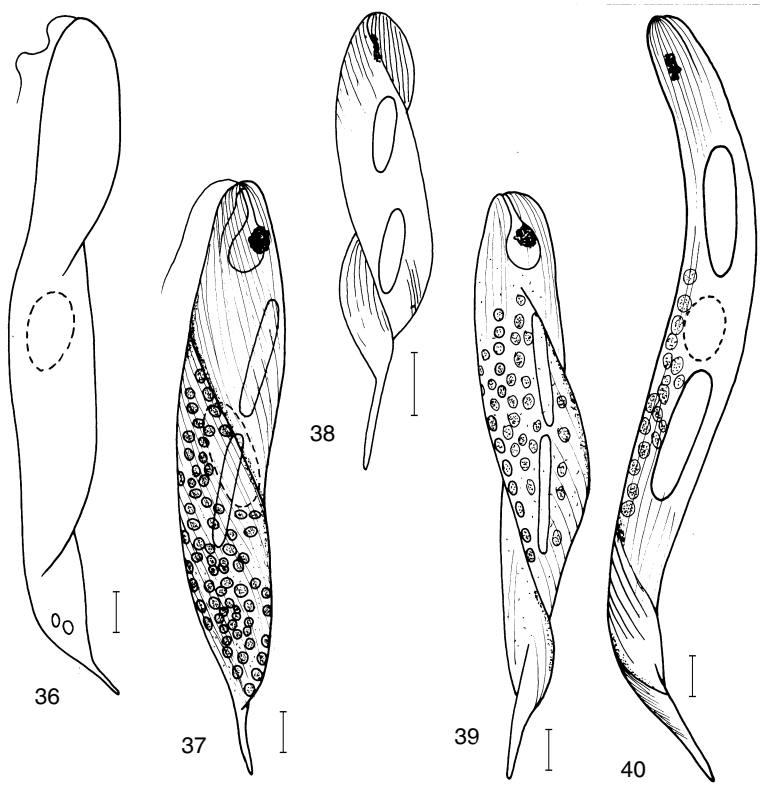
Distribution in Poland – Very common.

General distribution – Cosmopolitan.

Habitats – pH 5.1–8.7, planktonic, benthic, small water bodies, ponds, pools, ditches, and fishponds. Saprobity – Mesosaprobic (Kolkwitz & Marsson 1908), β-α-mesosaprobic (Zelinka & Marvan 1961), catarobic-mesosaprobic (Lemmermann 1913), β-mesosaprobic (Cyrus & Sladeček 1973).

****Euglena tripteris*** var. ***maior*** (Swirenko) Popova 1966 (Fig. 36, 40)

Cells 170.0–200.0 µm long, 16.5–24.0 µm wide, band shaped; each one twisted at the posterior end. Found in site – **28**: p(1); **27**: p(+); pH 6.5–7.5. The specimens are larger than the *E. tripteris* var. *tripteris*.



Figs 36–40. 37–39. *Euglena tripteris* (Dujardin) Klebs var. *tripteris*; **36, 40.** *E. tripteris* var. *maior* (Swirenko) Popova.

Distribution in Poland – Previously recorded by Półtoracka (1968) in lakes warmed by wastewater from a thermoelectric plant and lakes with a normal water temperature at Konin, and by Kowalski (1975) in the Szczecin Pomerania.

General distribution – EUROPE: Russia (Popova 1951), Hungary (Hortobagyi 1957), Ukraine (Asaul 1975), Romania (Péterfi 1962), Czech Republic (Wołowski 1992c); ASIA: Western Siberia (Popova 1966), Turkmenistan, Usbekhistan (Vetrova 1993).

Habitats – Planktonic, benthic, in small water bodies, swamps. Saprobity – Catharobic to mesosaprobic.

Notes – According to Zakryś (1986) it is synonymous with *E. tripteris* var. *tripteris*.

Euglena texta (Dujardin) Hübner var. ***texta*** (Starmach 1983) (Fig. 41; Plate IV: 1–2)

Syn.: *Crumenula texta* Dujardin, *Lepocinclis texta* (Dujardin) Lemmermann

Cells 30.0–52.2 µm long, 17.5–40.0 µm wide, round-oval, slightly narrowed at the anterior end, broadly rounded at the posterior end. Found in site – **27**: p(+–4); **41**: p(+–5); **56**: p(3); **64**: p(2); **68**: p(3); **70**: p(3); **93**: p(4); pH 6.5–7.9.

Distribution in Poland – Common.

General distribution – Cosmopolitan.

Habitats – Planktonic also benthic in small water bodies, slowly flowing waters, village and fishponds; according to Matuła (1995) in peat bogs with pH 5.1–6.6. Saprobity – Mesosaprobic (Kolkwitz & Marsson 1908, Lemmermann 1913), α-β-mesosaprobic (Cyrus & Sladeček 1973).

*****Euglena matvienkoi*** Popova 1955 (Fig. 42)

Syn.: *Lepocinclis intermedia* Matvienko

Cells 42.0–44.0 µm long, 32.0–34.0 µm wide, ovoid; each narrowed at the anterior end, broadly rounded at the posterior end. Euglenoid movement absent. Pellicle striated; nucleus in the central part of cell. Stigma very large, present at the reservoir. The locomotory flagellum as long as the cell. Chloroplasts large, with double pyrenoid. Paramylon grains small. Found in site – **35**: p(1); **41**: p(1); pH 8.0.

General distribution – EUROPE: Russia (Popova 1955), Ukraine (Asaul 1975; Vetrova 1993).

Habitat – Peat bog, swamp and ponds.

Notes – The taxon is related to *E. texta* but the chloroplasts of *E. texta* are without pyrenoids.

Subgenus **Lentiferae** Pringsheim 1956

Euglena proxima Dangeard (Pringsheim 1956) (Figs 43–44; Plate IV: 4)

Cells 43.4–78.5 µm long, 11.0–21.5 µm wide, fusiform; each cell slightly narrowing at the anterior end, posterior end tapering into short hyaline tail-piece. Found in site – **9**: p(2); **26**: p(2); **30**: p(1); **41**: p(+); **60**: p(1); **86**: p(1); pH 7.0–8.2.

Distribution in Poland – Very common.

General distribution – Cosmopolitan.

Habitats – Small water bodies, puddles, edge of peat-bogs, slowly flowing rivers, and village ponds, forms neuston membranes. Also in salt water of Panama Canal (Prescott 1955). Saprobity – Oligosaprobic (Lemmmermann 1913), saprophilous (Fjerdingstad 1964).

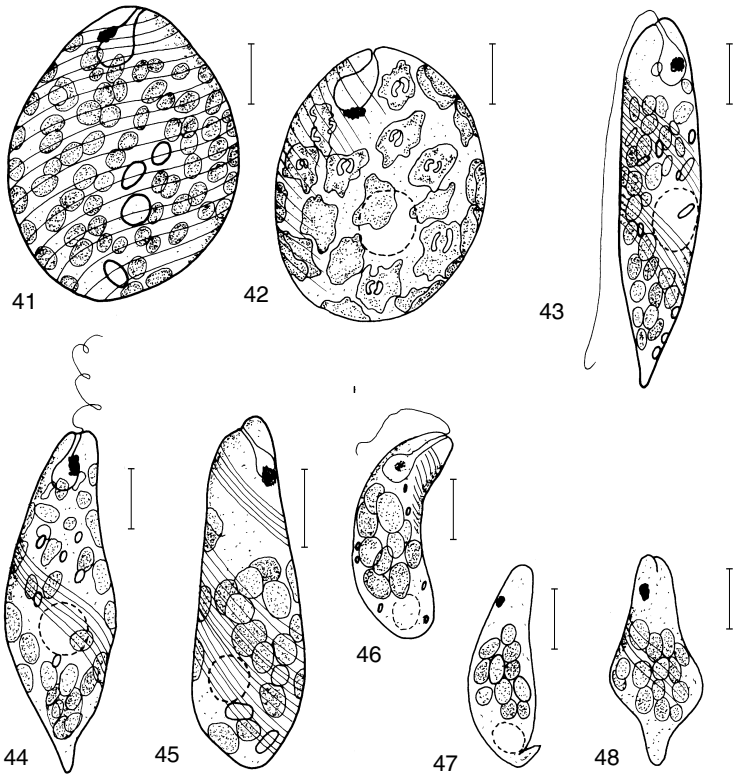
****Euglena rustica*** Schiller var. ***rustica*** (Huber-Pestalozzi 1955) (Figs 45–46)

Cells 35.0–45.2 µm long, 11.8–12.5 µm wide, fusiform-obovoid, sac like, each cell elongated at the anterior end and rounded at the posterior end. Pellicle thin, faintly striated. One emergent flagellum as long as 1/2 of the cell length. 6 chloroplasts without pyrenoids. Paramylon grains small. Found in site – **13**: p(2); **26**: p(+); **70**: p(+); **73**: p(3); pH 7.5–10.0.

Distribution in Poland – Previously recorded by Szymańska and Zakryś (1990) from ponds between villages Leszno and Kazuń near Warszawa. Unlike description of Szymańska and Zakryś (1990) my specimens had disc-shaped chloroplasts without pyrenoids.

General distribution – EUROPE: Austria (Schiller in Huber-Pestalozzi 1955).

Habitats – Village ponds. Saprobity – Meso-polisaprobic (Huber-Pestalozzi 1955).



Figs 41–48. 41. *Euglena texta* (Dujardin) Klebs var. *texta*; **42.** *E. matvienkoi* Popova; **43–44.** *E. proxima* Dangeard; **45–46.** *E. rustica* Schiller var. *rustica*; **47–48.** *E. multiformis* Schiller.

*****Euglena multiformis*** Schiller (Huber-Pestalozzi 1955) (Figs 47–48)

Cells 31.5–34.7 µm long, 9.5–11.7 µm wide, elongated fusiform, each cell rounded at the anterior end, at the posterior end tapering into short tail-piece. Euglenoid movement very strong. Flagellum 1/2 length of the cell. Stigma linear, pellicle finely striated. Chloroplasts plate-shaped, small, numerous. Found in site – **60**: p(1); **73**: p(1); pH 8.0–8.2.

General distribution – EUROPE: Austria (Huber-Pestalozzi 1955), Czech Republic (Wołowski 1992c).

Habitats – Fishponds, village ponds and puddles.

Euglena hemichromata Skuja 1948 (Figs 49–51; Plate IV: 9–10)

Cells 57.0–84.0 µm long, 10.5–45.5 µm wide, fusiform to cylindrical-fusiform; each cell slightly extended and rounded at the anterior end, gradually tapering at the posterior end. Found in site – **2**: p(+); **9**: p(1); **13**: p(2); **14**: p(+); **25**: p(2–3); **26**: p(+–3); **27**: p(+); **41**: p(1–2); **56**: p(1); **64**: p(+); **69a**: p(+); pH 6.5–10.0.

Distribution in Poland – Previously recorded in the Kraków-Częstochowa Upland in sewage treatment plant in Kraków (Wołowski 1998). Common.

General distribution – Cosmopolitan.

Habitats – Small water bodies, ponds, puddles, ditches, farm sewage, and field ponds; according to Matuła (1995) in peat bogs with pH 3.6–5.1. In organically polluted waters often forms water blooms. Saprobity – β-mesosaprobic (Cyrus & Sladeček 1973).

Notes – According to Pringsheim (1956) this species belongs to the *Radiatae* group. In my opinion since *E. hemichromata* has numerous ellipsoidal chloroplasts located at the posterior end of each cell, it belongs to the *Lentiferae* group.

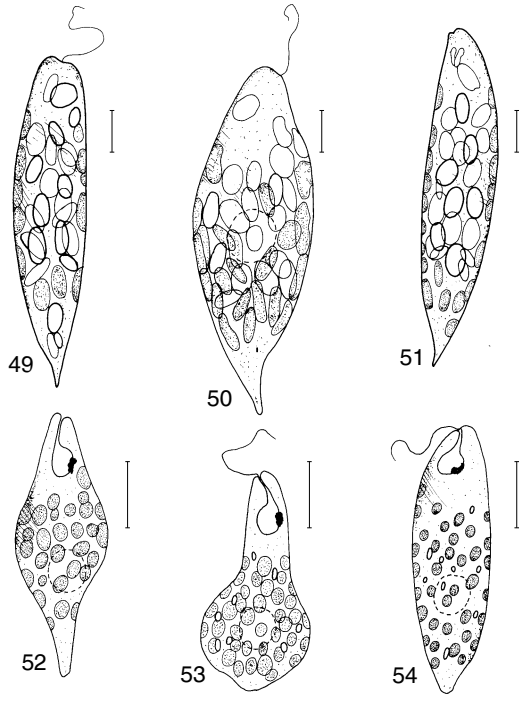
****Euglena chlamydophora*** Mainx 1927 (Figs 52–54; Plate IV: 3)

Cells 32.2–54.0 μm long, 9.0–20.0 μm wide, spindle-shaped to cylindrical; euglenoid movement violent. Chloroplasts several, dissimilar discs. Paramylon grains small, round to ellipsoidal, numerous. Pellicle finely striated. Flagellum shorter than the cell length. Several specimens were found in various sizes. Found in site – **26**: p(+); **29**: p(3); **41**: p(+); **52**: p(1); **53**: p(1); **76**: p(1); pH 7.0–8.5.

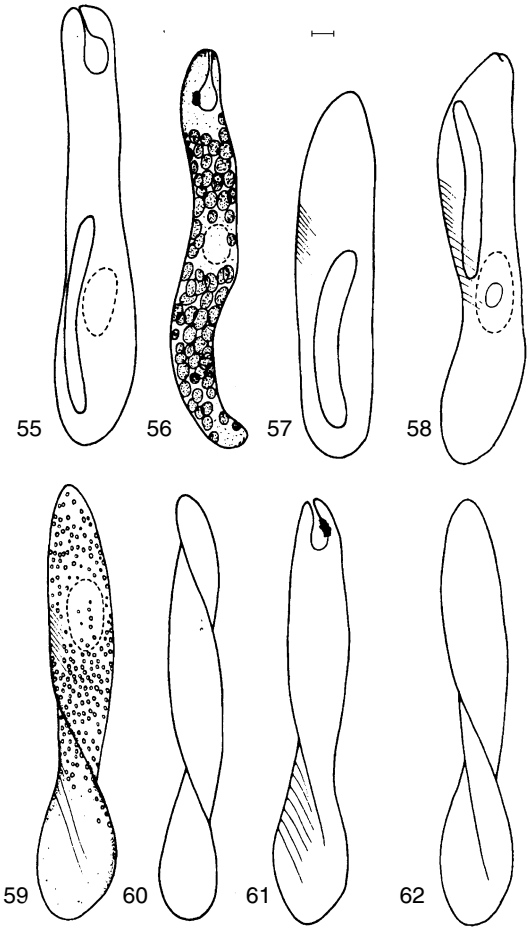
Distribution in Poland – Previously recorded by Burchardt (1977) in Lake Pątnowskie.

General distribution – EUROPE: Czech Republic, Germany (Pascher 1931), Hungary (Kiss 1982); SOUTH AMERICA: Argentina (Tell & Conforti 1986).

Habitats – Ditches, lakes, and ponds.



Figs 49–54. 49–51. *Euglena hemichromata* Skuja; **52–54.** *E. chlamydophora* Mainx.



Figs 55–62. 55–58. *Euglena ehrenbergii* Klebs; **59–62.** *E. truncata* Walton.

****Euglena ehrenbergii*** Klebs 1883 (Pringsheim 1956) (Figs 55–58; Plate IV: 7)

Syn.: *E. heimii* Lefèvre, *E. subehrenbergii* Skuja

Cells 110–247 μm long, 16.0–42.5 μm wide, longitudinally cylindrical, flattened; each cell slightly truncate at the anterior end, rounded at the posterior end. Found in site – **26**: m(1); **27**: m(+–2); **41**: m(+–2); **53**: m(+); **56**: p(1); **70**: m(1); pH 6.5–7.5.

Distribution in Poland – Common.

General distribution – Cosmopolitan.

Habitats – Benthic, small water bodies, swamps, peatbogs, puddles, fresh and brackish water. According to Lackey (1958) occurred in a settling basin for radioactive waste. Saprobity – Catharobic to oligosaprobic (Lemmermann 1913), saprophilous (Fjerdingstad 1964), β-mesosaprobic (Cyrus & Sladeček 1973).

******Euglena truncata*** Walton 1915 (Figs 59–62; Plate IV: 8)

Cells 155.0–159.0 µm long, 17.2–32.0 µm wide, elongated, band-like; euglenoid movement very slight, often assuming a twisted appearance; pellicle spirally striated. Flagellum shorter than the cell length. Chloroplasts numerous, discoid. Pyrenoids absent. Paramylon as many small granules. Found in site – **41**: m(2); pH 7.5.

General distribution – NORTH AMERICA: U.S.A. (Walton 1915; Zakryś & Walne 1994).

Habitats – Lakes and ponds.

Notes – The shape of the cell is similar to *E. ehrenbergii* but *E. truncata* has no large granules, the cells are usually twisted two or three times and are more flattened than *E. ehrenbergii* which is elongated cylindrical. According to Zakryś and Walne (1994) *E. subehrenbergii* is a synonym for *E. truncata*. *E. subehrenbergii*, however, is a synonym for *E. ehrenbergii* Klebs which was already stated by Pringsheim (1956).

*****Euglena sima*** Wermel (Starmach 1983) (Plate IV: 5)

Cells ca 112 µm long, 9.3 µm wide long-cylindrical; each cell tapering toward the anterior end and gradually narrowing to the posterior end with non-hyaline tail-piece. Pellicle smooth. Nucleus oval, located in the centre of the cell, paramylon grains small. Chloroplasts numerous, discoid, small. Found in site – **26**: m(+); pH 7.5.

General distribution – Rare; EUROPE: Ukraine (Asaul 1975), Bulgaria, Hungary, Russia (Popova 1966).

Habitats – Swamps, lakes, village ponds.

Notes – According to Pringsheim (1956) taxon is similar to *E. desses*. In my opinion it belongs to *Lentiferae* group.

*****Euglena pavlovskoënsis*** (Elenkin & Poljanskij) Popova 1951 (Plate IV: 6)

Syn.: *E. ignobilis* Johnson

Cells 90.0–116.0 µm long, 11.5–12.5 µm wide, longitudinally cylindrical; each cell rounded at the anterior end, tapering at the posterior end. Cells were more slender than Popova's specimens (1951: 13.5–16.0 mm wide). Found in site – **64**: p(1); pH 8.5.

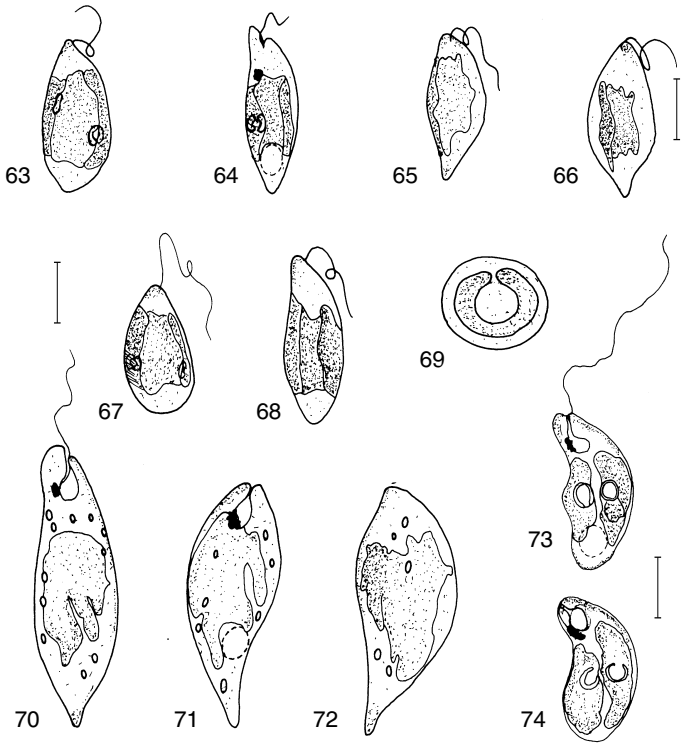
General distribution – EUROPE: Russia (Popova 1951), Ukraine (Asaul 1975); NORTH AMERICA: U.S.A. (Johnson 1944).

Habitats – Planktonic in small rivers, ponds, puddles.

Subgenus **Catilliferae** Pringsheim 1956

****Euglena archeoplastidiata*** Chadefaud 1937 Figs 63–69; Plate V: 14)

Cells 24–32 µm long, 10.5–12.0 µm wide, ovate, each cell usually slightly elongated at the anterior end and broadly rounded at the posterior end. Single chloroplast, sometimes parietal, with one or two pyrenoids. Paramylon grains small, numerous. Pellicle finely striated. Flagellum aproximately equal to the cell length. Found in site – **41**: p(+–3); pH 7.5.



Figs 63–74. 63–69. *Euglena archeoplastidiata* Chadefaud; **70–72.** *E. ettlii* Wołowski; **73–74.** *E. agilis* Carter.

Distribution in Poland – Previously recorded in West Pomerania by Zakryś (1986).

General distribution – EUROPE: France (Chadefaud 1937; Bourrelly 1963); ASIA: India (Naidu 1966); SOUTH AMERICA: Argentina (Tell & Conforti 1986).

Habitats – Swamps, ditches, and village ponds.

Euglena ettlii Wołowski 1993 (Figs 70–72)

Cells 24.4–48.8 µm long, 5.5–9.5 µm wide, fusiform; each cell gradually narrowing and rounded at the anterior end, at the posterior end tapering and ending in a colourless short tail. Found in site – **9**: p(2); **14**: p(+); pH 7.5–8.0.

Distribution in Poland – Described from a karstic village pond in the Kraków-Częstochowa Upland (Wołowski 1993).

Euglena agilis Carter (Zakryś 1997a) (Figs 73–81; Plate V: 1–13)

Syn.: *E. pisciformis* Klebs 1883, *E. bichloris* Schiller, *E. bipyrenoidata* Prošk.-Lavr., *E. nana* Johanson, *E. vangoori* Deflandre

Cells 14.5–49.0 µm long, 7.0–20.0 µm wide, short fusiform, pyriform, to oblong.

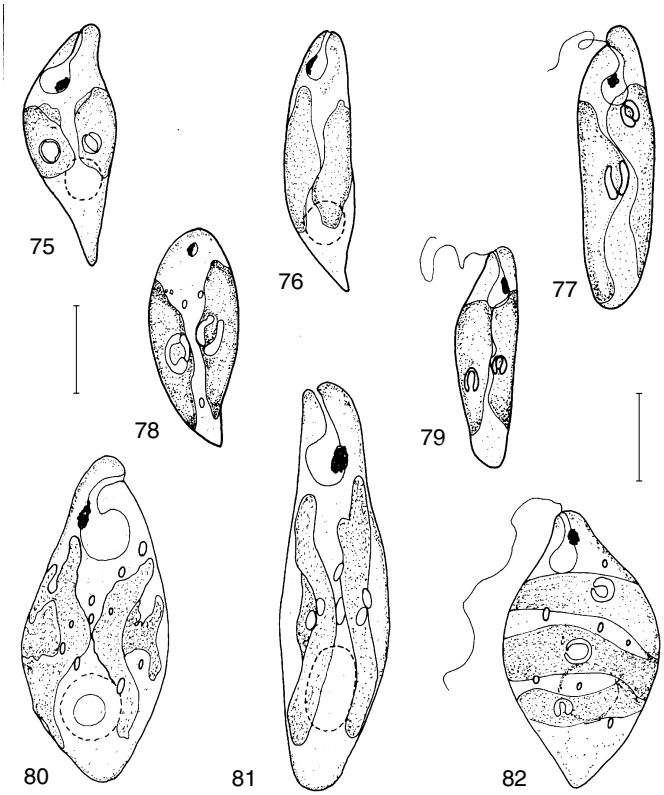
Found in site – **6**: p(1); **9**: p(1); **26**: p(2); **27**: p(+–5); **28**: p(2); **35**: p(1); **41**: p(+–5); **53**: p(2); **64**: p(+); **68**: p(1); **69a**: p(10); **70**: p(2); **73**: p(2); **86**: p(1); **92**: p(+); **93**: p(+); pH 6.8–8.5.

Distribution in Poland – Recorded in the Kraków-Częstochowa Upland by Bucka (1958) from post-regulation ponds by the banks of the River Vistula in Kraków. Common.

General distribution – Cosmopolitan.

Habitats – Small water bodies, ditches, puddles, ponds, lakes and peat bogs, with pH 5.8–8.4 (Popova 1966); according to Matuła (1995) in peat bogs with pH 3.6–5.1. Known to form water blooms. Saprobity – β-α mesosaprobic (Lemmermann 1913; Zelinka & Marvan 1961), saprophilous (Fjerdingstad 1964; Cyrus & Sladeček 1973).

Notes – Together with the species several specimens were found known only from cultivated material described by Pringsheim such as: ***E. pisciformis*** var. ***striata*** Pringsheim 1956 (Figs 75 & 76). Cells 28.0–30.0 µm long, 7.4–10.0 µm wide, fusiform, asymmetric. Anterior part widest before the middle, posterior part with double attenuations. Chloroplasts two or three with double pyrenoids. Contractile body movement weak. Found in site – **23**: p(1); **26**: p(+); **41**: p(+); pH 7.5–8.0. ***E. pisciformis*** var. ***lata*** Pringsheim 1956 (Fig. 78). Cells 25.9–31.8 µm long, 14.5–17.6 µm wide, widely fusiform, asymmetric with short tail at the posterior end of each cell. Two chloroplasts with double pyrenoids. Nucleus located near the posterior end. Flagellum the same



Figs 75–82. 75–81. *Euglena agilis* Carter; **82.** *E. minima* Francé.

length as the cell. The specimens are larger and broader than other varieties. Found in site – **26**: p(+); pH 7.4. ***E. pisciformis*** var. ***obtusa*** Pringsheim 1956 (Figs 80–81). Cells 34.8–52.9 µm long, 14.1–23.5 µm wide, pyriform, with faintly marked asymmetry. Chloroplasts two, longitudinal, with double pyrenoids. Found in site – **27**: p(+–3); pH 7.5–8.3. According to Zakryś (1997a, b) all these varieties should be treated as synonymous with *E. agilis*.

*****Euglena minima*** Francé 1897 (Fig. 82; Plate V: 15)

Cells ovoid-fusiform; each cell slightly elongated at the anterior end and rounded at the posterior end, 20.0–32.0 µm long, 10.0–11.5 µm wide. One ribbon-like chloroplast, twisted, with two pyrenoids. Euglenoid movement strong. Pellicle finely striated. Emergent flagellum one, the same length as the cell. Found in site – **9**: p(1); **26**: p(+); **27**: p(+); pH 7.2–8.5.

General distribution – EUROPE: Hungary (Francé 1897), Lithuania (Skuja 1939), Belgium, Denmark (Conrad & Van Meel 1952), Slovenia (Lazar 1960), Romania (Péterfi 1965), Russia (Popova 1966), Ukraine (Asaul 1975); ASIA: Philippines (Martinez 1978); AFRICA: Congo (Conrad & Van Meel 1952); NORTH AMERICA: U.S.A. (Walton 1915; Johnson 1944).

Habitats – Forest ponds, fishponds, puddles, peat bogs, sometimes from clean waters and ditches. Saprobity – Oligosaprobic (Kolkwitz & Marsson 1908), catarobic-oligosaprobic (Lemmermann 1913).

Notes – Some of the specimens found were smaller, some larger than the one described by Francé (1897: 27 µm long, 8–9 µm wide). According to Pringsheim (1956) the latter was probably a variety of *E. pisciformis* Klebs 1883.

Euglena anabaena Mainx 1926 var. ***anabaena*** (Figs 83–88; Plate VI: 1–2)

Syn.: *E. anabaena* var. *minor* Mainx, *E. anabaena* var. *minima* Mainx, *E. exilis* Gojdics

Cells 19.5–73.5 µm long, 8.0–23.0 µm wide, fusiform to broadly fusiform; each cell narrowing at the anterior end, at the posterior end tapering into colourless tail-piece. Found in site – **14**: p(3); **26**: p(3); **27**: p(+); **28**: p(3); **41**: p(+–4); **64**: p(+); pH 7.0–8.5.

Distribution in Poland – Previously recorded in the Kraków-Częstochowa Upland by Bucka (1958) in post-regulation ponds by the River Vistula in Kraków; in Poland found also from several places in the north-east by Zakryś (1986) and from Lake Rzepiskowy in the same part of that country (Wołowski 1991b).

General distribution – EUROPE: Czech Republic, Germany (Mainx 1926), Russia (Popova 1966), Ukraine (Asaul 1975); ASIA: Western Siberia (Popova 1966); AFRICA: Ivory Coast (Bourrelly 1961b), Senegal (Compère 1991); NORTH AMERICA: U.S.A. (Gojdics 1953; Zakryś & Walne 1994); SOUTH AMERICA: Argentina (Tell & Conforti 1986).

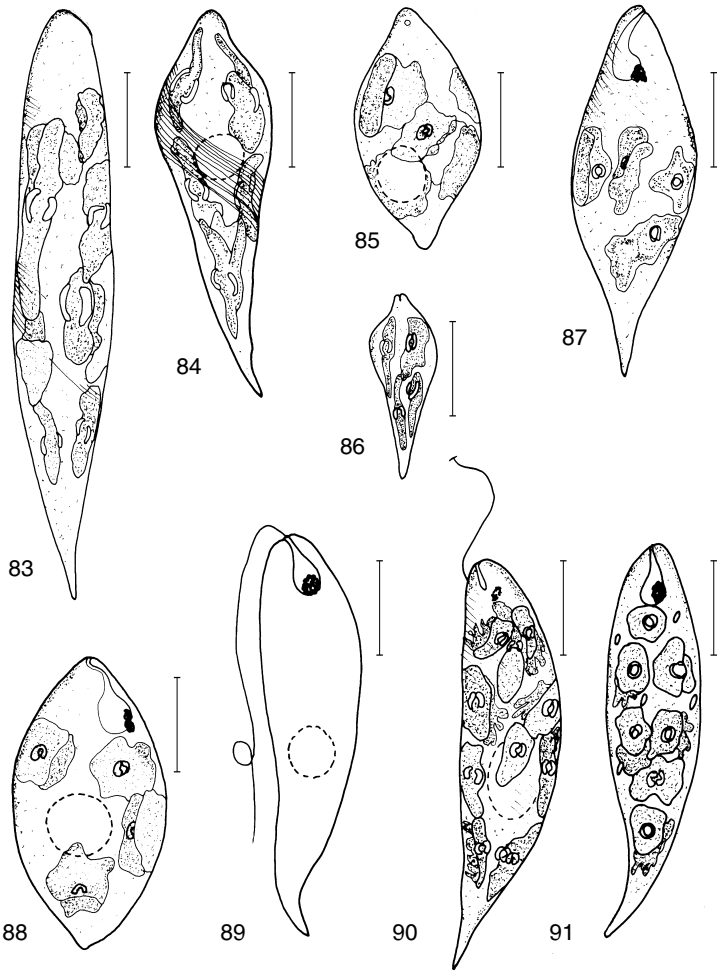
Habitats – Ponds, lakes, puddles.

Notes – The dimensions of all specimens found were intermediate between Mainx's (1926) type, var. *minor* and var. *minima*. This confirms the assumption of Pringsheim (1956) that both varieties should be treated as conspecific.

Euglena caudata Hübner var. ***caudata*** (Pringsheim 1956) (Figs 89–93; Plate VI: 5)

Syn.: *Euglena caudata* var. *minor* Deflandre 1924

Cells 50.0–97.0 µm long, 10.0–28.0 µm wide, fusiform; each cell slightly narrowed



Figs 83–91. 83–88. *Euglena anabaena* Mainx var. *anabaena*; **89–91.** *E. caudata* Hübner var. *caudata*.

and rounded at the anterior end, at the posterior end tapered and extended into tail. Found in site – **26**: p(3); **27**: p(1); **28**: p(+–1); **35**: p(+); **41**: p(+–2); **52**: p(+); **55**: p(2); **56**: p(+); **60**: p(1); **61**: p(1); **62**: p(2); **64**: p(1); pH 6.5–8.9.

Distribution in Poland – Recorded in Kraków-Częstochowa Upland in a fishpond in the Ojców National Park (Wołowski 1992a); found also in the Tatra Mts (Dreżepolski 1925), Niebieskie (Blue) Springs at Tomaszów Mazowiecki (Brutkowska 1952), peat bog at Bielawskie Błota (Czubiński *et al.* 1954), fishpond farm at Gołysz (Bucka & Kyselowa 1967), in the River Vistula near Warszawa (Zakryś 1986), and in Lake Rzepiskowy (Wołowski 1991b).

General distribution – Cosmopolitan.

Habitats – Small water bodies, puddles, ditches, ponds, rice-fields. Saprobity – Catharobic (Lemmermann 1913), α-mesosaprobic to polisaprobic (Cyrus & Sladeček 1973).

****Euglena granulata*** (Klebs) Schmitz (Hüber-Pestalozii 1955) (Figs 94–95)

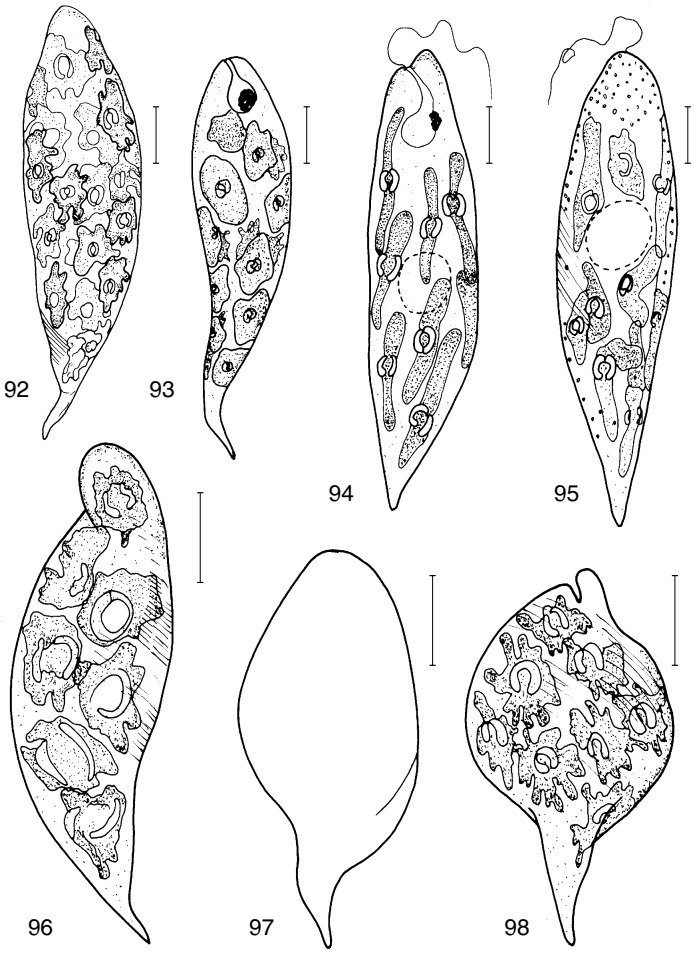
Cells 59.2–98.5 μm long, 10.7–27.5 μm wide, cylindrical fusiform, each cell rounded at the anterior end, tapering at the posterior end. Found in site – **25**: p(3); **27**: p(1); **35**: p(1); **41**: p(+); **59**: p(1); pH 6.9–8.0.

Distribution in Poland – Previously recorded from Lake Durawskie at Węgrówiec by Gabański *et al.* (1937), from Chlebowo peat bogs at Oborniki near Poznań (Gołowin 1964), from puddles at Rydzewo, Sulejki, and Białka near Warszawa (Zakryś 1986).

General distribution – Cosmopolitan.

Habitats – Planktonic in ponds, slow-flowing waters, peat bogs, and field ponds. Saprobity – Oligo-mesosaprobic (Lemmermann 1913).

Notes – Species similar to *E. caudata* but the posterior end of *E. granulata* is shorter.



Figs 92–98. 92–93. *Euglena caudata* Hübner var. *caudata*; **94–95.** *E. granulata* (Klebs) Schmitz; **96–98.** *E. polymorpha* Dangeard.

Euglena polymorpha Dangeard (Pringsheim 1956) (Figs 96–98; Plate VI: 10–11)

Syn.: *E. granulata* (Klebs) Schmitz var. *polymorpha* (Dan.) Popova 1966

Cells 37.0–85.2 µm long, 23.5–29.5 µm wide, broadly fusiform; each cell slightly narrowing and rounded at the anterior end, at the posterior end tapering into short tail-piece. Found in site – **26**: p(1); **28**: m(1); **41**: p(+); **75**: p(+); pH 6.5–8.5.

Distribution in Poland – Recorded in the Kraków-Częstochowa Upland in post-regulation ponds by the banks of the Vistula near Kraków (Bucka 1958), in the Tatra Mts (Drežepolski 1925), in small water bodies in Kraków and Zakopane district (Czosnowski 1948), and in the River Vistula at Warszawa (Zakryś 1986).

General distribution – Cosmopolitan.

Habitats – Small water bodies, ponds, lakes, peat bogs, slow-flowing rivers, also in salt water in Panama Canal (Prescott 1955). Saprobity – Saprophilous (Fjerdingstad 1964).

****Euglena gracilis*** Klebs 1883 fo. ***gracilis*** (Figs 99–100; Plate VI: 3)

Cells 41.5–65.0 µm long, 7.5–23.5 µm wide, oblong-fusiform, attenuated at the anterior end, tapering at the posterior end. Found in site – **19**: p(1); **20**: p(1); **27**: p(1–2); **28**: p(1); **41**: m(+); **51**: m(1); **52**: p(2); **55**: p(1); **56**: p(+); **86**: m(2); pH 6.5–8.0.

General distribution – Cosmopolitan.

Habitats – Planktonic and benthic, small water bodies, peat bogs, puddles, lakes, springs, village ponds, field and fishponds; often forms water blooms. Saprobity – Catharobic (Lemmermann 1913), β-mesosaprobic to polysaprobic (Zelinka & Marvan 1961), saprophilous (Fjerdingstad 1964), xenosaprobic to β-mesosaprobic (Cyrus & Sladeček 1973).

****Euglena gracilis*** fo. ***hiemalis*** Popova 1966 (Figs 101–103; Plate VI: 4)

Syn.: *E. hiemalis* Matv., *E. gracilis* var. *bacillaris* Pringsheim 1963

Cells 45.0–70.0 µm long, 11.5–17.0 µm wide, cylindrical, each cell slightly narrowing at the anterior end. Found in site – **64**: p(2); pH 7.0.

Distribution in Poland – Previously recorded by Burchardt (1976) from Konin district lakes.

General distribution – EUROPE: Russia, Ukraine (Popova 1966), Ukraine (Asaul 1975), Czech Republic (Wołowski 1992c); ASIA: Western Siberia (Popova 1966); North America: U.S.A. (Gojdics 1953).

Habitats – Swamps, puddles, lakes, ponds; often forms water blooms; found also in winter.

****Euglena clavata*** Skuja 1948 (Fig. 104; Plate VI: 6–7)

Cells 31.1–58.2 µm long, 11.5–23.0 µm wide, broadly fusiform; each cell slightly truncate at the anterior end, with tail-piece at the posterior end. Found in site – **26**: p(3); **56**: p(1); pH 6.5–7.5.

Distribution in Poland – Previously recorded by Kotlińska (1976) in Lake Rusałka, by Szyszka (1976) in Lake Gosławskie, and by Tyszka-Mackiewicz (1983) in the River Vistula from Puławy to Warszawa.

General distribution – EUROPE: Sweden (Skuja 1948), Hungary (Hortobágyi 1963), Uherko-

vich (1979), Slovakia (Wołowski & Hindák 1996); SOUTH AMERICA: Argentina (Tell & Conforti 1986); NORTH AMERICA: U.S.A. (Zakryś & Walne 1994).

Habitats – Ponds and swamps.

****Euglena oblonga*** Schmitz (Zakryś & Walne 1994) (Plate VI: 8–9)

Cells 34–40 µm long, ca 20 µm wide, broadly fusiform, ovoid; each cell rounded at the anterior end, at the posterior end passing into small, obtuse non-hyaline point. Pellicle finely spirally striated. Chloroplasts irregularly lobed with double pyrenoids. Paramylon grains small, oval. Flagellum about one or one-half the cell length. Found in site – **26**: p(+); pH 7.5.

Distribution in Poland – Previously recorded by Stefko (1976) from Lake Malta in Poznań, Kotlińska (1976) from Lake Rusałka in Poznań, and by Zakryś (1986) from an irrigation canal in Ciechocinek, and drainage canal in Kampinowska Forest.

General distribution – Cosmopolitan.

Habitats – Lakes, ponds, ditches.

****Euglena clara*** Skuja 1948 (Figs 105–106)

Cells 26.5–69.5 µm long, 10.0–24.0 µm wide, elliptical, rounded at the ends. Found in site – **14**: p(+); **27**: p(+); **41**: p(+); **53**: p(+); **75**: p(1); pH 7.5–8.5.

Distribution in Poland – Previously recorded by Burchardt (1976, 1977) in plankton of Lake Pątnowskie, Stefko (1976) in Lake Maltańskie, and by Zakryś (1986) from Poznań district and Zielona Góra.

General distribution – EUROPE: Sweden (Skuja 1948), England (Pringsheim 1956), Ukraine (Asaul 1975), Czech Republic (Wołowski 1992c), Slovakia (Wołowski & Hindák 1996); SOUTH AMERICA: Argentina (Tell & Conforti 1986)); NORTH AMERICA: U.S.A. (Zakryś & Walne 1994).

Habitats – Planktonic in ponds, swamps, peat bogs.

****Euglena obtusa*** Schmitz (Pringsheim 1956) (Figs 107–108; Plate VII: 1–2)

Syn.: *E. limosa* Gard, *E. fenestrata* Elenkin

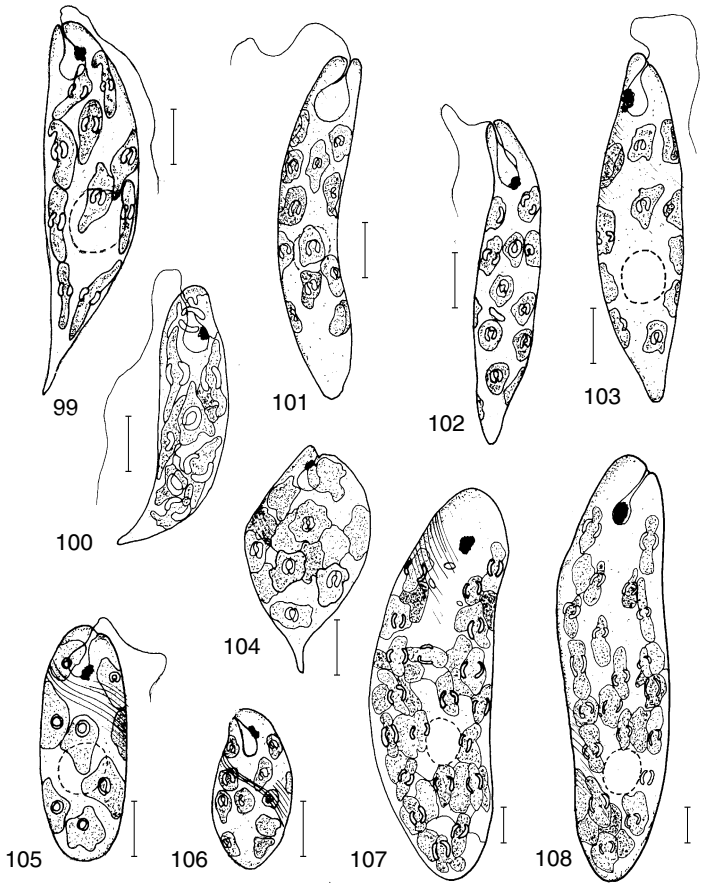
Cells 80.0–117.0 µm long, 17.0–24.5 µm wide, broadly cylindrical, rounded at the ends. Found in site – **30**: m(5), **62**: p(1); **64**: m(1); pH 7.0–8.0.

Distribution in Poland – Previously recorded by Czosnowski (1948) from cly pit in Zakopane in the Tatra Mts, and by Zakryś (1986) from Lake Kursko.

General distribution – EUROPE: England (Pringsheim 1956), France (Bourrelly 1957), Germany, Russia, Ukraine (Popova 1966), Ukraine (Asaul 1975), Czech Republic (Wołowski 1992c), Slovakia (Wołowski & Hindák 1996); ASIA: Western Siberia, Uzbekistan, Tadzhikistan (Popova 1966); NORTH AMERICA: U.S.A. (Gojdics 1953).

Habitats – Benthic in small water bodies, puddles, ditches, ponds, with beds of loam, or sand also reported from marine sandy beach (Bourrelly 1957).

Notes – The specimens described from India by Venkatesvarlu (1976: 668, *fig. 51*) seem to be *E. ehrenbergii*, as their length, 150–195 µm, is much greater than that given by Schmitz: 130 µm (after Popova 1966), and the chloroplasts have double pyrenoids.



Figs 99–108. 99–100. *Euglena gracilis* Klebs var. *gracilis*; **101–103.** *E. gracilis* fo. *hiemalis* Popova; **104.** *E. clavata* Skuja; **105–106.** *E. clara* Skuja; **107–108.** *E. obtusa* Schmitz.

Euglena splendens Dangeard (Pringsheim 1956) (Figs 109–110; Plate VII: 5–7)

Cells 67.5–97.0 µm long, 19.5–30.0 µm wide, broadly fusiform; each cell rounded at the anterior end, at the posterior end slightly tapering and ending in a short rounded projection. Found in site – **6**: p(2); **26**: p(2); pH 7.5–8.0.

Distribution in Poland – Recorded in the Kraków-Częstochowa Upland in post regulation ponds by the banks of the River Vistula near Kraków by Bucka (1958); also known in Poland from ponds in Kraków (Czosnowski 1948), from forest ponds (Bucka & Krzeczkowska-Wołoszyn 1971), from fishponds at Gołysz (Krzeczkowska-Wołoszyn 1977), and in polluted ponds in the villages Szadałowo, Witankowo, Nidzica, and Bolewice (Zakryś 1986).

General distribution – Cosmopolitan.

Habitats – Puddles, peat bogs, and garden ponds. Saprobity – Mesosaprobic (Lemmermann 1913), α-mesosaprobic (Cyrus & Sladeček 1973).

****Euglena sanguinea*** Ehrenberg (Pringsheim 1956) (Figs 111–113; Plate VII: 4)

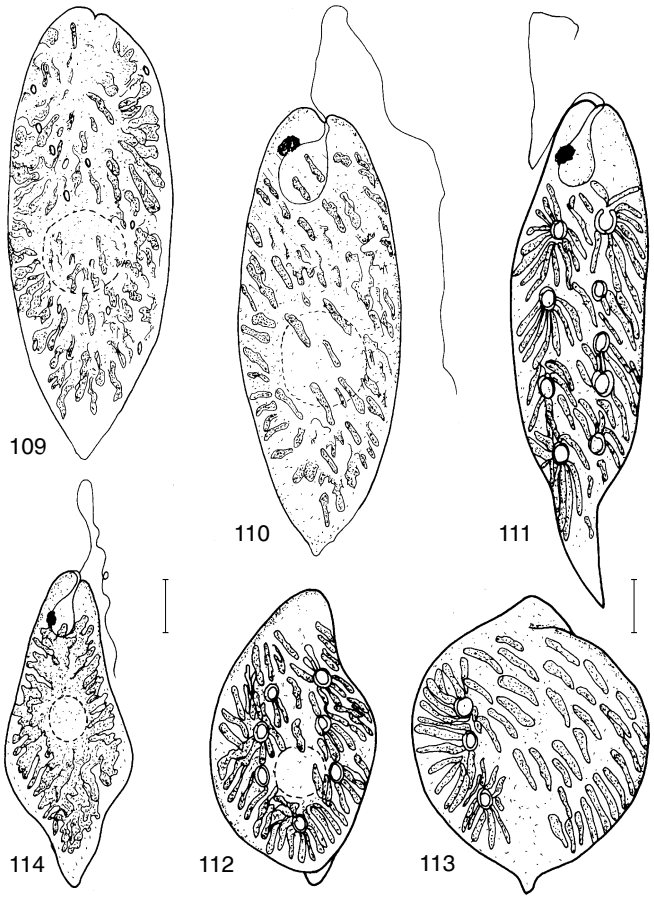
Cells 55.8–90.0 µm long, 15.8–37.0 µm wide, broadly fusiform; each cell rounded at the anterior end, tapering at the posterior end. Found in site – **13**: p(3); **26**: p(3); **64**: p(+); pH 7.0–10.0.

Distribution in Poland – Common.

General distribution – Cosmopolitan.

Habitats – Eutrophic waters, ponds, puddles, ditches, lakes, rim of peat bogs; known to form water blooms. Saprobity – Oligosaprobic-catharobic (Lemmermann 1913), β-mesosaprobic (Cyrus & Sladeček 1973).

Notes – Because the species has a barely visible structure of chromatophores it was described as various taxa by several authors. According to Chu (1947) *E. oblonga*, *E. purpurea*, *E. paludosa*, *E. mucifera*, *E. reticulata*, and *E. rubica* are synonyms for *E. sanguinea*. Pringsheim (1956) finally acknowledged only two synonyms: *E. haematodes* (Ehrenberg) Lemmermann and *E. rubida*



Figs 109–114. 109–110. *Euglena splendens* Dangeard; **111–113.** *E. sanguinea* Ehrenberg; **114.** *E. siemińskiana* Wołowski.

Mainx. He also gave as probable synonyms not definitely recognized: *E. rubra* Hardy, *E. purpurea* Mainx, *E. heliorubescens*, and some species related to *E. sanguinea,* namely *E. paludosa* Mainx, *E. splendens*, and *E. fundoversata* Johanson (1944). My observations confirm the assumption of Chu and Pringsheim that *E. rubida, E. rubra, E. haematodes* and E. *purpurea* are synonymous with *E. sanguinea*.

Euglena siemińskiana Wołowski 1992a (Fig. 114; Plate VII: 4)

Cells 44.5–60.0 µm long, 14.5–23.0 µm wide, pyriform-ovoid; each cell rounded at the antetrior end, attenuated at the posterior end. Found in site – **87**: m(5); pH 7.0.

Distribution in Poland – Described from the Kraków-Częstochowa Upland from the surface of wet soil (Wołowski 1992a).

Subgenus **Radiatae** Pringsheim 1956

Euglena viridis Ehrenberg fo. ***viridis*** (Popova 1966) (Figs 115–116; Plate VIII: 2–5)

Cells 27.0–64.7 µm long, 9.5–23.5 µm wide, fusiform; each cell slightly extended and rounded at the anterior end, posterior end with tail-piece. Found in site – **9**: p(3); **10**: p(2); **14**: p(2); **15**: p(1); **23**: p(2); **25**: p(1); **6**: p(+–3); **27**: p(+–3); **28**: p(3); **36**: p(2); **41**: p(+–1); **50**: p(+); **53**: p(1); **60**: p(2); **61**: p(2); **64**: p(+); **69b**: p(1); **73**: p(2); **86**: p(2); **92**: p(1–2); pH 6.8–8.5.

Distribution in Poland – Recorded in the Kraków-Częstochowa Upland in a pond in the Botanical Garden in Kraków (Kukucz 1937), from fishponds at Mydlniki near Kraków (Engelhorn 1939), from small puddles in Kraków (Czosnowski 1948) and from post-regulation ponds by the banks of the River Vistula near Kraków (Bucka 1958). Very common.

General distribution – Cosmopolitan.

Habitats – Various water bodies, throughout the year; with pH 4.5–8.0, and according to Matuła (1995) in peat bogs with pH 3.6–5.1. Occurred in spirit distilleries (Fjerdingstad 1964); resistant to chromium (Lackey 1958). Saprobity – Polysaprobic (Kolkwitz & Marsson 1908), β-mesosaprobic-polysaprobic (Zelinka & Marvan 1961), saprobiontic (Fjerdingstad 1964), α-meso-polysaprobic (Popova 1966; Cyrus & Sladeček 1973; Asaul 1975).

****Euglena stellata*** Mainx 1926 fo. ***stellata*** (Figs 117–118; Plate VIII: 6–7)

Cells 53.0–61.0 µm long, 13.0–21.0 µm wide, fusiform; each cell broadly rounded at the anterior end, gradually narrowed at the posterior end. This species has a star-shaped chloroplast, close to the anterior end. Found in site – **26**: p(4); pH 7.8.

Distribution in Poland – Previously recorded by: Burchardt (1977) from Lake Pątnowskie, Burchardt *et al.* (1979) in phytoplankton of water bodies in Pawłowice, Zakryś (1986) without giving the sites, and Chudyba *et al.* (1987) from Lake Tyrsko.

General distribution – EUROPE: Czech Republic (Mainx 1926), France (Chadefaud 1939); AFRICA: Ivory Coast (Bourrelly 1961b); SOUTH AMERICA: Argentina (Tell & Conforti 1986).

Habitats – Ditches, puddles, ponds; according to Palmer (1959) resistant to chromium.

Notes – Related to *E. viridis* but *E. stellata* is thicker at the anterior end, its star-shaped chloroplast is more spread, and it has a larger pyrenoid (Dragos *et al.* 1979).

****Euglena tristella*** Chu 1947 (Fig. 119)

Cells 47.0–57.0 µm long, 10.0–18.5 µm wide, fusiform; each cell slightly extending and rounded at the anterior end, narrowing to short tail-piece at the posterior end. This species possesses three star-shaped chloroplasts, each of them with centrally located pyrenoid. Found in site – **26**: p(1); pH 7.8.

Distribution in Poland – Previously recorded by Zakryś (1986) in a rural pool at the village Baranowo.

General distribution – EUROPE: England (Pringsheim 1956), Romania (Péterfi 1986); ASIA: China (Chu 1947).

Habitats – Ponds, streams, farm ditches.

Notes – The taxon is related to *E. geniculata* but differs from it in having three (instead of two) paramylon centres and having densely packed, fringed and tessellated chloroplasts (Pringsheim 1956). According to Péterfi *et al.* (1979) *E. geniculata* was found to have a quite different pyrenoid pattern and as such should now be excluded from the subgenus *Radiatae*. I agree with Pringsheim's (1956) opinion, which is supported by the latest investigation of Zakryś and Walne (1998) using the transmission electron-microscope, that chloroplast structure and morphology of *E. geniculata* are similar to those of *E. viridis, E. stellata,* and *E. tristella.*

****Euglena geniculata*** Dujardin var. ***geniculata*** (Pringsheim 1956)
(Fig. 120; Plate VIII: 9)

Syn.: *E. schmitzii* Conrad & Van Meel 1952, Gojdics 1953, Zakryś 1986

Cells 46.0–80.0 µm long, 9.0–20.0 µm wide, fusiform, each cell rounded at the anterior end, tapered at the posterior end. Found in site – **1**: m(1); **3**: p(1); **8**: p(2); **9**: p(1); **16**: p(2); **26**: m(+–4); **27**: m(1); **30**: p(2); **53**: p(1); **68**: p(1); **70**: p(1); **73**: m(1); pH 6.5–8.5.

Distribution in Poland – Common.

General distribution – Cosmopolitan.

Habitats – Small water bodies, ponds, ditches, puddles, rich in organic substances; pH 5.5–8.5 (Asaul 1975). Saprobity – Oligosaprobic (Kolkwitz & Marrson 1908), catharobic-oligosaprobic (Lemmerman 1913), α-mesosaprobic to polysaprobic (Cyrus & Sladeček 1973).

****Euglena geniculata*** var. ***terricola*** Dangeard (Pringsheim 1956)
(Fig. 121; Plate VIII: 8)

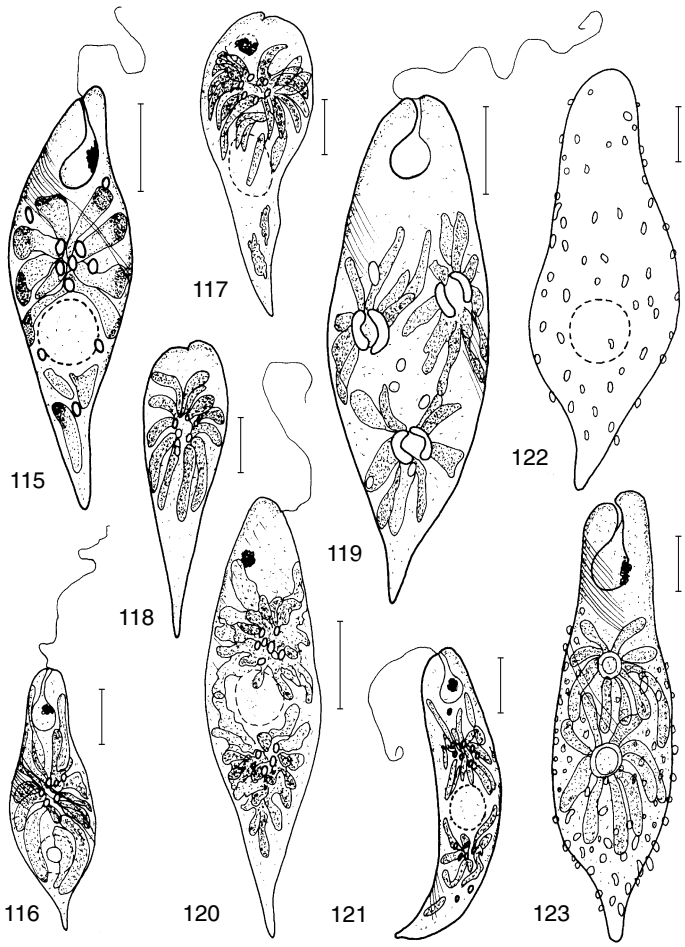
Syn.: *E. terricola* Dujardin

Cells ca 50.0–53.0 µm long, 10.0 µm wide, cylindrical fusiform, each cell rounded at the anterior end, slightly narrowing at the posterior end. Found in site – **26**: p(+–3); pH 7.5.

Distribution in Poland – Previously recorded in the Tatra Mts by Dreżepolski (1925, 1948), by Humbelt-Pawłowska (1939) in phytoplankton of water plant in Warszawa, Luer-Jeziorańska (1939) in plankton of the River Jeziorka, Wysocka-Bujalska (1952) in the River Vistula near Warszawa, and Kadłubowska (1961) in reservoirs near Łódź and neighbourhood,

General distribution – Cosmopolitan.

Habitats – Swamps, puddles, ponds, rivers. Saprobity – Catharobic (Lemmermann 1913; Huber-Pestalozzi 1955), α-mesosaprobic (Sladeček & Perman 1977).



Figs 115–123. 115–116. *Euglena viridis* Ehrenberg fo. *viridis*; **117–118.** *E. stellata* Mainx fo. *stellata*; **119.** *E. tristella* Chu; **120.** *E. geniculata* Dujardin var. *geniculata*; **121.** *E. geniculata* var. *terricola* Dangeard; **122–123.** *E. chadefaudii* Bourrelly.

****Euglena chadefaudii** Bourrelly 1951 (Figs 122–123)

Cells 77.0–80.5 µm long, 25.5–28.5 µm wide, fusiform; each cell rounded at the anterior end, and gradually tapering to the posterior end. Two irregularly star-shaped chloroplasts similar to *E. geniculata* are present. Under the pellicle there are mucus bodies; pellicle striated, covered by mucilage and by small pieces of detritus. Flagellum slightly shorter than the length of the cell. Found in site – **26**: m(1); pH 7.5.

General distribution – EUROPE: France (Bourrelly 1951); NORTH AMERICA: U.S.A. (Gojdics 1953).

Habitats – Lakes and ponds.

Subgenus **Serpentes** Pringsheim 1956

Euglena adhaerens Matvienko (Popova 1966) (Plate IX: 9)

Syn.: *E. tatrica* Czosnowski 1948

Cells 110–115 µm long, 8.0–11.0 µm wide, long cylindrical, truncate and each cell gradually narrowing at the anterior end. Found in site – **62**: p(+); **62**: p(2); pH 7.0–8.0.

Distribution in Poland – Previously recorded in Poland by Czosnowski (1948) from peat bogs in the Tatra Mts, and Matuła (1980) in peat bogs in the Karkonosze Mts and by Wołowski (1992a) from the Kraków-Częstochowa Upland in Ojców National Park).

General distribution – EUROPE: Sweden (Skuja 1956), Latvia, Russia (Popova 1966), Ukraine (Asaul 1975), Hungary (Uherkovich 1977, 1988); ASIA: Western Siberia (Popova 1966).

Habitats – Swamps, peat bogs, puddles, village ponds and fishponds. Saprobity – Oligosaprobic (Cyrus & Sladeček 1973).

*****Euglena hirudo*** Drežepolski 1925 (Fig. 124; Plate IX: 5)

Cells 52.9–64.0 µm long, 9.0–10.5 µm wide, cylindrical to spindle-shaped. Chloroplasts small, oval each with a pyrenoid; nucleus elliptical. Emergent flagellum about 1/3 length of the cell. Euglenoid movement very violent. Found in site – **26**: p(+) & m(1); **28**: m(2); pH 7.4–8.2.

General distribution – Known only from EUROPE: Ukraine (Drežepolski 1925).

Habitats – Fishponds, village ponds.

Euglena deses Ehrenberg fo. ***deses*** (Pringsheim 1956) (Figs 125–127; Plate IX: 3)

Cells 60.0–125.0 µm long, 7.0–24.5 µm wide, oblong cylindrical, flattened, band shaped; each cell slightly attenuated at the anterior end, narrowed into a short hyaline projection at the posterior end. Found in site – **1**: m(2); **3**: m(1); **9**: m(1); **13**: m(1); **16**: (+–2); **26**: m(+–1); **27**: m(+–2); **29**: m(4); **31**: p(1); **36**: m(1); **40**: m(2); **41**: p(+); **53**: m(1); **56**: m(2); **59**: m(2); **68**: m(2); **77**: p(1); **87**: s(3); **93**: m(2); pH 7.0–8.5.

Distribution in Poland – Very common.

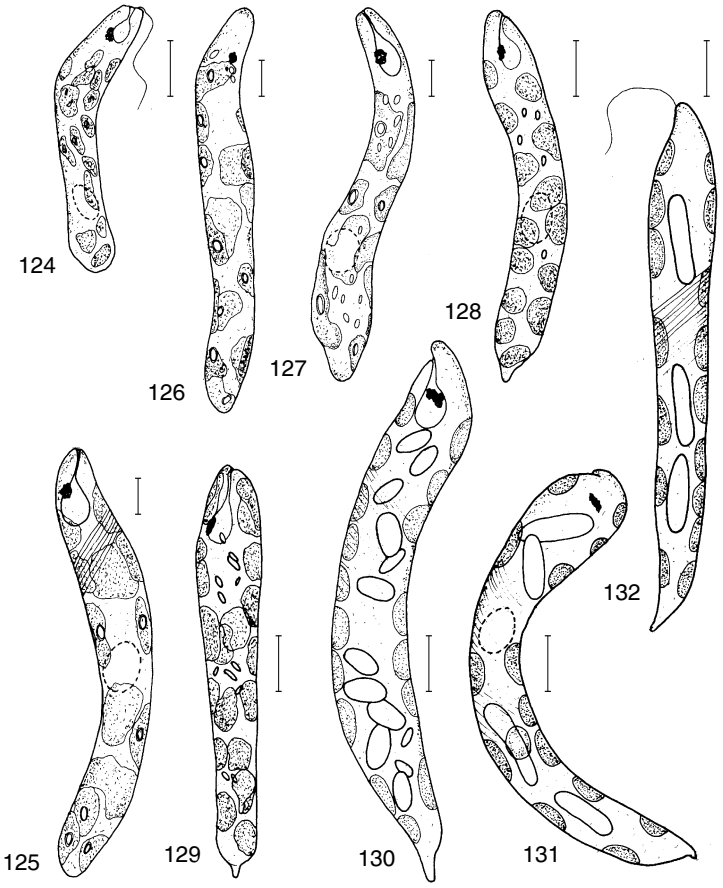
General distribution – Cosmopolitan, very common.

Habitats – Small water bodies, puddles, ponds, swamps, lakes, peat bogs, edge of river banks and ditches, fishponds; often makes green coating on the surface of mud and soil. Saprobity – Mesosaprobic (Kolkwitz & Marsson 1908; Lemmermann 1913), saprophilous (Fjerdingstad 1964), polysaprobic (Cyrus & Sladeček 1973). According to Lackey (1958) occurred in a settling basin for radioactive waste.

Euglena deses fo. ***klebsii*** (Lemmermann) Popova 1966 (Figs 128–129; Plate IX: 6–7)

Syn.: *E. intermedia* (Klebs) Schmitz var. *klebsii* Lemmermann 1910, *E. klebsii* Lemmermann

Cells 61.0–73.0 µm long, 7.5–13.5 µm wide, longitudinally cylindrical, flattened. Found in site – **16**: m(1); **27**: m(+); **55**: m(1); **56**: m(1); **60**: m(1); **68**: p(1); **87**: m(1); pH 6.5–8.6.



Figs 124–132. 124. *Euglena hirudo* Drežepolski; **125–127.** *E. deses* Ehrenberg fo. *deses*; **128–129.** *Euglena deses* fo. *klebsii* (Lemmermann) Popova; **130–132.** *E. deses* fo. *intermedia* Klebs.

Distribution in Poland – Previously recorded by Drežepolski (1925) in Lake Morskie Oko in the Tatra Mts, by Stefko (1976) from Lake Maltańskie in Poznań, Biernacka (1963) from Rożnów Reservoir, by Wołowski (1992b) from wet soil in the Kraków-Częstochowa Upland, by Matuła (1995) in peat bogs in the Karkonosze Mts.

General distribution – Cosmopolitan, very common.

Habitats – Small water bodies, ponds, puddles, rice-fields, non mineralized water, and according to Matuła (1995) in peat bogs with pH 3.6–4.25. Saprobity – Mesosaprobic.

Euglena deses fo. ***intermedia*** Klebs 1883 (Figs 130–132; Plate IX: 4)

Syn.: *E. intermedia* (Klebs) Schmitz

Cells 85.5–126.0 µm long, 7.0–20.0 µm wide, cylindrical; each cell slightly truncate at the anterior end. Found in site – **1**: p(1); **16**: p(1); **25**: m(2); **25a**: m(3); **27**: m(+); **35**: m(1); **36**: m(1) & p(1); **41**: m(+); **77**: m(1); **91**: m(2); pH 6.5–10.0.

Distribution in Poland – Previously recorded in the Kraków-Częstchowa Upland by Wołowski (1992b) from wet soil. Common.

General distribution – Cosmopolitan, very common.

Habitats – Puddles, ditches, swamps, small rivers, rice-fields, tolerant of saline water. Saprobity – Mesosaprobic (Lemmermann 1913), β-mesosaprobic to polysaprobic (Zelinka & Marvan 1961), saprophilous (Fjerdingstad 1964), β-mesosaprobic (Popova 1966), oligosaprobic to α-mesosaprobic (Cyrus & Sladeček 1973).

*****Euglena lucens*** Günther (Huber-Pestalozzi 1955) (Plate IX: 1–2)

Cells 84.0–97.0 μm long, 12.5 μm wide, oblong cylindrical, each cell slightly narrowed at the anterior end, with short tail at the posterior end. Pellicle slightly striated; chloroplasts large, oval; numerous paramylon grains; nucleus located in the centre of the cell. Found in site – **13**: m(1); **16**: m(+); pH 8.5–10.0.

General distribution – EUROPE: Germany (Huber-Pestalozzi 1955); SOUTH AMERICA: Argentina (Tell & Conforti 1986).

Habitats – Ponds, ditches.

Notes – Acording to Pringsheim (1956) it is probably synonymous with *E. deses*, however, it has larger chloroplasts and the cells are narrowed at the anterior end.

Euglena mutabilis Schmitz (Starmach 1983) (Figs 133–135)

Cells 72.0–102.0 μm long, 7.3–13.8 μm wide, long cylindrical, flattened, each cell slightly narrowed at the anterior end, tapered at the posterior end. Found in site – **26**: m(3); **56**: m(2); **61**: m(2); **87**: s(1); pH 6.5–7.5.

Distribution in Poland – Common.

General distribution – Cosmopolitan.

Habitats – Associated with surfaces in ditches and forest puddles, wet soils and village ponds, and according to Matuła (1995) in peat bogs with pH 3.6–6.6. Occurred in a settling basin for radioactive waste (Lackey 1958), and wastes from a sulphuric acid factory with pH 1.9 (Hein 1953). Saprobity – Saprophilous (Fjerdingstad (1964), oligosaprobic (Cyrus & Sladeček 1973).

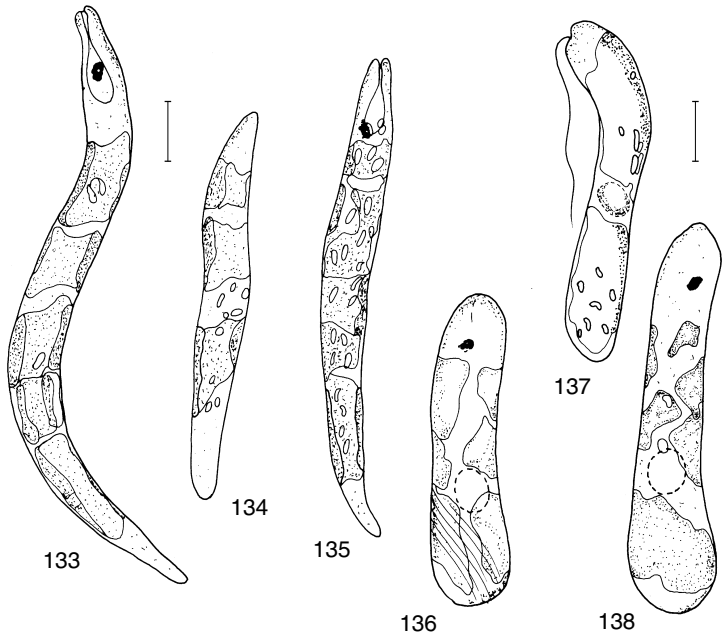
*****Euglena slavjanskiensis*** Proškina-Lavrenko (Popova 1966)
(Figs 136–138; Plate IX: 8)

Cells 50.0–61.1 μm long and 8.2–11.5 μm wide, cylindrical; each cell rounded at the anterior end, sometimes slightly extended to short tailpiece at the posterior end. Pellicle spirally striated. Chloroplasts discoid, slightly lobed, about 6 in a cell. Paramylon grains small, ovoid. Flagellum about 1/2 the length of the cell. Found in site – **87**: m(1); pH 7.0.

General distribution – EUROPE: Russia; ASIA: Western Siberia, Tadzhikistan (Popova 1966).

Habitats – Small ponds, rivers and on the surface of the wet soil.

Notes – The taxon is close to *E. deses* but its euglenoid movement is more gentle.



Figs 133–138. 133–135. *Euglena mutabilis* Schmitz; **136–138.** *E. slavjanskiensis* Proškina-Lavrenko.

KHAWKINEA Jahn & McKibben 1937

****Khawkinea quartana** (Moroff) Jahn & McKibben 1937 (Fig. 139)

Syn.: *Euglena quartana* Moroff, *Astasia guartana* (Moroff) Pringsheim var. *maior* Pringsheim 1956

Cells 62.0–70.0 µm long, ca 17.0 µm wide, ovoid, sometimes cylindrical; anterior end of each cell rounded, conical, posterior end gradually narrowing. Flagellum slightly longer than the cell. Stigma orange. Canal opening subapical. Pellicle smooth. Contractile body movement violent. Found in site – **25**: m(+); **86**: m(3); pH 8.5.

General distribution – EUROPE: Czech Republic (Cyrus & Sladeček 1973), Estonia (Popova & Safonova 1976); ASIA: India (Naidu 1966); NORTH AMERICA (Walton 1915; Wołowski & Walne 1997).

Habitats – Stagnant water, swamps, small springs, rice-fields, sewage treatment plants (Cyrus & Sladeček 1973).

ASTASIA Dujardin 1841

Astasia cylindrica Pringsheim 1942 (Figs 140–142)

Cells 17.5–22.2 µm long, 5.5–7.9 µm wide, markedly concave, slightly curved and widely rounded at the anterior end. Found in site – **86**: m(2); pH 7.0.

Distribution in Poland – Recorded in the Kraków-Częstochowa Upland (Wołowski 1991c).
General distribution – EUROPE: Austria, Germany (Pringsheim 1942), Ukraine (Asaul 1975).
Habitats – Small water bodies, ponds, lakes and "Elżbieta" spring with partly rotted leaves.

****Astasia ovalis*** Huber-Pestallozzi 1955 (Figs 143–144)

Cells 13.0–21.0 µm long, 7.0–9.5 µm wide, ovoid, short cylindrical, rounded at the anterior and the posterior ends. Pellicle thin, smooth. Several small, rounded and 2 large paramylon grains per cell. Flagellum up to the cell length. Nucleus situated in the centre of the cell. Contractile body movement absent. Found in site – **86**: m(2); pH 7.0

General distribution – Known only from EUROPE: Switzerland (Huber-Pestalozzi 1955).
Habitats – Small, stagnant water bodies, puddles, sulphuric water, "Elżbieta" spring with partly rotted leaves.
Notes – The shape of the cells is similar to *Astasia parvula* which has larger cells.

*****Astasia clavata*** Pringsheim 1942 (Fig. 145)

Cells 22.0–24.0 µm long, 5.9–7.0 µm wide, club-shaped anterior end of each cell rounded, the posterior end slightly narrowed. Pellicle slightly striated. Nucleus situated in the central part of the cell. One emergent flagellum longer than cell length. Contractile body movement gentle. Found in site – **86**: m(+); pH 7.0.

General distribution – EUROPE: Austria, Germany (Pringsheim 1942), Czech Republic (Huber-Pestalozzi 1955), Ukraine (Asaul 1975).
Habitats – Small water bodies, swamps, puddles, and "Elżbieta" spring with partly rotted leaves.

*****Astasia pusilla*** Ehrenberg *em.* Popova & Safonova 1976 (Figs 146–148)

Cells 13.0–15.5 µm long, 5.0–7.0 µm wide, cylindrical, each cell slightly narrowed at the anterior end and cut at the top, the posterior end rounded. Pellicle with a few, thick striations. Nucleus shifted to the posterior end. Paramylon grains generally small, a few slightly larger. Contractile body movement violent. Found in site – **86**: m(+); pH 6.8–7.0.

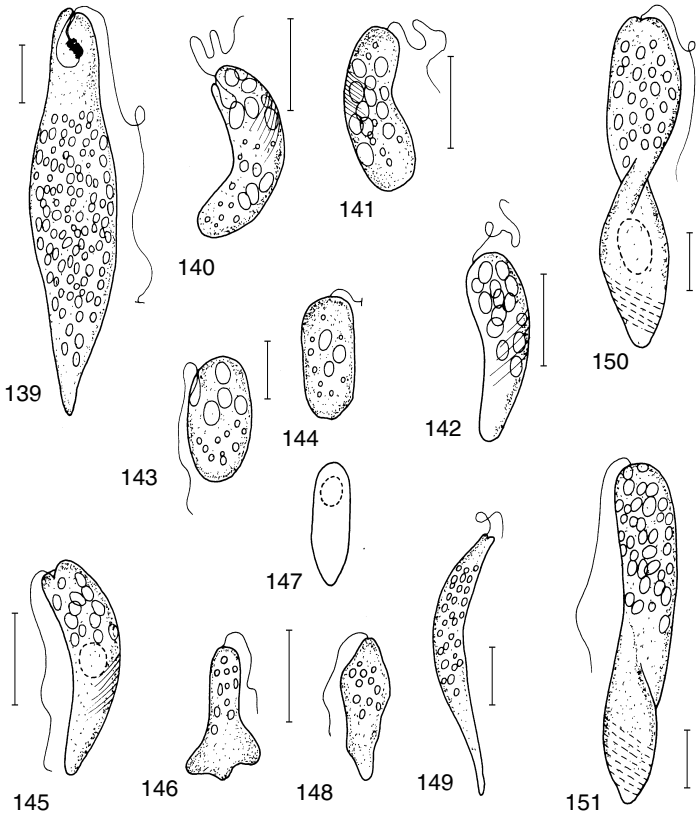
General distribution – EUROPE: Czech Republic, Germany, Russia; ASIA: Western Siberia (Popova & Safonova 1976).
Habitats – Puddles, and "Elżbieta" spring with partly rotted leaves.
Notes – According to Popova and Safonova (1976) the species is similar to *A. inflata* var. *minor* Pringsh. in dimensions and shape but the contractile body movement is different.

Astasia curvata Klebs 1893 (Fig. 149)

Syn.: *Euglena curvata* Klebs

Cells 42.0–48.0 µm long, 5.0–7.0 µm wide, fusiform-cylindrical, elongated, flattened, each slightly narrowed and truncated at the anterior end, tapering and bluntly extended at the posterior end. Found in site – **86**: m(+); pH 7.0.

Distribution in Poland – Known from the Kraków-Częstochowa Upland (Wołowski 1991c). Previously recorded in the Sudety Mts (Słabęcka-Szweykowska 1953).



Figs 139–151. 139. *Khawkinea quartana* (Moroff) Jahn & McKibben; **140–142.** *Astasia cylindrica* Pringsheim; **143–144.** *A. ovalis* Huber-Pestallozzi; **145.** *A. clavata* Pringsheim; **146–148.** *A. pusilla* Ehrenberg *em.* Popova & Safonova; **149.** *A. curvata* Klebs; **150–151.** *A. praecompleta* Skuja.

General distribution – EUROPE: Latvia (Skuja 1926), Austria, Germany (Pringsheim 1936), Slovenia (Lazar 1960), Belgium (Compère 1966), Czech Republic (Cyrus & Sladeček 1973), Estonia, Latvia, Switzerland, Russia (Popova & Safonova 1976), Ukraine (Asaul 1975, Vetrova 1980); ASIA: Western Siberia (Popova & Safonova 1976); NORTH AMERICA: U.S.A. (Walton 1915); SOUTH AMERICA: Brazil (Popova & Safonova 1976).

Habitats – Small water bodies, ditches, puddles, ponds, swamps, sewage treatment plants, rice-fields, and "Elżbieta" spring with partly rotted leaves.

Astasia praecompleta Skuja 1939 (Figs 150–151)

Cells 55.5–63.0 µm long, 8.5–10.0 µm wide, cylindrical, sometimes broadly fusiform, slightly curved, flattened; each cell rounded at the anterior end, gradually tapering at the posterior end. Found in site – **86**: m(1); pH 6.8–7.0.

Distribution in Poland – Recorded in the Kraków-Częstochowa Upland (Wołowski 1991c).

General distribution – EUROPE: Belgium, Latvia (Skuja 1939), Russia (Popova 1951),

Ukraine (Asaul 1975), Estonia, Latvia (Popova & Safonova 1976), Romania (Péterfi 1986); ASIA: Western Siberia (Popova & Safonova 1976).

Habitats – Small water bodies, stagnant waters, fishponds, puddles, forest ponds with sphagnum and "Elżbieta" spring with partly rotted leaves.

*****Astasia recta*** Christen 1958 (Figs 152–153)

Cells 70.0–74.0 µm long, 9–10.0 µm wide, cylindrical; each cell rounded at the anterior part and gradually narrowing into a conical posterior. Pellicle striated. Flagellum about 1/3 length of the cell. Nucleus relatively small and either in the centre or towards the posterior end. Paramylon grains are small, cylindrical. Contractile body movement slight. Found in site – **86**: m(1); pH 6.8–7.0.

General distribution – EUROPE: Switzerland (Christen 1958), Germany (Ettl 1968).

Habitats – Small ponds and "Elżbieta" spring with partly rotted leaves.

*****Astasia longa*** Pringsheim 1936 (Figs 154–157)

Syn.: *Astasia chattonii* Lwoff & Duse

Cells 55.5–63.0 µm long, 8.5–10.0 µm wide, cylindrical, elongated. At the anterior part gently tapered, slightly narrowed at the posterior end, like a short tail. Pellicle finely striated. Flagellum up to 1/4 of the cell length. Nucleus located in central part of the cell. Paramylon grains small, ovate. Contractile body movement gentle. Found in site – **86**: m(2); pH 8.6.

General distribution – EUROPE: Czech Republic, Germany (Pringsheim 1936, 1963), Switzerland (Huber-Pestalozzi 1955), Ukraine (Asaul 1975; Vetrova 1980), Iceland, Russia (Popova & Safonova 1976); ASIA: Western Siberia (Popova & Safonova 1976).

Habitats – Ephemerical and stagnant water bodies, according to Asaul (1975) with pH 5.5, swamps, peat bogs, puddles, and "Elżbieta" spring with partly rotted leaves. Saprobity – α-mesosaprobic (Cyrus & Sladeček 1973).

*****Astasia fustis*** Pringsheim 1942 (Figs 158–161)

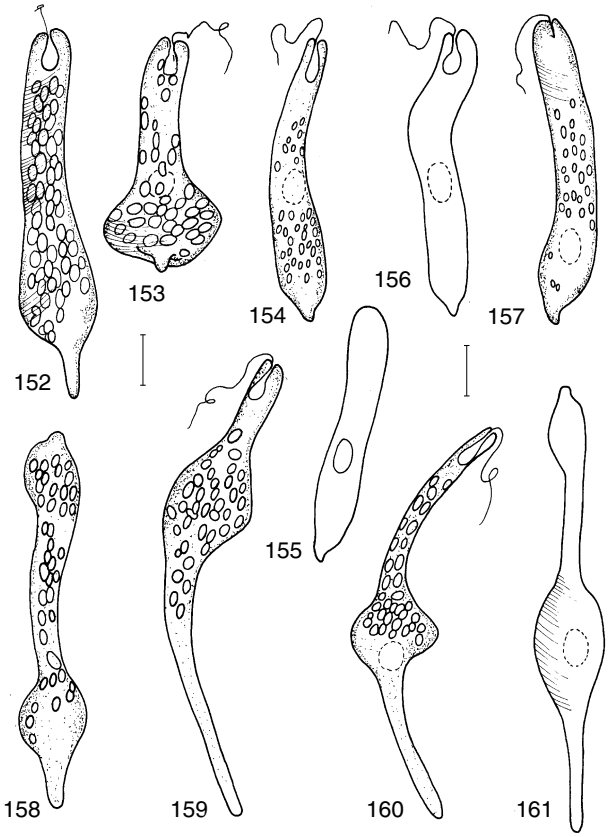
Cells 73.5–90.0 µm long, 11.1–17.7 µm wide, cylindrical-elongated; each cell rounded at the anterior end, slightly tapering and tail-like towards the posterior end. The pellicle finely and spirally striated. The nucleus rounded without constant position, translocated. Canal opening apical. Flagellum up to 1/4 of the cell length. Paramylon grains abundant, ovate, usually translocated. Movement by wave like expansion to anterior or posterior cell, slight and rather constant. Found in site – **86**: m(2); pH 6.8.

General distribution – EUROPE: Austria, Germany (Pringsheim 1942), Ukraine (Asaul 1975).

Habitats – Stagnant water bodies, in lakes, and "Elżbieta" spring with partly rotted leaves.

****Astasia harrisii*** Pringsheim 1942 (Figs 162–164)

Cells 62.3–63.5 µm long, ca 13.0 µm wide, fusiform, slightly bent, each cell truncated



Figs 152–161. 152–153. *Astasia recta* Christen; **154–157.** *A. longa* Pringsheim; **158–161.** *A. fustis* Pringsheim.

at the anterior end, gradually extending at the posterior end. Found in site – **86**: m(1); pH 6.8.

Distribution in Poland – Previously recorded in fishpond plankton at Gołysz (Krzeczkowska-Wołoszyn 1979) and in a lake in the Wigry National Park (Wołowski 1991b).

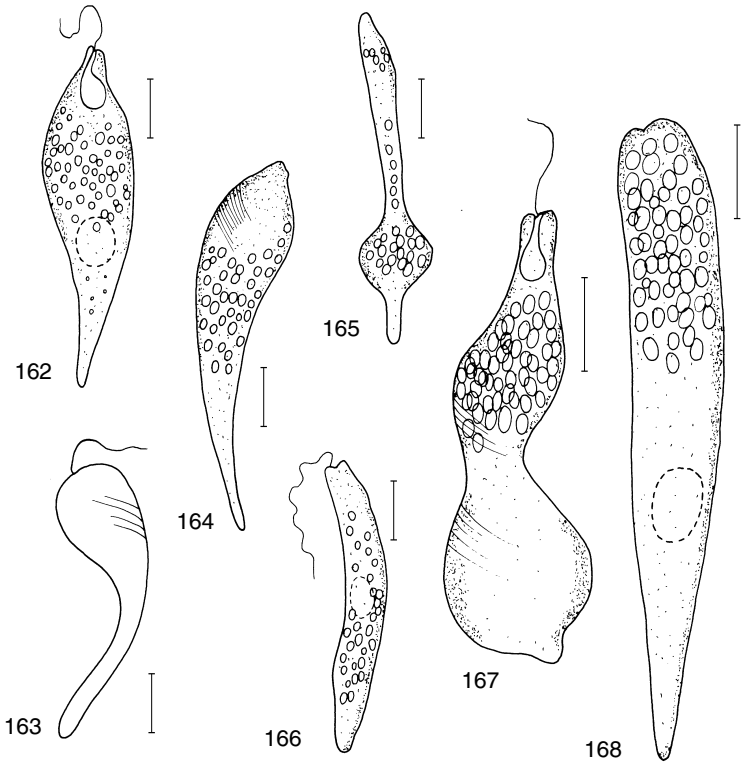
General distribution – EUROPE: Austria, Germany (Pringsheim 1942, 1963), Switzerland (Christen 1958), Russia (Popova & Safonova 1976), Ukraine (Asaul 1975; Vetrova 1980); ASIA: Western Siberia (Popova & Safonova 1976).

Habitats – Swamps, puddles, rice-fields and "Elżbieta" spring with partly rotted leaves.

****Astasia breviciliata*** Matvienko 1938 (Figs 165–166)

Cells 49.5–59.5 µm long, 2.9–10.0 µm wide, fusiform; each cell truncated at the anterior end. Found in site – **86**: m(1); pH 6.8.

Distribution in Poland – Previously recorded in Lake Smolak in plankton (Sosnowska 1974).



Figs 162–168. 162–164. *Astasia harrisii* Pringsheim; **165–166.** *A. breviciliata* Matvienko; **167–168.** *A. klebsii* Lemmermann.

General distribution – EUROPE: Ukraine (Asaul 1975; Popova & Safonova 1976; Vetrova 1980).

Habitats – Peat bogs, swamps and "Elżbieta" spring with partly rotted leaves.

Astasia klebsii Lemmermann 1910 (Figs 167–168)

Cells 45.1–70.0 µm long, 15.5–18.5 µm wide, fusiform, clavate; each cell broadly rounded at the anterior end, gradually tapering at the posterior end. Found in site – **86**: m(4); pH 6.8.

Distribution in Poland – Previously recorded in the Kraków-Częstochowa Upland in Nature Reserve "Parkowe" in "Elżbieta spring" (Wołowski 1991c).

General distribution – Cosmopolitan.

Habitats – Swamps, puddles, rice-fields, "Elżbieta" spring with partly rotted leaves; according to Lackey (1958) occurred in a settling basin for radioactive waste. Saprobity – α-mesosaprobic to polysaprobic (Vetrova 1980; Cyrus & Sladeček 1973).

TRACHELOMONAS Ehrenberg 1833

Sectio I ROTUNDATAE

Subsectio *SPHERICAE*

Seria *Volvocinae*

Trachelomonas volvocina Ehrenberg var. ***volvocina*** (Starmach 1983)
(Figs 169–170; Plate X: 1–3)

Lorica 14.0–23.5 µm in diameter, globular, smooth, reddish-brown. Found in site – **3**: p(2); **6**: p(2); **12**: p(3), **22**: p(30; **26**: p(+–2); **27**: p(+–2); **28**: p(1); **41**: p(+–3); **52**: p(2); **61**: p(2); **64**: p(+–2); **68**: p(2); **69a**: p(1); pH 7.0–8.4.

Distribution in Poland – Very common.
General distribution – Cosmopolitan, very common.
Habitats – Various water bodies, and according to Matuła (1995) peat bogs with pH 3.6–6.6. Saprobity – Mesosaprobic (Kolkwitz & Marsson 1908); catharobic-mesosaprobic (Lemmermann 1913), oligosaprobic (Swirenko 1939), α-oligosaprobic to α-mesosaprobic (Zelinka & Marvan 1961), oligo- to polysaprobic (Cyrus & Sladeček 1973).

****Trachelomonas volvocina*** var. ***compressa*** Dreżepolski 1925 (Plate X: 7)

Lorica 16.5–18.5 µm in diameter, globular, smooth, pore with annular thickening. Found in site – **12**: p(+); pH 7.0.

Distribution in Poland – Previously recorded by Dreżepolski (1925, 1948) from a pond in Łuków at Dęblin and from a pond at Winiary in Gniezno, and by Czosnowski (1948) from a clay pit in Zakopane, Tatra Mts.
General distribution – Cosmopolitan.
Habitats – Puddles, ditches, swamps, fish and village ponds.

*****Trachelomonas volvocina*** var. ***coronata*** Dreżepolski 1925 (Fig. 171)

Lorica 23.0–24.0 µm long, 16.0–20.5 µm wide, globular, smooth, pore surrounded by collar with crenulate margin. Found in site – **28**: p(1); **64**: p(+); pH 6.3–8.5.

General distribution – EUROPE: Ukraine (Dreżepolski 1925; Asaul 1975), Russia (Vetrova 1986).
Habitats – Fishponds and village ponds.

****Trachelomonas volvocina*** var. ***derephora*** Conrad 1916 (Plate X: 4)

Lorica 14.0 µm in diameter, globular, smooth, pore surrounded by a low collar. Found in site – **41**: p(+); **64**: p(2); pH 7.1–8.5.

Distribution in Poland – Previously recorded in lake warmed by wastewater from a thermoelectric plant (Półtoracka 1968), in a fishpond at Ochaby (Bucka 1966), and from the River Radunia (Gołdyn 1989).

General distribution – Cosmopolitan.
Habitats – Planktonic in river and peat bogs, rice-fields, fishponds, and village ponds.

Trachelomonas volvocina var. ***subglobosa*** Lemmermann 1913 (Plate X: 5–6)

Lorica 12.0–15.5 µm long, 10.7–15.5 µm wide, globular, smooth, pore surrounded by a depressed collar. Found in site – **27**: p(+); **28**: p(1); **41**; p(+); pH 6.3–8.1.

Distribution in Poland – Recorded in the Kraków-Częstochowa Upland in ponds of the Ojców National Park (Wołowski 1992a); previously known from a fishpond in Łuków at Dęblin (Dreżepolski 1925), in lakes of the Mazurian District (Sosnowska 1974), and in Lake Rusałka near Poznań (Kotlińska (1976).
General distribution – EUROPE: Germany, Austria, Sweden (Lemmermann 1913), Russia (Safonova 1965), Lithuania, Russia (Popova 1966), Ukraine (Asaul 1975); ASIA: Western Siberia, Uzbekistan, China (Popova 1966), Yakutsya (Vasileva 1987).
Habitats – Fishponds, ditches, pools and village ponds.

****Trachelomonas volvocinopsis*** Swirenko 1939 fo. ***volvocinopsis***
(Figs 172–173; Plate X: 8–10)

Lorica 15.5–24.0 µm in diameter, globular, smooth, pore with annular thickening, reddish-brown. Found in site – **12**: p(2); **26**: p(+); **27**: p(2–3); **41**: p(+); **52**: p(2); **56**: p(10); **64**: p(+ –1); **68**: p(1); **86**: p(1); pH 6.5–8,9.

Distribution in Poland – Common.
General distribution – Cosmopolitan, very common.
Habitats – Planktonic, lakes, ponds, swamps, ditches, rice-fields, and in a spring with partly rotted leaves; according to Matuła (1995) in peat bogs with pH 5.1–6.6. Saprobity – Oligosaprobic (Svirenko 1939), β-mesosaprobic (Cyrus & Sladeček 1973).

Seria *Spiniferae*

*****Trachelomonas woycickii*** Koczwara 1916 (Fig. 174; Plate XI: 1–2)

Lorica 14.0–17.0 µm in diameter, globular covered with short spines, dark brown. Found in site – **41**: p(+); **64**: p(1); pH 7.0.

General distribution – EUROPE: Ukraine (Koczwara 1916; Asaul 1975), Lithuania (Skuja 1926; Dreżepolski 1925), Hungary (Uherkovich 1976), France (Bourrelly & Couté 1978; Cardinal 1979), Russia (Vetrova 1986); ASIA: Eastern Siberia (Popova 1966), Yakutsya (Vasileva 1987); SOUTH AMERICA: Argentina (Tell & Conforti 1986).
Habitats – Small ponds and ditches.

*****Trachelomonas janczewskii*** Dreżepolski 1925 var. ***janczewskii*** (Fig. 175)

Lorica 22.2–24.5 µm long, ca 17.0 µm wide, broadly oval, covered with spines, reddish-brown, pore surrounded by collar. Found in site – **41**: p(1); pH 8.0.
General distribution – EUROPE: Lithuania (Dreżepolski 1925), Russia (Safonova 1965; Popova 1966), Ukraine (Asaul 1975), Romania (Péterfi 1986); ASIA: Western Siberia (Popova 1966).
Habitats – Fishponds and village ponds, pools.

Trachelomonas globularis* (Awerincew) Lemmermann 1913 fo. ***globularis*
(Fig. 176; Plate XI: 6–7)

Lorica 18.5–29.5 µm long, 14.5–24.0 µm wide, almost globular, covered eith short thick spines, reddish-brown. Found in site – **55**: p(1); pH 6.5–8.4.

Distribution in Poland – Previously recorded in Lake Rusałka near Poznań (Kotlińska 1976).

General distribution – EUROPE: France (Deflandre 1926), Romania (Péterfi 1986), Russia, Ukraine (Popova 1951, 1966); ASIA: Western Siberia, Turkmenistan (Popova 1966); NORTH AMERICA: U.S.A. (Walton 1915; Weik & Mohlenbrock 1963); SOUTH AMERICA: Argentina (Tell & Conforti 1986).

Habitats – Swamps, lakes and field ponds. Saprobity – Catharobic (Lemmerman 1913), oligosaprobic (Swirenko 1939).

Trachelomonas globularis* fo. ***crenulatocollis (Szabados) Popova 1966
(Plate XI: 8–9)

Syn.: *T. globularis* var. *crenulatocollis* Szabados

Lorica 16.8–19.0 µm in diameter, globular, brown, covered with tiny spines. Apical pore ca 2.9 µm in diameter with smooth rim, without collar. Found in site – **41**: p(1); pH 8.0.

General distribution – EUROPE: Hungary (Szabados 1939), Russia (Popova 1966), Ukraine (Popova 1966; Asaul 1975).

Habitats – Ponds, swamps and ditches.

***Trachelomonas acanthostoma* Stokes 1887 (Plate XI: 3–5)

Syn.: *T. acanthostoma* Stokes var. *europea* Dreżepolski 1921/1922, 1925

Lorica 18.2–20.0 µm long. 15.3 µm wide, oval with numerous small pores, apical pore surrounded by spines, reddish-brown. Found in site – **12**: p(1); **64**: p(1); pH 7.1–8.0.

General distribution – EUROPE: Belorussia (Dreżepolski 1921/1922; Skuja 1934), Ukraine (Dreżepolski 1925; Popova 1966; Asaul 1975), Latvia, Russia (Popova 1966), Portugal (Rino & Pereira 1988); ASIA: Western Siberia, China (Popova 1966), Japan (Yamagishi 1977); NORTH AMERICA: U.S.A. (Stokes 1887); SOUTH AMERICA: Venezuela, Brazil (Tell & Comforti 1986).

Habitats – Fish and village ponds. Saprobity – Oligosaprobic (Swirenko 1939).

Notes – Specimens obtained were smaller than was described by Stokes (1887: 36 µm). Variety described by Dreżepolski (1921/1922) was also smaller.

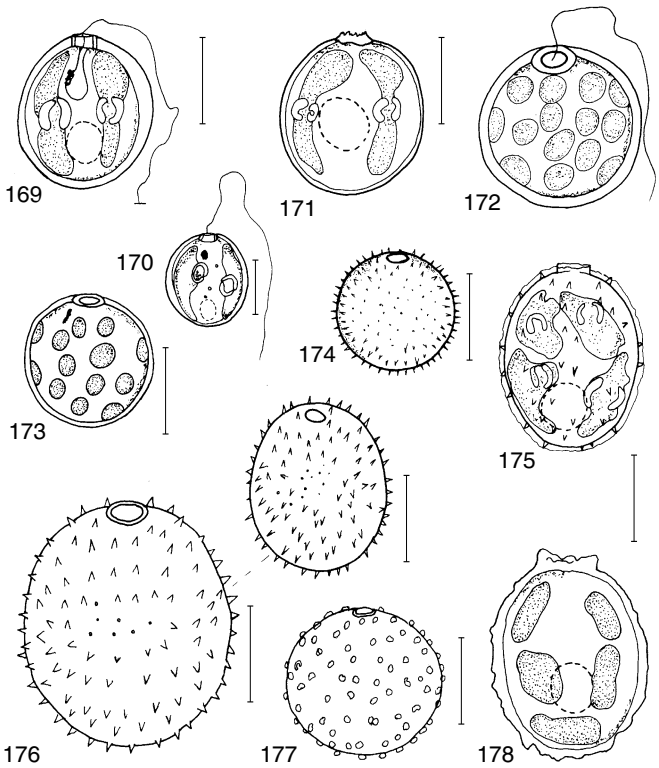
****Trachelomonas decorata* (Skvortzov) Deflandre 1926 (Fig. 177)

Syn.: *T. volvocina* Ehrenberg var. *pustulosa* Playfair, *T. intermedia* Dangeard var. *decorata* Skvortzov, *T. pustulosa* Huber-Pestalozzi

Lorica 16.5–18.0 µm in diameter, oval, yellow-brown, covered by irregular verrucae, pore without collar, surrounded by annular thickening. Found in site – **12**: m(+); pH 7.1.

General distribution – Rare. ASIA: Manchuria (Skvortzov 1925); AUSTRALIA (Huber-Pestalozzi 1955).

Habitats – Ponds.



Figs 169–178. 169–170. *Trachelomonas volvocina* Ehrenberg var. *volvocina*; **171.** *T. volvocina* var. *coronata* Dreżepolski; **172–173.** *T. volvocinopsis* Swirenko fo. *volvocinopsis*; **174.** *T. woycickii* Koczwara; **175.** *T. janczewskii* Dreżepolski var. *janczewskii*; **176.** *T. globularis* (Awer) Lemmermann fo. *globularis*; **177.** *T. decorata* (Skvortzov) Deflandre; **178.** *T. poltavica* (Swirenko) Skvortzov.

Seria *Diversiskulptatae*

*****Trachelomonas lomnickii*** Dreżepolski 1925 (Plate XI: 10)

Lorica 18.5 µm in diameter, globular with small pores, collar 2.8 high. Found in site – **27**: p(1); **28**: p(1); pH 6.5–7.5.

General distribution – EUROPE: Ukraine (Dreżepolski 1925).
Habitats – Fishponds and village ponds.

****Trachelomonas reinhardii*** Swirenko (Swirenko 1939) (Plate XI: 11–12)

Lorica 20.5–22.6 µm long, 15.2–16.5 µm wide, broadly oval, truncate at the posterior end with numerous pores, high collar, reddish-brown. Found in site – **64**: p(+); pH 7.0.

Distribution in Poland – Previously recorded by Krzeczkowska-Wołoszyn (1964, 1966) from fishponds at Gołysz and by Burchardt (1977) from phytoplankton of Lake Pątnowskie.

General distribution – EUROPE: Russia (Swirenko 1939; Popova 1966), Ukraine (Asaul 1975); ASIA: Western Siberia (Popova 1966).

Habitats – Planktonic, from lakes and ponds.

*****Trachelomonas verrucosa*** Stokes fo. ***irregularis*** Deflandre 1927 (Plate XII: 1–2)

Lorica 11.5–14.0 µm long, 9.3–12.3 µm wide, broadly-oval, covered with irregular granules, light brown. Apical pore at the rim surrounded by annular thickening. Found in site – **12**: p(1); **27**: p(+); pH 6.5–7.0.

General distribution – EUROPE: France (Deflandre 1927; Couté & Iltis 1981); NORTH AMERICA: U.S.A. (Whitford 1982).

Habitats – Ponds and lakes.

*****Trachelomonas poltavica*** (Swirenko) Skvortzov (Popova 1966)
(Fig. 178; Plate XIV: 1–2)

Syn.: *T. granulata* Swirenko var. *poltavica* Swirenko 1915

Lorica 20.0–22.5 µm long, 17.0–18.5 µm wide, widely elliptical, covered by irregular verrucae. Apical pore with irregularly shaped rim. Found in site – **12**: p(1); **64**: p(+); pH 7.1–7.6.

General distribution – EUROPE: Russia (Popova 1966), Ukraine (Swirenko 1939; Asaul 1975); ASIA: Western Siberia (Popova 1966).

Habitats – Puddles, ditches, small rivers, and village ponds. Saprobity – Mesosaprobic (Swirenko 1939).

****Trachelomonas rugulosa*** Stein (Popova 1966) (Plate XIII: 1–3)

Syn.: *T. rugulosa* Stein fo. *steinii* Deflandre 1926

Lorica 14.0–19.0 µm long, 14.0–18.0 µm wide, almost globular, covered with irregular thin folds, pore with annular thickening, reddish-brown. Found in site – **2**: p(2); **41**: p(1); pH 6.5.

Distribution in Poland – Previously recorded at Rybnik Reservoir in Upper Silesia (Skalska 1982).

General distribution – EUROPE: France (Deflandre 1926), Spain (Margalef 1948), Austria (Huber-Pestalozzi 1955), Russia, Hungary, Bulgaria; NORTH AMERICA: U.S.A. (Palmer after Deflandre 1926); SOUTH AMERICA: Venezuela (Deflandre 1928); ASIA: Japan (Fukushima 1954), Singapore (Popova 1966).

Habitats – Ponds, puddles, ditches. Saprobity – Oligosaprobic (Swirenko 1939).

*****Trachelomonas nexilis*** Palmer (Starmach 1983) (Plate XII: 4–5)

Lorica 15.2–17.0 µm in diameter, almost globular, reddish-brown, ornamentation appears to be a discontinuous net, with depressions of various shapes, predominantly vermicular. Collar short, located in the small depression on the top of lorica. Found in site – **27**: p(1); pH 7.5.

General distribution – EUROPE: Portugal (Rino & Pereira 1989–1990), France (Bourrelly

& Couté 1978); NORTH AMERICA: U.S.A. (Conrad & Van Meel 1952; Conforti & Joo 1994); SOUTH AMERICA: Argentina (Conrad & Van Meel 1952; Tell & Conforti 1986; Conforti 1993).

Habitats – Small lakes, ponds, and ditches.

*****Trachelomonas stokesiana*** Palmer fo. ***torquata*** (Conrad) Huber-Pestalozzi 1955 (Plate XIII: 4)

Syn.: *T. rugulosa* Stein fo. *torquata* Conrad & Van Meel 1952

Lorica 13.5 µm long, 11.8 µm wide, globular, reddish-brown, covered by irregular, spirally twisted ribbons. Collar higher than in the typical form, with annular thickening. Found in site – **64**: p(+); pH 7.0.

General distribution – EUROPE: Belgium, Germany (Conrad & Van Meel 1952).

Habitats – Forest ponds, ditches and puddles.

Seria *Compressae*

****Trachelomonas curta*** Da Cunha fo. ***curta*** (Starmach 1983) (Plate XII: 3)

Syn.: *T. lismorensis* Playfair var. *inermis* Playfair 1915.

Lorica ca 13.0 µm long, 14.5 µm wide, transverse oval, smooth, apical pore surrounded by annular thickening. Found in site – **64**: p(+); pH 7.6.

Distribution in Poland – Previously recorded in Lake Tyrsko (Chudyba *et al.* 1987).

General distribution – EUROPE: Holland, Denmark (Conrad & Van Meel 1952), Russia (Popova 1955), Romania (Péterfi 1986), Portugal (Rino & Pereira 1989–1990); AFRICA: Chad (Compère 1975; Péterfi & Coman 1987), Senegal (Compère 1991); ASIA: Western Siberia (Popova 1966), Malaysia (Prowse 1958), Japan (Yamagishi 1977), Cambodia (Yamagishi & Hirano 1973); AUSTRALIA (Starmach 1983); NORTH AMERICA: U.S.A. (Conforti & Joo 1994); SOUTH AMERICA: Venezuela (Deflandre 1928; Yacubson 1980–1981), Brazil (Popova 1966), Argentina (Tell & Conforti 1986).

Habitats – Swamps, lakes and a village pond. Saprobity – β-mesosaprobic (Cyrus & Sladeček 1973).

Subsectio *ELLIPTICAE*

Seria *Intermediae*

****Trachelomonas oblonga*** Lemmermann 1913 var. ***oblonga*** (Plate XII: 6)

Lorica 15.4–25.0 µm long, 12.0–17.5 µm wide, oblong, smooth, with low collar, yellow-brown. Found in site – **27**: p(+); **41**: p(+–1); **55**: p(2); **56**: p(1); **64**: p(+); pH 6.5–8.6.

Distribution in Poland – Very common.

General distribution – Cosmopolitan, very common.

Habitats – Planktonic and benthic, small water bodies, field ponds; according to Popova (1966) known also from the Arctic and high parts of mountains. Saprobity – Catharobic (Lemmermann 1913), oligosaprobic (Swirenko 1939); β-mesosaprobic (Cyrus & Sladeček 1973).

*__Trachelomonas oblonga__ var. __punctata__ Lemmermann 1913 (Plate XIII: 6–10)

Lorica 14.0–21.0 µm long, 12.2–16.5 µm wide, oblong, with numerous small pores. Found in site – **12**: p(1); pH 7.1.

Distribution in Poland – Previously recorded in the Rożnów dam reservoir (Siemińska J. 1952).

General distribution – EUROPE: Germany (Lemmermann 1913), Lithuania (Koczwara 1916), France (Deflandre 1926), Ukraine (Drežepolski 1925; Popova 1966; Asaul 1975), Russia (Popova 1966); ASIA: Western Siberia, India; AUSTRALIA; NORTH AMERICA (Popova 1966); SOUTH AMERICA: Argentina (Tell & Conforti 1986).

Habitats – Ponds and slow flowing rivers. Saprobity – Oligosaprobic (Swirenko 1939).

**__Trachelomonas oblonga__ var. __pulcherrima__ (Playfair) Popova 1955
(Fig. 179; Plate XIII: 11–12)

Syn.: *T. pulcherrima* Playfair 1915; non *T. pulcherrima* Roll

Lorica 15.5–25.0 µm long, 12.8–13.5 µm wide, oblong, smooth, without collar, yellow-brown. Found in site – **28**: p(1); pH 7.0.

General distribution – EUROPE: Russia (Popova 1955; Safonova 1965), Ukraine (Asaul 1975), Romania (Péterfi 1986), Czech Republic (Wołowski 1992c); ASIA: India (Naidu 1966), Western Siberia (Popova 1966); NORTH AMERICA: U.S.A. (Weik & Mohlenbrock 1963); SOUTH AMERICA: Chile (Parra *et al.* 1982).

Habitats – Ponds, lakes, ditches, puddles; also known from high mountains (Popova 1966).

**__Trachelomonas pusilla__ Playfair 1915 (Plates XII: 7 & XIII: 5)

Lorica 13.5–14.5 µm long, 12.0–13.5 µm wide, spherical but slightly flattened at the apical pore and slightly narrowed at the posterior end; wall smooth or sometimes scrobiculate, dark brown. Apical pore without collar. Found in site – **3**: p(2); pH 6.6.

General distribution – EUROPE: France (Deflandre 1926; Conrad & Van Meel 1952), Portugal (Rino & Pereira 1988, 1989–1990); AUSTRALIA (Playfair 1915; Conrad & Van Meel 1952); NORTH AMERICA (Conforti & Joo 1994); SOUTH AMERICA: Argentina (Conforti 1986; Tell & Conforti 1986).

Habitats – Ponds and ditches.

***__Trachelomonas botanica__ Playfair var. __borealis__ Playfair 1921 (Fig. 180; Plate XIV: 3)

Lorica 21.5–26.4 µm long, 15.2–19.5 µm wide, broadly elliptical, punctate, with small single verruca at the posterior end. Collar broad, funnel-like, crenate at the rim. Found in site – **27**: p(+); **41**: p(+); **64**: p(+); pH 7.6–8.1

General distribution – AUSTRALIA (Playfair 1921).

Habitats – Ponds.

Notes – A more oblong form than the type, specimens are smaller than described by Playfair (1921: 36.0 µm long, 30.5 µm wide).

Trachelomonas intermedia* Dangeard fo. ***intermedia* (Popova 1966)
(Plates XII: 9 & XIV: 7)

Lorica 17.0–24.0 µm long, 15.0–16.6 µm wide, oval covered with pores, dark reddish-brown. Found in site – **3**: p(2); pH 6.6.

Distribution in Poland – Common.
General distribution – Cosmopolitan, very common.
Habitats – Small ditches, puddles, rice-fields and garden ponds. Saprobity – Oligosaprobic (Swirenko 1939).

Trachelomonas intermedia* fo. ***crenulatocollis (Szabados) Popova 1966
(Plate XIV: 4–6)

Lorica 21.8–24.0 µm long, 15.5–18.5 µm wide, oval, dark-brown with low collar crenate at the rim. Found in site – **64**: p(1); pH 8.4.

General distribution – EUROPE: Hungary (Szabados 1939), Russia (Popova 1966), Ukraine (Asaul 1975); ASIA: Far East (Popova 1966).
Habitats – Small ephemeral water bodies, ditches, puddles and swamps.

***Trachelomonas subverrucosa* Deflandre 1926 (Plate XV: 1–8)

Lorica 19.5–23.0 µm long, 16.5–19.5 µm wide, almost globular, verrucose and punctate. Apical pore without collar. Found in site – **3**: p(2); pH 6.6.

General distribution – EUROPE: France (Deflandre 1926}, Hungary (Hortobágyi 1963), Russia (Popova 1966), Ukraine (Asaul 1975); ASIA: Manchuria (Conrad & Van Meel 1952), Far East, China (Popova 1966).
Habitats – Ponds, lakes, peat bogs, also under ice.

Trachelomonas lacustris* Drežepolski var. ***klebsii* (Deflandre) Popova 1966
(Figs 181–182; Plate XVI: 11)

Syn.: *T. klebsii* Deflandre 1926, *T. hispida* Stein var. *cylindrica* Klebs 1883

Lorica 23.7–26.0 µm long, 13.5–16.0 µm wide, cylindrical, thickly covered with short spines, yellow-brown. Found in site – **41**: p(+–2); pH 7.9.

Distribution in Poland – Very common.
General distribution – Cosmopolitan.
Habitats – Swamps, lakes, and ponds.

Trachelomonas abrupta* Swirenko var. ***abrupta* (Swirenko 1939) (Plate XVI: 10)

Lorica cylindrical, ca 25.0 µm long, 13.5 µm wide, yellow-brown, punctate and ornamented with small spines. Found in site – **28**: m(+); pH 6.6.

Distribution in Poland – Common.
General distribution – Cosmopolitan.
Habitats – Lakes, ponds, puddles.

Seria *Scrobiculatae*

****Trachelomonas granulosa*** Playfair var. ***subglobosa*** Playfair 1915 (Figs 183–184)

Lorica 18.0–21.0 µm long, 15.0–18.0 µm wide, almost globular, covered with small granules, low collar. Found in site – **12**: p(1); pH 7.1.

Distribution in Poland – Previously recorded by: Drężepolski (1948) at Gniezno, Starmach (1962) from a fishpond near Osieki village, Półtoracka (1968) from a lake warmed by wastewater from a thermoelectric plant, Kotlińska (1976) from plankton of Lake Rusałka near Poznań, and Skalska (1979) from reservoir Pławniowice Duże.

General distribution – Cosmopolitan.

Habitats – Puddles, ponds, lakes, swamps.

*****Trachelomonas compacta*** Middelhoek (Starmach 1983) (Plate XIV: 8)

Lorica 14.5–15.5 µm long, 12.1–14.4 µm wide, almost oblong, scrobiculate. Apical pore surrounded by annular thickening or sometimes with low collar. Found in site – **64**: p(2); pH 7.0.

General distribution – EUROPE: Holland (Middelhoek 1951 after Huber-Pestalozzi 1955), France (Bourrelly & Couté 1978).

Habitats – Fishponds and village ponds.

*****Trachelomonas guttata*** Middelhoek (Huber-Pestalozzi 1955) (Plate XVI: 1)

Lorica 18.5–23.0 µm long, 14.8–16.0 µm wide, elliptical with small verrucae at the end, reddish-brown, scrobiculate. Apical pore without thickening, sometimes with low collar with irregular rim. Found in site – **41**: p(+); pH 8.1.

General distribution – EUROPE: Holland (Middelhoek 1951 after Huber-Pestalozzi 1955).

Seria *Scabrae*

****Trachelomonas scabra*** Playfair 1915 var. ***scabra*** (Plate XVI: 2–9)

Lorica 22.2–25.5 µm long, 15.0–18.0 µm wide, elliptical with irregular thickenings, creased, high collar, reddish brown. Found in site – **12**: p(3); **27**: p(+); **41**: p(3); pH 7.0–8.0.

Distribution in Poland – Previously recorded by Krzeczkowska-Wołoszyn (1964, 1966) from fishponds in Ochaby and Gołysz, and by Stefko (1976) from Lake Maltańskie in Poznań.

General distribution – Cosmopolitan.

Habitats – Planktonic, ponds, lakes and ditches.

Seria *Spiniferae*

Trachelomonas hispida (Perty) Stein var. ***hispida*** (Starmach 1983)
(Figs 186–187; Plates XVII: 1–6 & XVIII: 4)

Lorica 22.5–30.0 µm long, 12.5–25.2 µm wide, elliptical or broadly elliptical, covered

with spines and small pores, brown. Found in site – **9**: p(2); **10**: p(2); **26**: p(+); **27**: p(+); **41**: p(+); **83**: p(1); **84**: p(1); pH 6.5–8.5.

Distribution in Poland – Very common.

General distribution – Cosmopolitan, very common.

Habitats – Small water bodies, lakes, puddles, ponds, swamps and fishponds; according to Palmer (1959) occurred in wastes containing iron. Saprobity – Mesosaprobic (Kolkwitz & Marsson 1908), catharobic-mesosaprobic (Lemmerann 1913), oligosaprobic (Swirenko 1939), oligosaprobic to α-mesosaprobic (Zelinka & Marvan 1961), β-mesosaprobic (Cyrus & Sladeček 1973); pH 6.0–7.5(–8.4) (Popova 1966).

Trachelomonas hispida var. ***coronata*** Lemmermann (1913) (Plate XVII: 10–12)

Lorica 26.0–30.0 µm long, 19.0–21.0 µm wide, elliptical, covered with sharp spines, collar with conical spines at the rim. Found in site – **61**: p(1); **62**: p(2); pH 7.2–8.0.

Distribution in Poland – Previously recorded by: Ligowski (1986) from River Widawka, and by Oleksowicz (1986) from Bory Tucholskie, Gołdyn (1989) from River Radunia, Wołowski (1992a) from fishpond in Ojców National Park, Szeląg-Wasilewska & Gołdyn (1994) from lakes at Bytów and Chojnice.

General distribution – EUROPE: Latvia, France, Denmark (Conrad & Van Meel 1952), Russia (Popova 1966), Ukraine (Asaul 1975), Italy (Alfinito 1982), Portugal (Rino & Pereira 1988, 1989–1990); ASIA: Japan (Fukushima 1954; Yamagishi 1977); Western Siberia (Popova 1966); NORTH AMERICA: U.S.A. (Lemmermann 1913); CENTRAL AMERICA: Panama (Popova 1966); SOUTH AMERICA: Venezuela (Huber-Pestalozzi 1955), Argentina (Conforti 1986; Tell & Conforti 1986).

Habitats – Stagnant, slow-flowing waters, lakes, puddles, ditches, and ponds.

****Trachelomonas hispida*** var. ***crenulatocollis*** (Maskell) Lemmermann 1910 (Plate XVIII: 1–3)

Syn.: *T. crenulatocollis* Maskell

Lorica 21.5–34.7 µm long, 14.8–24.1 µm wide, broadly oval, covered with tiny spines, collar dentate at the rim. Found in site – **41**: p(+); **27**: p(+); pH 8.0–8.4.

Distribution in Poland – Previously recorded by: Drežepolski (1925) in the Tatra Mts, Luer-Jeziorańska (1939) from plankton of River Jeziorka, Kyselowa (1973) from fishponds enriched with wastes from sugar beet factory, Skalska (1975) from Kochłówka stream in Upper Silesia.

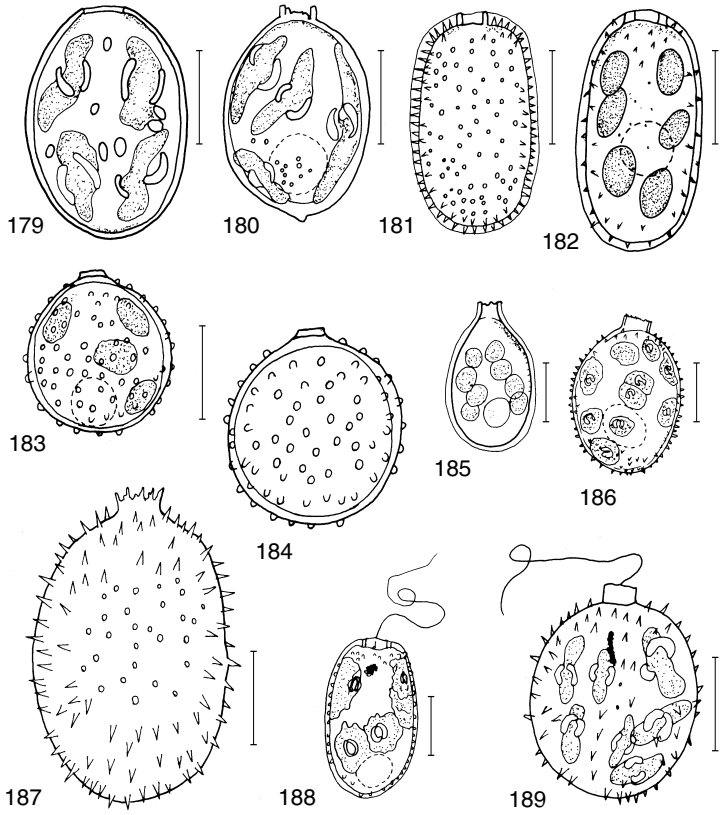
General distribution – Cosmopolitan.

Habitats – Small water bodies, puddles, peat bogs, swamps and ponds. Saprobity – Oligosaprobic-mesosaprobic (Swirenko 1939).

****Trachelomonas hispida*** var. ***granulata*** Playfair 1915 (Fig. 188; Plates XIV: 9–10 & XVII: 7–9)

Syn.: *T. australica* (Playfair) Deflandre var. *granulata* (Playfair) Deflandre 1926, *T. hispida* var. *verrucosa* Drežepolski 1925

Lorica 18.0–27.5 µm long, 13.5–21.3 µm wide, broadly oval, covered with granules, dark brown. Found in site – **41**: p(+); pH 7.5.



Figs 179–189. 179. *Trachelomonas oblonga* Lemmermann var. *pulcherrima* (Playfair) Popova; **180.** *T. botanica* Playfair var. *borealis* Playfair; **181–182.** *T. lacustris* Drežepolski var. *klebsii* (Deflandre) Popova; **183–184.** *T. granulosa* Playfair var. *subglobosa* Playfair; **185.** *T. ampuliphormis* Roll; **186–187.** *T. hispida* (Perty) Stein var. *hispida*; **188.** *T. hispida* var. *granulata* Playfair; **189.** *T. hispida* var. *spinulosa* Skvortzov.

Distribution in Poland – Previously recorded by: Drežepolski (1925) without exact information about the sites of occurrence, Półtoracka (1968) from plankton of lakes with warmed waters, Skalska (1975) from the strongly saline and polluted Kochłówka stream in Upper Silesia.

General distribution – EUROPE: Russia (Popova 1966), Ukraine (Asaul 1975), Hungary (Uherkovich & Franken 1980); AUSTRALIA (Playfair 1915).

Habitats – Lakes, peat bogs, and ponds.

****Trachelomonas hispida*** var. ***spinulosa*** Skvortzov (Popova 1966)

(Fig. 189; Plate XVIII: 1)

Syn.: *T. spinulosa* (Skvortzov) Deflandre

Lorica 24.0–33.5 µm long, 15.0–18.5 µm wide, broadly oval, covered with spines, dentate collar, dark brown. Found in site – **9**: p(2); **10**: p(1); **41**: p(+); pH 7.5–8.0.

Distribution in Poland – Previously it was found by Półtoracka (1968) and Sosnowska (1974) from plankton in lakes with warmed water and in Mazurian Lake District.

General distribution – EUROPE: Russia (Popova 1951, 1966), Ukraine (Asaul 1975), Bulgaria; ASIA: Western Siberia, Far East, China (Popova 1966).

Habitats – Swamps, ditches, puddles.

Notes – Similar to *T. hispida* var. *crenualatocollis* but with shorter and thicker spines.

****Trachelomonas polonica*** Dreżepolski 1925 (Plate XVIII: 7)

Lorica 26.0–27.5 µm long, 14.5–15.0 µm wide, cylindrical, covered with short spines, low and narrow collar. Found in site – **12**: p(1); pH 7.1.

Distribution in Poland – Previously recorded by Dreżepolski (1921/1922, 1925) from the Tatra Mts and from a fishpond in Łuków near Dęblin.

General distribution – EUROPE: Lithuania (Dreżepolski 1921/1922), Ukraine (Koczwara 1916).

Habitats – Known from fishponds, village ponds.

****Trachelomonas allia*** Dreżepolski 1925 (Plate XVIII: 5)

Lorica 26.6 µm long, 16.0 µm wide, cylindrical, covered with sharp thin spines, reddish-brown. Found in site – **64**: p(+); pH 7.0.

Distribution in Poland – Described from the Tatra Mts by Dreżepolski (1925).

General distribution – EUROPE: France (Deflandre 1926), Belgium (Conrad & Van Meel 1952), Russia (Popova 1966), Ukraine (Asaul 1975), Portugal (Rino & Pereira 1989–1990); ASIA: Western Siberia, Indonesia (Popova 1966); AUSTRALIA: New Guinea (Vyvermann 1991); SOUTH AMERICA: Brazil (Menezes & Fernandes 1987), Argentina (Tell & Conforti 1986).

Habitats – Ponds, lakes, ditches, ephemeral water bodies. Saprobity – Oligosaprobic to β-mesosaprobic (Cyrus & Sladeček 1973).

****Trachelomonas dreżepolskiana*** Conrad (Conrad & Van Meel 1952) (Plate XVIII: 8–9)

Syn.: *T. abrupta* Swirenko var. *cylindrica* Dreżepolski, *T. subulata* Skvortzov

Lorica 24.7–29.5 µm long, 12.5–15.5 µm wide, cylindrical, covered with short spines, apical pore surrounded by annular thickening. Found in site – **28**: p(+); **41**: p(2); pH 6.0–7.5.

Distribution in Poland – Previously recorded by Szeląg-Wasilewska and Gołdyn (1994) from oligotrophic lakes near Bytów and Chojnice.

General distribution – EUROPE: Lithuania (Dreżepolski 1921/1922), Belgium (Conrad & Van Meel 1952).

*****Trachelomonas raciborskii*** Wołoszyńska var. ***incerta*** Dreżepolski 1925 (Plate XIX: 1)

Lorica 16.3–17.5 µm long, 15.3–16.0 µm wide, broadly elliptical, smooth, few spines at the anterior end, without collar. Found in site – **41**: p(+); pH 7.9.

General distribution – EUROPE: Lithuania (Dreżepolski 1925); ASIA: Indonesia – Java

(Wołoszyńska 1914); SOUTH AMERICA: Venezuela (Deflandre 1928), Argentina (Tell & Conforti 1986).

Habitats – Fishponds, village ponds.

Trachelomonas bacillifera Playfair var. ***minima*** Playfair 1915 (Plate XVIII: 10–11)

Lorica 25.0–27.8 µm long, 20.0–20.5 µm wide, broadly elliptical, covered with blunt rod-like extension, without collar. Found in site – **61**: p(+); **62**: p(1); **64**: m(+) & p(+); pH 7.0–8.2.

Distribution in Poland – In Kraków-Częstochowa Upland found in a fishpond in Ojców National Park (Wołowski 1992a); previously recorded by Luer-Jeziorańska (1939) from River Jeziorka, Kyselowa (1965) from ponds in southern Poland, Kyselowa (1966) from some ponds in the basin of the upper River Vistula, and by Bucka and Kyselowa (1967) from fishponds at Gołysz and Landek.

General distribution – EUROPE: France (Conrad & Van Meel 1952), Romania (Péterfi 1962), Hungary (Hortobágyi 1963), Russia (Popova 1966); AFRICA: Ivory Coast (Bourrelly 1961b); NORTH AMERICA: U.S.A. (Conforti & Joo 1994); SOUTH AMERICA: Argentina (Tell & Conforti 1986); AUSTRALIA (Playfair 1915).

Habitats – Fishponds, lakes, ditches.

******Trachelomonas hirta*** Da Cunha var. ***duplex*** Deflandre 1926 (Plate XVIII: 6)

Lorica 25.5 µm long, 16.5 µm wide, elliptical, irregularly covered with strong spines, reddish-brown. Apical pore without collar. Found in site – **41**: p(+); pH 8.0.

General distribution – AFRICA: Madagascar (Deflandre 1926); SOUTH AMERICA: Argentina (Tell & Conforti 1986).

Habitats – Lakes and ponds.

*****Trachelomonas robusta*** Swirenko *em.* Deflandre 1926 (Plate XIX: 2–4)

Lorica 19.2–21.0 µm long, 16.1–17.0 µm wide, broadly oval, yellowish-brown, covered with rare, strong spines. Apical pore surrounded by spines. Found in site – **41**: p(1); pH 8.0.

General distribution – EUROPE: France (Deflandre 1926; Couté & Iltis 1981), Holland (Conrad & Van Meel 1952), Russia (Popova 1966), Ukraine (Asaul 1975), Portugal (Rino & Pereira 1988, 1989–1990); ASIA: Japan (Yamagishi 1977); AFRICA: Burundi (Caljon 1988), Chad (Compère 1975); NORTH AMERICA; SOUTH AMERICA: Venezuela, (Deflandre 1928), Argentina (Tell & Conforti 1986).

Habitats – Swamps, ponds, puddles. Saprobity – Oligosaprobic (Swirenko 1939).

Notes – Similar to *T. superba*, but smaller and regularly covered by spines.

****Trachelomonas superba*** Swirenko *em.* Deflandre 1926 (Fig. 190)

Lorica 27.0–29.5 µm long, 24 µm wide, broadly elliptical, covered by sharp, fine spines, without collar. Found in site – **64**: m(+); pH 8.4.

Distribution in Poland – Previously recorded by Luer-Jeziorańska (1939) from River Jeziorka.

General distribution – Cosmopolitan, common.
Habitats – Lakes, puddles, swamps, village and fishponds, rivers.
Notes – The length of lorica shorter than given in diagnosis.

*****Trachelomonas mirabilis*** Swirenko var. ***minor*** Woronichin (Popova 1966) (Fig. 191)

Lorica 25.5–26.0 µm long, 20.5 µm wide, ellipsoid, brown, ornamented with scattered conical spines of various lengths. Collar 2.5 µm high with sharp conical spines at the rim. Found in site – **64**: p(+); pH 7.5.

General distribution – Rare. EUROPE: Latvia, Estonia, Belorussia (Popova 1966), Ukraine (Asaul 1975); ASIA: Western Siberia (Popova 1966).
Habitats – Swamps, puddles, mud, and ponds.

*****Trachelomonas sarmatica*** Drežepolski 1925 (Plate XIX: 7–10)

Lorica 20–22.0 µm long, 11–13.0 µm wide, elliptical-trapezoid shaped, covered with short spines. Found in site – **3**: p(2); **26**: m(+); pH 6.6–7.5.

General distribution – EUROPE: Ukraine (Drežepolski 1925).
Habitats – Village ponds, fishponds and small artificial water bodies.

Seria *Helicoideae*

*****Trachelomonas eurystoma*** Stein var. ***producta*** Playfair (Huber-Pestalozzi 1955) (Plate XIX: 5)

Lorica 26.5 µm long, 18.5 µm wide, ovoid, posterior end gradually narrowed, ending with short verruca, collar crenated, light-brown. Found in site – **64**: p(+); pH 7.0.

General distribution – EUROPE: Holland, Austria, Germany (Conrad & Van Meel 1952); AUSTRALIA (Huber-Pestalozzi 1955).
Habitats – Ponds. Saprobity – β-mesosaprobic (Cyrus & Sladeček 1973).

*****Trachelomonas ovoides*** Conrad 1952 (Figs 192–193; Plate XIX: 6)

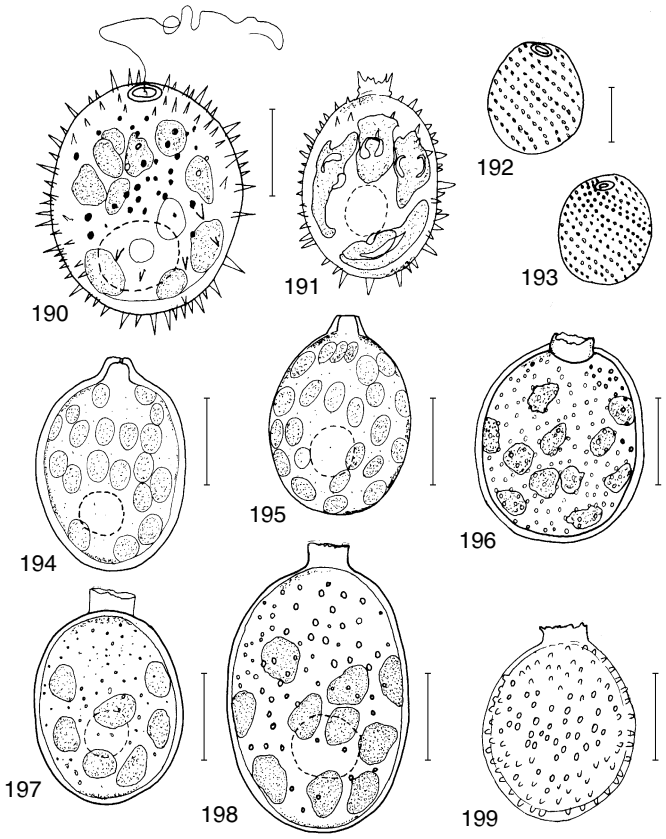
Lorica 15.0–20.5 µm long and 13.0–16.5 µm wide, obovoid, covered with tiny granules arranged in spirals. Apical pore without collar. Found in site – **29**: p(1); pH 7.0.
General distribution – EUROPE: Belgium (Conrad & Van Meel 1952); ASIA: Japan (Yamagishi 1977).
Habitats – Stagnant waters, ponds.

Subsectio *AMPULIFORMES*

Seria *Erectae*

*****Trachelomonas recticollis*** Deflandre 1926 (Plate XX: 5–6)
Syn.: *T. euchlora* Awar. var. *minor* Playfair (according to Popova 1966)

Lorica 20.9–23.1 µm long, 14.5–16.8 µm wide, oval, smooth, brown. Collar 2.5 µm



Figs 190–199. 190. *Trachelomonas superba* Swirenko *em*. Deflandre; **191.** *T. mirabilis* Swirenko var. *minor* Woronichin; **192–193.** *T. ovoides* Conrad; **194–195.** *T. manginii* Deflandre; **196–197.** *T. planctonica* Swirenko fo. *planctonica*; **198.** *T. planctonica* fo. *oblonga* (Dreżepolski) Popova; **199.** *T. planctonica* fo. *ornata* (Skvortzov) Popova.

high, cylindrical, smooth at the rim, with annular thickening at the base. Found in site – **56**: p(1); pH 6.5.

General distribution – EUROPE: Russia (Safonova 1965), Ukraine (Asaul 1975), Romania (Péterfi 1986); ASIA: Western Siberia (Popova 1966); SOUTH AMERICA: Argentina (Tell & Conforti 1986); AUSTRALIA (Huber-Pestalozzi 1955; Popova 1966).

Habitats – Rich humic waters, small water bodies.

*****Trachelomonas manginii*** Deflandre var. ***subpunctata*** Safonova 1963

(Figs 194–195; Plate XX: 1–4)

Lorica 14.0–22.5 µm long, 12.5–16.5 µm wide, oval, yellowish-brown, smooth or with minute pin-points. Apical pore surrounded by cylindrical collar. Found in site – **41**: p(+); pH 7.0.

General distribution – Cosmopolitan, common.
Habitats – Various water bodies, during autumn and winter.

****Trachelomonas planctonica*** Swirenko 1939 fo. ***planctonica***
(Figs 196–197; Plate XXI: 1–7)

Lorica 18.0–35.0 µm long, 14.0–27.0 µm wide, broadly elliptical, covered with pores and granules, with dentate collar, reddish brown. Found in site – **3**: p(2); **12**: p(2); **27**: p(+–2); **28**: p(1); **36**; p(2); **41**: p(+–1); **54**; p(1); **64**: p(+–2); pH 6.6–8.5.

Distribution in Poland – Common.
General distribution – Cosmopolitan, very common.
Habitats – Stagnant waters, fishponds, puddles, ditches, by the banks of lakes and in small rivers and village ponds. Saprobity – Oligosaprobic-mesosaprobic (Swirenko 1939), oligosaprobic to β-mesosaprobic (Cyrus & Sladeček 1973).

****Trachelomonas planctonica*** fo. ***oblonga*** (Dreżepolski) Popova 1966 (Fig. 198)
Syn.: *T. planctonica* var. *oblonga* Dreżepolski 1925

Lorica 24.2–30.0 µm long, 17.0–21.0 µm wide, oblong, collar straight truncate at the top. Found in site – **27**: p(+), **31**: p(1); pH 6.6–8.3.

Distribution in Poland – Previously recorded in Przeczyce dam reservoir on River Przemsza (Sieminiak 1984) and from River Radunia (Gołdyn 1989).
General distribution – Cosmopolitan.
Habitats – Lakes, ponds, puddles, small rivers.

*****Trachelomonas planctonica*** fo. ***ornata*** (Skvortzov) Popova 1966
(Fig. 199; Plate XXI: 8–9)

Lorica 20.5–22.5 µm long, 15.1–17.5 µm wide, elliptical, verrucose and covered with pores, collar with irregular rim. Found in site – **27**: p(2); **64**: p(+); pH 6.5–7.0.

General distribution – EUROPE: Holland (Conrad & Van Meel 1952), Russia (Popova 1966); ASIA: Western Siberia, China (Popova 1966).
Habitats – Planktonic, puddles, lakes, fishponds and village ponds.

*****Trachelomonas ampuliphormis*** Roll (Starmach 1983) (Fig. 185)

Lorica ca 25.0 µm long, 15.0 µm wide, flask-shaped, smooth with short straight collar, light brown. Found in site – **92**: p(+); pH 6.8.

General distribution – EUROPE: Russia, Ukraine (Popova 1966; Asaul 1975); ASIA: Manchuria (Skvortzov after Deflandre 1926); AUSTRALIA (Playfair 1915).
Habitats – Swamps and fishponds.

*****Trachelomonas pavlovskoënsis*** (Poljanskij) Popova 1966 fo. ***pavlovskoënsis***
(Plate XX: 7–8)

Syn.: *T. arnoldiana* Skvortzov var. *decurtata* Skvortzov *sensu* Bourrelly 1947.

Lorica 21.0–23.0 µm long, 16.5–18.5 µm wide, ovoid to oval, yellowish brown or colourless, thickly punctate or covered with spines. Collar smooth, sometimes crenate at the rim. Found in site – **64**: p(1); pH 7.0.

General distribution – EUROPE: France (Bourrelly 1947), Russia (Popova 1966), Ukraine (Asaul 1975); ASIA: Western Siberia (Popova 1966).

Habitats – Planktonic, lakes and ponds at pH 6.0 (Popova 1966). Saprobity – β-mesosaprobic (Cyrus & Sladeček 1973).

*****Trachelomonas pavloskoënsis*** fo. ***ellipsoidea*** Popova 1955 (Plate XX: 9)

Lorica 36.5–37.0 µm long, 23.5–24.0 µm wide, ellipsoid, verrucose; collar 4 µm high, smooth at the rim. Found in site – **35**: p(1); **36**: p(2); pH 6.9–8.0.

General distribution – EUROPE: Russia (Popova 1966), Ukraine (Asaul 1975); ASIA: Western Siberia (Popova 1966).

Habitats – In polluted water bodies, field ponds, sometimes with *T. pavlovskoënsis* fo. *pavlovskoënsis*.

Trachelomonas dubia Swirenko *em.* Deflandre fo. ***dubia*** Deflandre 1926 (Fig. 200)

Lorica 24.8 µm long, 11.5 µm wide, elliptical, smooth, collar cylindrical, reddish-brown. Found in site – **55**: p(1); pH 6.6.

Distribution in Poland – Recorded in Kraków-Częstochowa Upland in Pilica springs by Kadłubowska (1964); found also by Czosnowski (1948) from clay-pit at Capki near Zakopane and near Kraków at Piaski Wielkie.

General distribution – Cosmopolitan.

Habitats – Puddles, lakes, swamps, springs, clay-pits and field ponds. Saprobity – Oligosaprobic (Swirenko 1939).

Seria *Incurvae*

****Trachelomonas similis*** Stokes fo. ***similis*** (Popova 1955)
(Figs 201–202; Plate XXII: 1–4)

Lorica 23.0–25.0 µm long, 16.0–17.5 µm wide, ellipsoid, covered with scattered punctations, collar bent, irregularly dentate. Found in site – **28**: p(1); **64**: p(+); pH 6.5–7.0.

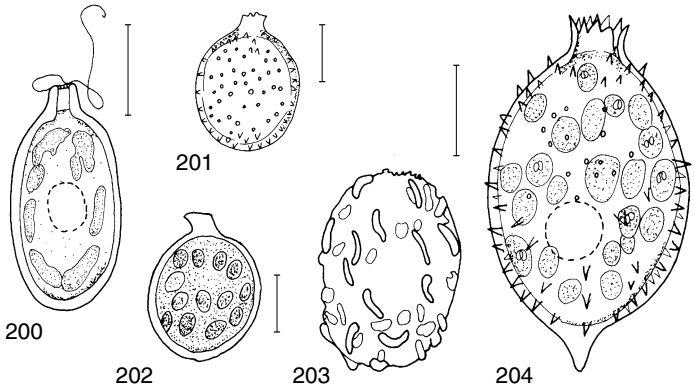
Distribution in Poland – Common.

General distribution – Cosmopolitan.

Habitats – Humic waters, polluted waters, ditches and ponds; also in salt water of Panama Canal (Prescott 1955). Saprobity – Catharobic (Lemmermann 1913), oligosaprobic (Swirenko 1939), β-mesosaprobic (Cyrus & Sladeček 1973).

*****Trachelomonas similis*** var. ***spinosa*** Huber-Pestalozzi 1955 (Plate XXII: 5–6)

Lorica ca 22 µm long, 12.5 µm wide, collar about 1–1.5 µm high, covered in spines. Dimensions of lorica are smaller than given by Huber-Pestalozzi (1955: 30 µm long, 23 µm wide, collar 4 µm high). Found in site – **64**: p(+); pH 8.5.



Figs 200–204. 200. *Trachelomonas dubia* Swirenko *em*. Deflandre fo. *dubia*; **201–202.** *T. similis* Stokes fo. *similis*; **203.** *T. gregussii* Hortobágyi var. *danubialis* Hortobágyi; **204.** *T. caudata* (Ehrenberg) Stein fo. *caudata*.

General distribution – Rare. EUROPE: Holland (Huber-Pestalozzi 1955); AFRICA: Ivory Coast (Bourrelly 1961b); SOUTH AMERICA: Brazil (Menezes & Fernandez 1987).

Habitats – Ponds.

*****Trachelomonas gregussii*** Hortobágyi var. ***danubialis*** Hortobágyi 1979 (Fig. 203)

Lorica 20.0–22.5 µm long, ca 16.5 µm wide, elliptical, irregularly ornamented by vermicular granules, without collar. Found in site – **12**: p(+); pH 7.1.

General distribution – Known only from EUROPE: Hungary (River Danube at Budapest; Hortobágyi 1979).

Habitats – Rivers, and village ponds.

Notes – The variety has the same ornamentation of the lorica as the type but is different in that it lacks a collar.

Sectio II CAUDATAE

Subsectio *CALLIFERAE*

Seria *Spiniferae*

****Trachelomonas caudata*** (Ehrenberg) Stein fo. ***caudata*** (Starmach 1983)
(Fig. 204; Plates XXII: 7–9 & XXIII: 1–9)

Lorica 40.0–41.0 µm long, 20.0–21.5 µm wide, elongate-ellipsoid, collar 3.7–5.6 µm high, with spines ca 3.7 µm long at the distal end where it is slightly widened. Posterior end gradually tapering to a conical cauda. Found in site – **55**: p(4); pH 6.6.

Distribution in Poland – Common.

General distribution – Cosmopolitan.

Habitats – Fishponds, ditches, puddles, small rivers, swamps, and field ponds. Saprobity – β-mesosaprobic (Cyrus & Sladeček 1973).

STROMBOMONAS Deflandre 1930

**Strombomonas acuminata* (Schmarda) Deflandre 1930 (Plate XXIV: 1–2)

Lorica ca 44.0–46.5 µm long, 24.5–25.0 µm wide, slightly trapezoid, covered with irregular small thickenings, high collar, thick conical spine at the posterior end. Found in site – **55**: p(2); pH 6.6.

Distribution in Poland – Previously recorded by Kotlińska (1976) from Lake Rusałka in Poznań.

General distribution – Cosmopolitan.

Habitats – Fishponds, small lakes, puddles and field ponds.

***Strombomonas planctonica* (Wołoszyńska) Popova 1955 (Plate XXIV: 3)

Syn.: *Trachelomonas affinis* Lemmermann var. *planctonica* Wołoszyńska

Lorica 42.0–47.5 µm long, 22.9–32.0 µm wide, ovoid or pyriform, yellow-brown, verrucose, gradually tapering to a conical cauda. Collar smooth at the rim. Found in site – **41**: p(2); pH 8.0.

General distribution – EUROPE: Russia (Popova 1955), Ukraine (Asaul 1975); ASIA: Uzbekistan, China (Popova 1966); SOUTH AMERICA: Brazil (Conforti 1993).

Habitats – Ponds, lakes, small rivers, ditches, polluted waters. Saprobity – β-mesosaprobic (Cyrus & Sladeček 1973).

ASCOGLENA Stein 1878

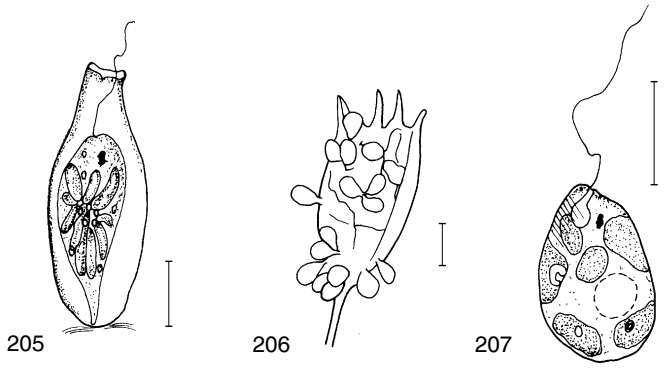
***Ascoglena viridis* Popova 1947 (Fig. 205)

Envelope 40.0 µm long, 15.5 µm wide, flask-shaped, light-yellow, attached to substratum at posterior end. Cell 30.0 µm long, 11 µm wide, fusiform. Star-like chloroplasts without pyrenoids, with one paramylon grain in centre. Nucleus situated in the posterior part of the cell; stigma situated on the reservoir. Found in site – **41**: m(+); pH 8.0.

General distribution – EUROPE: Russia (Popova 1947), Czech Republic (Cyrus & Sladeček 1973), Ukraine (Asaul 1975); ASIA: West Siberia (Popova & Safonova 1976).

Habitats – Planktonic, puddles, by the bank of a lake, ponds, sewage treatment plants. Saprobity – β-mesosaprobic (Cyrus & Sladeček 1973).

Notes – Only one specimen was found.



Figs 205–207. 205. *Ascoglena viridis* Popova; **206–207.** *Colacium vesiculosum* Ehrenberg fo. *cyclopicola* (Gicklhorn) Popova & Safonova.

COLACIUM Ehrenberg 1838

****Colacium vesiculosum*** Ehrenberg fo. ***cyclopicola*** (Gicklhorn) Popova & Safonova 1976
(Figs 206–207)

Syn.: *Cyclidiopsis arbuscula* Stein 1878, *Euglena cyclopicola* Gieklhorn 1925, *Colacium sideropus* Skuja 1939, *Colacium cyclopicola* (Gieklh.) Bourrelly 1947

Cells 15.5–26.5 µm long, 10.5–17.5 µm wide, ovoid to oblong. Found in site – **27**: p(+); **64**: p(+); pH 8.5.

Distribution in Poland – Previously recorded by Krzeczkowska-Wołoszyn (1966) from fish-ponds at Gołysz, Chudyba (1974, 1975, 1979) from Lake Kortowskie and lakes of Mazurian Landscape Park, and Burchardt (1977) from Lake Pątnowskie.

General distribution – Cosmopolitan, common.

Habitats – Ponds, lakes, forest puddles, on planktonic crustaceans and rotifers. According to Prescott (1955) in salt water of Panama Canal. Saprobity – Mesosaprobic (Kolkwitz & Marsson 1908); β-mesosaprobic (Cyrus & Sladeček 1973).

LEPOCINCLIS Perty 1849

Lepocinclis ovum (Ehrenberg) Minkiewič var. ***ovum*** (Starmach 1983)
(Figs 208–210; Plate XXIV: 4)

Cells 18.0–37.0 µm long, 12.0–22.3 µm wide, broadly elliptical each with small, short, rounded extension at the posterior end. Found in site – **22**: p(+); **23**: p(1); **26**: p(1); **28**; p(1); **41**: p(1); **50**: p(+); **51**: p(+); **55**: p(+); **56**: p(2); **62**: p(1); pH 6.5–8.6

Distribution in Poland – Previously recorded in the Kraków-Częstochowa Upland in a fish-pond in the Ojców National Park. Common.

General distribution – Cosmopolitan.

Habitats – Planktonic in stagnant and slow-flowing waters, streams, rivers, ponds, lakes, swamps, ditches, rice-fields and fishponds; also in radioactive wastes (Lackey 1958). Saprobity – Mesosaprobic (Kolkwitz & Marsson 1908), α-β-mesosaprobic (Cyrus & Sladeček 1973).

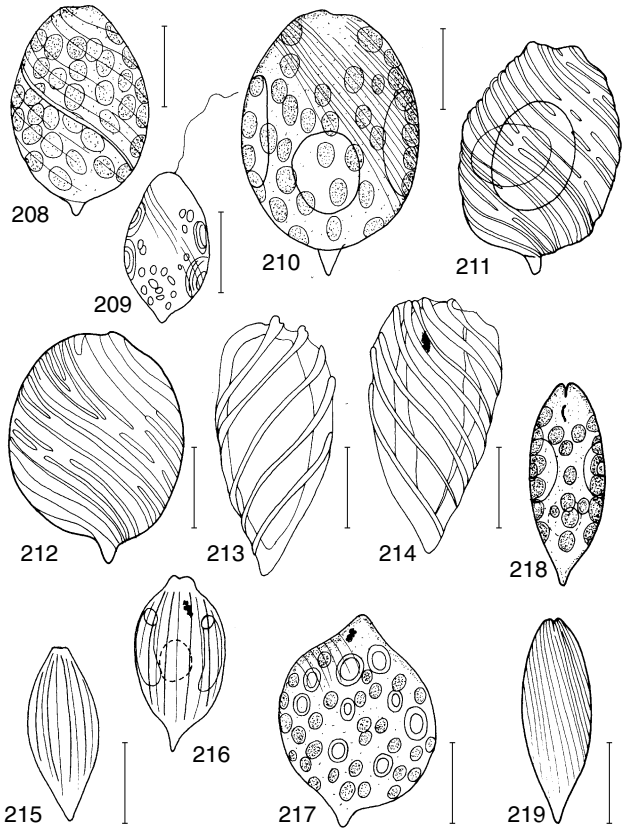
Lepocinclis ovum var. ***palatina*** Lemmermann 1910 (Figs 211–212; Plate XXIV: 5)

Cells 20.0–29.6 µm long, 17.0–21.5 µm wide, ovoid, covered with ridges, each cell has small projection at the posterior end. Found in site – **22**: p(3); pH 8.6.

Distribution in Poland – Previously recorded by Kyselowa (1973) in ponds enriched with organic wastes.

General distribution – EUROPE: Germany (Lemmermann 1910), Ukraine (Koczwara 1916; Drežepolski 1925; Asaul 1975), Romania (Tarnavischi *et al.* 1956), Russia (Popova & Safonova 1976), Bulgaria (Kiryakov 1983); ASIA: Western Siberia, China, India (Popova & Safonova 1976).

Habitats – Ponds, swamps, lakes.



Figs 208–219. 208–210. *Lepocinclis ovum* (Ehrenberg) Minkiewič var. *ovum*; **211–212.** *L. ovum* var. *palatina* Lemmermann; **213–214.** *L. ovum* var. *striata* (Hübner) Lemmermann; **215–216.** *L. steinii* Lemmermann; **217.** *L. nayalii* Conrad; **218–219.** *L. acicularis* Francé.

****Lepocinclis ovum** var. **striata** (Hübner) Lemmermann 1901 (Figs 213–214)

Cells 31.0–32.5 µm long, ca 14.0 µm wide, oval, covered with oblique ridges, posterior end of each cell has short extension. Found in site – **13**: p(2); pH 10.0.

General distribution – EUROPE: Germany (Lemmermann 1901, 1910), Belgium, Latvia (Conrad 1935), France (Popova & Safonova 1976), Ukraine (Dreżepolski 1925).

Habitats – Small water bodies, puddles, swamps, and village ponds.

***Lepocinclis steinii** Lemmermann 1901 (Figs 215–216)

Cell 22.2 µm long, 11.1 µm wide, shortly fusiform, bluntly truncate at the anterior end. Found in site – **26**: p(+); pH 7.0.

Distribution in Poland – Previously recorded by: Czosnowski (1948) in Piaski Wielkie near Kraków, Kyselowa (1973) in ponds with organic wastes, and Rakowska (1976) from River Bzura.

General distribution – Cosmopolitan.

Habitats – Planktonic, benthic, small water bodies, swamps, ditches, puddles, ponds. Saprobity – β-mesosaprobic (Cyrus & Sladeček 1973).

***Lepocinclis nayalii** Conrad 1935 (Fig. 217)

Cell ca 26.2 µm long, 19.0 µm wide, onion shaped, conically elongated at the anterior end, with short wart at the posterior end. Found in site – **70**: p(+); pH 7.5.

Distribution in Poland – Previously recorded by Burchardt (1976, 1977) in the Lake Pątnowskie.

General distribution – EUROPE: Hungary (Uherkovich & Schmidt 1974; Uherkovich & Lantos 1984); AFRICA: Egypt (Conrad 1935).

Habitats – Rivers, swamps, ponds, lakes.

****Lepocinclis acicularis** Francé (Starmach 1983) (Figs 218–219)

Cell 25.0 µm long, 8.5 µm wide, fusiform. Pellicle with a few spiral striae. Chloroplasts plate-shaped. Two large annular paramylon grains, located laterally. Found in site – **70**: p(+); pH 7.5.

General distribution – EUROPE: Ukraine (Asaul 1975), France (Capdeville 1985); ASIA: Malaya (Prowse 1958); NORTH AMERICA: U.S.A. (Thompson 1938).

Habitats – Swamps, ditches, peat bogs, lakes, ponds.

****Lepocinclis playfairiana** Deflandre (Starmach 1983) (Plate XXIV: 6–7)

Cells ca 37.5 µm long, ca 20.0 µm wide, onion shaped, each cell with bent, conical, hyaline cauda; top of anterior part rostrate; pellicle spirally striated; chloroplasts numerous, discoid. Found in site – **53**: m(+); pH 8.4.

General distribution – Rare. EUROPE: France (Conrad 1935), Ukraine (Asaul 1975), Czech Republic (Cyrus & Sladeček 1973), Bulgaria (Kiryakov 1983); AUSTRALIA (Conrad 1935).

Habitats – Village ponds, fishponds and puddles.

PHACUS Dujardin 1841

Sectio PHACUS

**Phacus stokesii* Lemmermann 1910 (Figs 220–221; Plate XXV: 1–2)

Syn.: *Cyslonura orbiculata* Stokes 1886

Cell ca 36.5–40.0 µm long, 33.5–36.0 µm wide, irregularly heart shaped. Found in site – **27**: p(+); pH 8.3.

Distribution in Poland – Previously recorded by Drężepolski (1925) without stating the site of occurrence, and Stawiński (1969) from fish ponds at Ochaby.

General distribution – EUROPE: Germany (Lemmermann 1910), Ukraine (Asaul 1975), France, Russia (Popova & Safonova 1976), Hungary (Nemeth 1997); NORTH AMERICA: U.S.A. (Walton 1915); SOUTH AMERICA: Argentina (Tell & Conforti 1986); ASIA: India (Naidu 1966), Malaya (Prowse 1958), West Siberia, China (Popova & Safonova 1976).

Habitats – Swamps, puddles, ponds. Saprobity – Catharobic (Lemmermann 1913).

**Phacus corculum* Pochmann 1941 (Figs 222–224; Plate XXV: 3)

Syn.: *Ph. brevicaudata* Lemmermann *in* Skvortzov 1937

Cell 17.5–27.0 µm long, 17.0–23.5 µm wide, heart shaped. Found in site – **64**: p(+); pH 7.5.

Distribution in Poland – Previously recorded by Stawiński (1969) in various water bodies near Bielsko-Biała.

General distribution – EUROPE: Hungary (Hortobágyi 1947); ASIA: India (Pochmann 1941); AFRICA: Senegal (Compère 1991).

Habitats – Lakes and ponds.

**Phacus parvulus* Klebs 1883 (Figs 225–227; Plate XXV: 4–5)

Cells 18.0–27.5 µm long, 7.7–16.0 µm wide, obovoid, each cell obliquely truncate at the anterior end, with short extension at the posterior end. Found in site – **23**: p(2); **27**: p(1); **41**: p(1); **70**: p(1); pH 6.9–8.0.

Distribution in Poland – Previously recorded by: Liebetanz (1925) from Kujawy salt ponds, Stawiński (1969) from Ochaby fishponds and various water bodies near Bielsko Biała, Szyszka (1976) from Lake Gosławickie a reservoir receiving hot water discharge, Burchardt (1977) in plankton of Lake Pątnowskie, Chudyba (1984) in plankton of brackish water and in Lake Garbaś Chudyba (1990).

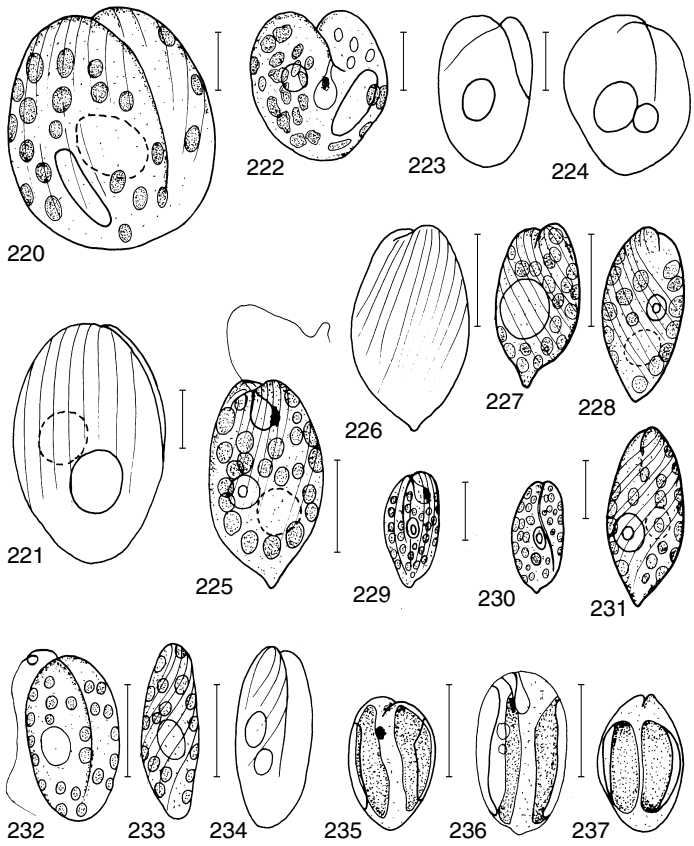
General distribution – Cosmopolitan, common.

Habitats – Stagnant water bodies: puddles, ponds, lakes. Saprobity – Oligosaprobic (Kolkwitz & Marsson 1908).

**Phacus pusillus* Lemmermann 1910 (Figs 228–231; Plate XXV: 13)

Syn.: *Ph. parvulus* Klebs var. *pusillus* (Lemmermann) Popova 1955

Cells 20.0–23.5 µm long, 8.0–9.0 µm wide, ovoid, flattened. Found in site – **65**: p(1); pH 7.0.



Figs 220–237. 220–221. *Phacus stokesii* Lemmermann; **222–224.** *Ph. corculum* Pochmann; **225–226.** *Ph. parvulus* Klebs; **227–231.** *Ph. pusillus* Lemmermann; **231–234.** *Ph. dangeardii* Lemmermann; **235–237.** *Ph. agilis* Skuja.

Distribution in Poland – Previously recorded by: Czosnowski (1952) from puddles near Kraków and Stawiński (1969) from various water bodies near Bielsko-Biała.

General distribution – Cosmopolitan, common.

Habitats – Plankton and benthos in slow-flowing and stagnant waters, ponds, fishponds, puddles. Saprobity – Catharobic (Lemmermann 1913), oligosaprobic-mesosaprobic (Swirenko 1939), oligosaprobic to α-mesosaprobic (Zelinka & Marvan 1961), β-α-mesosaprobic (Cyrus & Sladeček 1973).

****Phacus dangeardii*** Lemmermann 1910 (Figs 232–234; Plate XXV: 14)

Cell 18.0–20.5 μm long, 6.5–10.0 μm wide, ovoid, flattened. Found in site – **41**: p(+); pH 8.1.

Distribution in Poland – Previously recorded by: Stawiński (1969) in various water bodies near Bielsko-Biała, Burchardt (1977) in plankton of Lake Pątnowskie, and Dąmbska *et al.* (1978) in lakes in Wielkopolska National Park.

General distribution – EUROPE: France (Pochmann 1941), Romania (Péterfi 1969), Russia (Popova & Safonova 1976), Ukraine (Asaul 1975); NORTH AMERICA: U.S.A. (Walton 1915); ASIA: Malaya (Prowse 1958), South India (Naidu 1966), Western Siberia (Popova & Safonova 1976).

Habitats – Planktonic, in ditches, ponds, lakes and by river banks. Saprobity – Catharobic (Lemmermann 1913).

****Phacus agilis*** Skuja 1926 (Figs 235–237)

Syn.: *Ph. parvula* Klebs *in* Mainx 1927

Cells 15.1–18.3 µm long, 9.2 µm wide, each cell oval with small depression at the anterior end, short blunt extension at the posterior end. Found in site – **64**: p(+); **70**: m(+); pH 6.8–7.5.

Distribution in Poland – Previously found by Kyselowa (1973) in plankton of ponds enriched with organic wastes.

General distribution – EUROPE: Latvia (Skuja 1926), Germany (Pochmann 1941), Hungary (Hortobágyi 1966), Ukraine (Asaul 1975), Russia (Popova & Safonova 1976); ASIA: West Siberia (Popova & Safonova 1976), Malaya (Prowse 1958), Indonesia, Vietnam; AFRICA: Ivory Coast (Bourrelly 1961b).

Habitats – Planktonic and benthic, lakes, ponds, puddles, forest water bodies. Saprobity – β-mesosaprobic (Cyrus & Sladeček 1973).

****Phacus acuminatus*** Stokes var. ***acuminatus*** (Huber-Pestalozzi 1955) (Fig. 238; Plate XXV: 6 & 8)

Cells 25.0–49.5 µm long, 17.0–35.0 µm wide, each cell broadly oval, with incision at the anterior end, short extension at the posterior end. Found in site – **22**: m(2); **27**: p(+–1); **41**: p(+) & m(1); **59**: p(1); **65**: p(2); **86**: p(+); pH 6.8–7.5.

General distribution – Cosmopolitan.

Habitats – Planktonic, benthic, various types of water bodies. Saprobity – Catharobic (Lemmermann 1913), oligosaprobic-mesosaprobic (Swirenko 1939), α-β-mesosaprobic (Cyrus & Sladeček 1973).

******Phacus acuminatus*** var. ***indica*** Huber-Pestalozzi 1955 (Fig. 239)

Syn.: *Ph. triqueter* (Ehrenberg) Dujardin *sensu* Skvortzov 1937; *Ph. acuminatus* Stokes ssp. *indica* Pochmann

Cell 30.7 µm long, 22.5 µm wide, pentagonal, with two large paramylon grains. Found in site – **86**: p(+); pH 6.8.

General distribution – ASIA: India (Huber-Pestalozzi 1955).

Habitats – Ponds, puddles, and "Elżbieta" spring with partly rotted leaves.

****Phacus circulatus*** Pochmann 1942 (Plate XXVII: 4)

Syn.: *Ph. orbicularis* Hübner var. *żmudae* Namysłowski 1921

Cells 20–23 µm long, 20 µm wide, more or less spherical, each cell with one large,

centrally located paramylon grain; pellicle longitudionaly striated. Cauda very short and bent. Found in site – **41**: m(+); pH 7.5.

Distribution in Poland – Previously recorded by Namysłowski (1921) in Kraków in a pond.

General distribution – Not common. EUROPE: Romania (Péterfi 1962), Hungary (Hortobágyi 1966); ASIA: Malaya (Prowse 1958).

Habitats – Swamps, fishponds, and village ponds.

****Phacus brachykentron*** Pochmann 1941 (Fig. 240; Plate XXV: 12)

Syn.: *Ph. pleuronectes* Dujardin var. *rothertii* Namysłowski 1921

Cell 27.6 µm long, 17.6 µm wide, oval with short, sharp cauda. Found in site – **8**: p(1); pH 6.6.

Distribution in Poland – Previously recorded by Namysłowski (1921) from a pond in the Dębniki quarter of Kraków.

General distribution – EUROPE: Germany (Pochmann 1941), Czech Republic (Fott & Komárek 1960), Hungary (Hortobágyi 1963); CENTRAL AMERICA: Panama (Prescott 1955); AFRICA: Chad (Compère 1975).

Habitats – Swamps, puddles, ditches, lakes, ponds, salt marshes. Saprobity – α-β-mesosaprobic (Cyrus & Sladeček 1973).

****Phacus inflexus*** (Kiss) Pochmann 1941 (Figs 241–244)

Syn.: *Euglena inflexa* Kisselev 1931

Cells 23.0–26.5 µm long, 5.5–10.7 µm wide, almost pancake shaped, flat. Found in site – **23**: p(1); **27**: m(3); **41**: p(2); pH 7.0.

Distribution in Poland – Previously recorded by Kyselowa (1973) in ponds with organic waste.

General distribution – EUROPE: Germany (Pochmann 1941), Czech Republic (Cyrus & Sladeček 1973), Hungary (Nemeth 1997), Russia (Popova & Safonova 1976); NORTH AMERICA: Florida; CENTRAL AMERICA: Guadeloupe (Popova & Safonova 1976); SOUTH AMERICA: Argentina (Tell & Conforti 1986); AFRICA: Chad (Iltis 1972).

Habitats – Planktonic and benthic in ponds, lakes, puddles. Saprobity – β-mesosaprobic (Cyrus & Sladeček 1973).

*****Phacus striatus*** Francé (Popova & Safonova 1976) (Fig. 245)

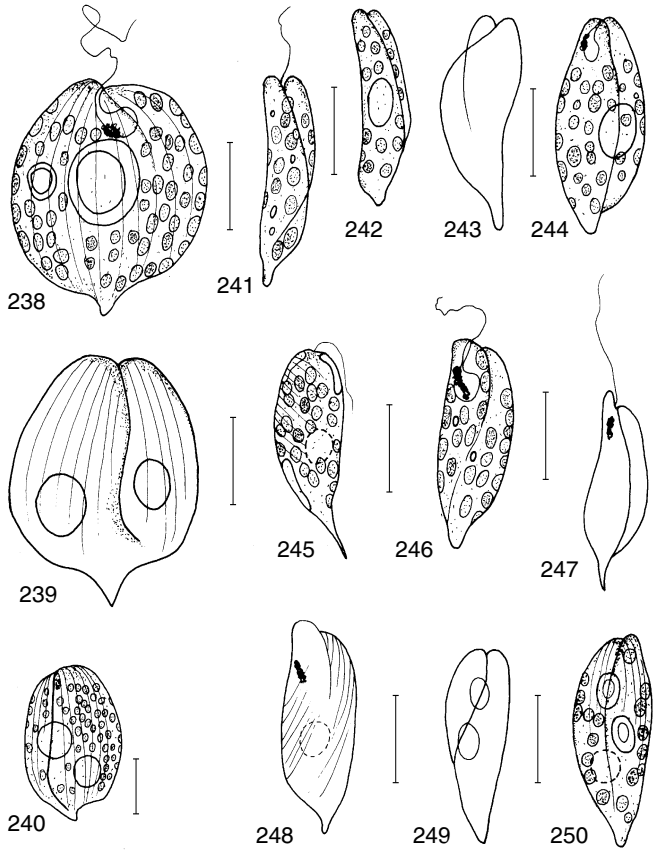
Syn.: *Ph. aenigmatica* Dreżepolski 1921/1922

Cells 24.5–27.0 µm long, 8.2 µm wide, pyriform, ovoid or obovoid, each cell slightly narrowed at the middle, with long, hyaline cauda at the end. Keel as long as cell length. Pellicle spirally striated from the left to the right. Chromatophores small, discoid. Paramylon grains three, discoid, lying peripherally. Found in site – **26**: p(+); **27**: p(+) & m(+); pH 8.0–8.4.

General distribution – Cosmopolitan, common.

Habitats – In plankton and benthos, small water bodies, lakes, ponds. Saprobity – Catharobic (Lemmermann 1913), oligosaprobic – α-mesosaprobic (Popova & Safonova 1976).

Figs 238–250. 238. *Phacus acuminatus* Stokes var. *acuminatus*; **239.** *Ph. acuminatus* var. *indica* Huber-Pestalozzi; **240.** *Ph. brachykentron* Pochmann; **241–244.** *Ph. inflexus* (Kiss) Pochmann; **245.** *Ph. striatus* Francé; **246–248.** *Ph.*



Figs 238–250. 238. *Phacus acuminatus* Stokes var. *acuminatus*; **239.** *Ph. acuminatus* var. *indica* Huber-Pestalozzi; **240.** *Ph. brachykentron* Pochmann; **241–244.** *Ph. inflexus* (Kiss) Pochmann; **245.** *Ph. striatus* Francé; **246–248.** *Ph. oscillans* Klebs; **249–250.** *Ph. skujae* Skvortzov.

****Phacus oscillans*** Klebs 1883 (Figs 246–248)

Cells 23.0–35.1 μm long, 7.5–13.3 μm wide, oval, each cell narrowing at the anterior end, two lobes, one higher than the other and sharp or blunt extension at the posterior end. Found in site – **23**: m(1); **26**: p(+) & m(1); **41**: p(1); pH 6.6–7.6.

Distribution in Poland – Previously recorded from Ochaby fishponds and different water bodies near Bielsko Biała by Stawiński (1969), from springs and ponds in Rogoźno (Łódź Prov.), from the area of salt pans near Łęczyca (Pliński 1970, 1971), from Lake Gosławickie, a reservoir receiving hot water discharge (Szyszka 1976), and from plankton of Lake Pątnowskie (Burchardt 1977).

General distribution – Cosmopolitan.

Habitats – Planktonic and benthic, in ponds, lakes, forest water bodies. Saprobity – Oligosaprobic (Popova & Safonova 1976).

*__Phacus skujae__ Skvortzov (Popova & Safonova 1976) (Figs 249–250)

Syn.: *Ph. pusilla* Lemmermann *sensu* Skuja 1926

Cells 21.6–23.0 µm long, 6.6–8.5 µm wide, fusiform in outline, slightly bent and flattened. Found in site – **68**: p(2); pH 7.5.

Distribution in Poland – Previously recorded by: Stawiński (1969) from Goczałkowice dam reservoir, and various water bodies near Bielsko-Biała, Burchardt *et al.* (1979) from reservoirs at Pławniowice near Poznań.

General distribution – Cosmopolitan.

Habitats – Planktonic and benthic in ponds, lakes and slow-flowing rivers. Saprobity – β-mesosaprobic (Cyrus & Sladeček 1973).

*__Phacus undulatus__ Pochman 1941 var. __undulatus__ (Fig. 251; Plate XXV: 7)

Syn.: *Ph. pleuronectes* (Ehrenberg) Dujardin var. *incerta* Koczwara 1916

Cells 22.2–42.5 µm long, 18.5–20.5 µm wide, each cell oval in outline, corrugated at the rim, with a long curved cauda at the posterior end. Found in site – **41**: p(+); **70**: m(+); pH 7.5–8.1.

Distribution in Poland – Previously recorded by: Pochmann (1941) from Silesia, Stawiński (1969) from Goczałkowice dam reservoir, and from various water bodies near Bielsko-Biała, Rakowska (1976) from River Bzura near Wyszogród, and Krzeczkowska-Wołoszyn (1977) from ponds with organic wastes.

General distribution – Cosmopolitan, common.

Habitats – Benthic and planktonic, in fish and village ponds, lakes, swamps, ditches; also in salt water of Panama Canal (Prescott 1955).

*__Phacus unguis__ Pochmann 1941 (Figs 252–254; Plate XXV: 9)

Cells 29.5–40.0 µm long, 16.5–22.9 µm wide, oval, each cell slightly corrugated at the rim with short cauda at the posterior end. Found in site – **41**: p(+–1); pH 7.5–7.9.

Distribution in Poland – Previously recorded by Stawiński (1969) from various water bodies near Bielsko-Biała.

General distribution – EUROPE: Germany (Pochmann 1941), Hungary (Hortobágyi 1966), Ukraine (Asaul 1975), Russia (Popova & Safonova 1976), Czech Republic (Wołowski 1992c); ASIA: Japan (Yamagishi 1977); SOUTH AMERICA: Argentina (Yacubson 1965; Tell & Conforti 1986); AFRICA: Chad (Compère 1975).

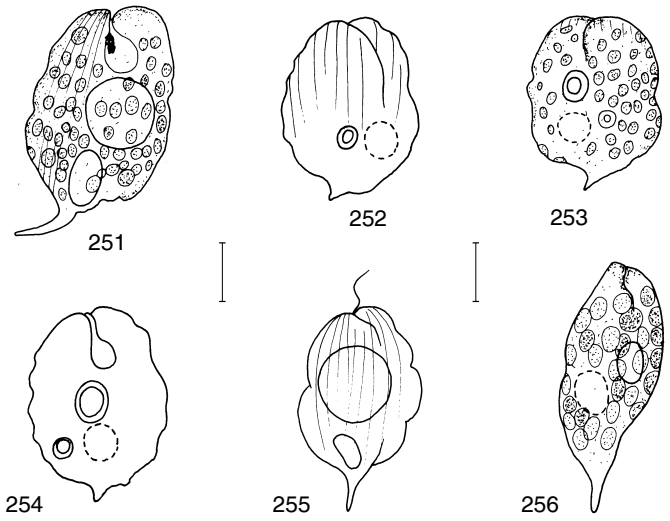
Habitats – Lakes, village and fishponds, swamps.

**__Phacus indicus__ Skvortzov 1922 (Figs 255–256)

Syn.: *Ph. caudata* Hübner var. *volicensis* Drežepolski 1925

Cells 26.6–43.0 µm long, 10.3–19.5 µm wide, each cell oval in outline with few deep incisions at the rim, straight sharp cauda at the posterior end. Found in site – **86**: p(1); pH 8.4.

General distribution – EUROPE: Ukraine (Drežepolski 1925; Asaul 1975); ASIA: Afganistan



Figs 251–256. 251. *Phacus undulatus* Pochmann var. *undulatus*; **252–254.** *Ph. unguis* Pochmann; **255–256.** *Ph. indicus* Skvortzov.

(Hirano 1966), China, India (Pochmann 1941); SOUTH AMERICA: Argentina (Tell & Conforti 1986).

Habitats – Stagnant waters, ponds, puddles, lakes and "Elżbieta" spring with partly rotted leaves.

Phacus orbicularis Hübner fo. ***orbicularis*** (Figs 257–258; Plate XXVI: 2)

Cells 46.0–67.5 µm long, 19.5–46.5 µm wide, each cell broadly oval, with long curved cauda at the posterior end. Found in site – **8**: p(1–2); **9**: m(1); **27**: p(1); **28**: p(+–1); **41**: p(+); **61**: p(1); pH 6.6–7.6.

General distribution – Cosmopolitan, very common.

Habitats – Planktonic and benthic in stagnant, mineralized, polluted and humic waters, ponds, swamps and lakes; also in salt water of Panama Canal (Prescott 1955). Saprobity – Catharobic (Lemmermann 1913), β-mesosaprobic (Cyrus & Sladeček 1973).

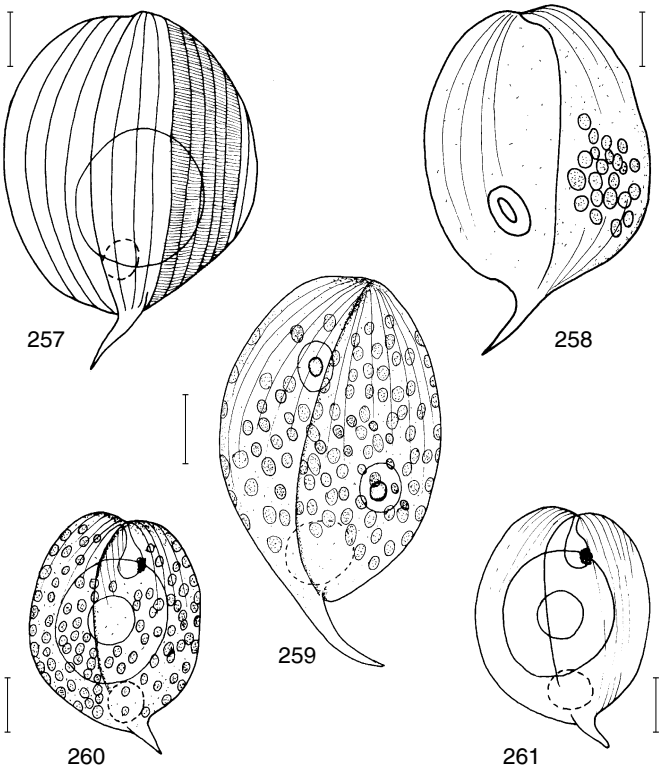
****Phacus orbicularis*** fo. ***cingeri*** (Roll) Safonova 1976 (Fig. 259)

Cell 55.5 µm long, 32.0 µm wide, broadly oval, with long curved cauda. Found in site – **64**: p(+); pH 8.2.

Distribution in Poland – Previously recorded by Stawiński (1969) from Ochaby fishpond near Goczłkowice reservoir and various water bodies near Bielsko-Biała, and Sieminiak (1984) from Przeczyce dam reservoir.

General distribution – EUROPE: Ukraine (Swirenko 1939), Romania, Russia (Popova & Safonova 1976).

Habitats – Lakes, ponds, fishponds, ditches. Saprobity – Oligosaprobic (Swirenko 1939).



Figs 257–261. 257–258. *Phacus orbicularis* Hübner fo. *orbicularis*; **259.** *Ph. orbicularis* fo. *cingeri* (Roll) Safonova; **260–261.** *Ph. orbicularis* fo. *communis* Popova.

****Phacus orbicularis*** fo. ***communis*** Popova 1947 (Figs 260–261; Plate XXVI: 3)

Cells 41.0–47.5 µm long, 28.0–35.5 µm wide, each cell broadly oval with short cauda at the posterior end. Found in site – **27**: p(1); **62**: p(1); pH 6.6–7.2.

Distribution in Poland – Previously recorded from Ochaby fishpond, Goczałkowice reservoir, and from various water bodies near Bielsko-Biała by Stawiński (1969), from the highly polluted and saline Kochłówka stream in Upper Silesia (Skalska 1975), from Lake Rusałka in Poznań (Kotlińska 1976), and from Przeczyce reservoirs (Sieminiak 1984).

General distribution – Cosmopolitan, very common.

Habitats – Stagnant water bodies, ponds, reservoirs, ditches, puddles, lakes.

Phacus pleuronectes (Ehrenberg) Dujardin 1925 var. ***pleuronectes***
(Figs 262–263; Plate XXVI: 4–5)

Cells 24.0–44.7 µm long, 17.5–34.0 µm wide, broadly ovoid, slightly twisted, each cell narrowed at the anterior end, with short curved cauda at the posterior end. Found in

site – **6**: p(+); **9**: p(2); **10**: p(1); **19**: p(1); **20**: p(1); **23**: p(2); **24**: m(1); **26**: p(1); **27**: p(1); **41**: p(+–1); **64**: p(2); **70**: p(1); **73**: p(+); pH 7.0–8.4.

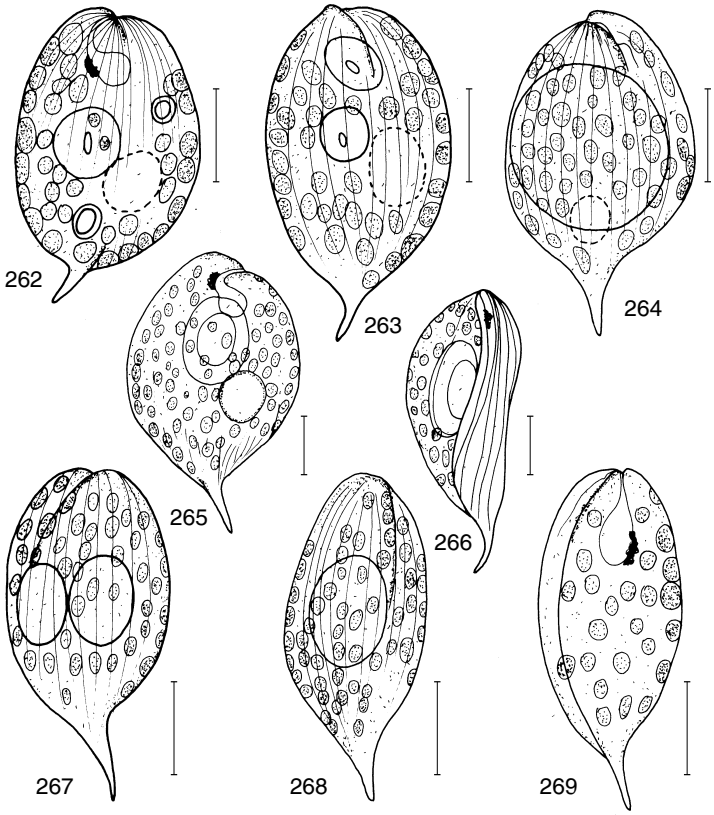
Distribution in Poland – Very common.

General distribution – Cosmopolitan.

Habitats – Small water bodies, lakes and ponds; also in salt water of Panama Canal (Prescott 1955). Saprobity – Oligosaprobic-catharobic (Lemmermann 1913), oligosaprobic-mesosaprobic (Swirenko 1939), α-β-mesosaprobic (Cyrus & Sladeček 1973).

****Phacus formosus*** Pochmann 1941 (Fig. 264; Plate XXVII: 1–2)

Cells 34.5–35.0 µm long, 18.0–20.3 µm wide, longitudinally ovoid, each cell asymmetrically elongated at the anterior end, sometimes nicked at the rim. At the anterior end there are longitudinal folds. Posterior end with straight cauda. Pellicle longitudionally striated. One or two large and a few small paramylon grains. Eyespot large. Chloroplasts small, discoid. Found in site – **28**: m(+); **86**: m(+); pH 6.5–6.8.



Figs 262–269. 262–263. *Phacus pleuronectes* (Ehrenberg) Dujardin var. *pleuronectes*; **264.** *Ph. formosus* Pochmann; **265–266.** *Ph. hamatus* Pochmann; **267–269.** *Ph. ankylonoton* Pochmann.

Distribution in Poland – Previously recorded by Sieminiak (1984) in Przeczyce reservoir.

General distribution – EUROPE: Ukraine (Dreżepolski 1925), Germany (Pochmann 1941, 1957/1958), Czech Republic (Fott & Komárek 1960).

Habitats – Ponds and puddles.

****Phacus hamatus*** Pochmann 1941 (Figs 265–266)

Cell 47.0 µm long, 30.0 µm wide, broadly oval, twisted, with curved cauda at the posterior end. Found in site – **64**: p(+); pH 8.2.

Distribution in Poland – Previously recorded by Dreżepolski (1948) near Gniezno and Winiary, and Burchardt (1977; Burchardt *et al.* 1981) in Lakes Pątnowskie and Jarosławickie.

General distribution – Cosmopolitan.

Habitats – Ponds, lakes, small rivers, puddles and ditches.

****Phacus ankylonoton*** Pochmann 1941 (Figs 267–269)

Syn.: *Ph. caudata* Hübner var. *polonica* Dreżepolski 1925

Cell 33.0–39.6 µm long, 10.5–17.0 µm wide, oval with long fold at the back, slightly curved cauda at the posterior end. Found in site – **9**: m(1); **86**: m(1–2); pH 7.0–7.2.

Distribution in Poland – Previously recorded by Stawiński (1969) near Bielsko Biała in ditches, ponds, and fishponds, and Stefko (1976) in the Lake Maltańskie phytoplankton.

General distribution – EUROPE: Germany (Pochmann 1941), Denmark (Conrad 1943), Hungary (Hortobágyi 1957; Uherkovich 1976), Russia (Popova & Safonova 1976), Ukraine (Dreżepolski 1925; Vetrova 1980); NORTH AMERICA: U.S.A. (Prescott & Vinyard 1965).

Habitats – Small water bodies, ponds, lakes, puddles, swamps.

*****Phacus obolus*** Pochmann 1941 (Figs 270–272; Plate XXVII: 3)

Syn.: *Ph. caudata* Hübner var. *lata* Allorge & Lefèvre 1930

Cell 33.5–41.5 µm long, 20.0–36.5 µm wide, broadly oval, slightly narrowed at the anterior end, with straight, conical cauda at the posterior end. Found in site – **6**: p(+); **86**: m(1); pH 6.8–8.4.

General distribution – EUROPE: France (Allorge & Lefèvre 1930), Hungary (Hortobágyi 1947, 1966), Czech Republic (Wołowski 1992c); ASIA: Uzbekistan (Pochmann 1941).

Habitats – Ponds, lakes.

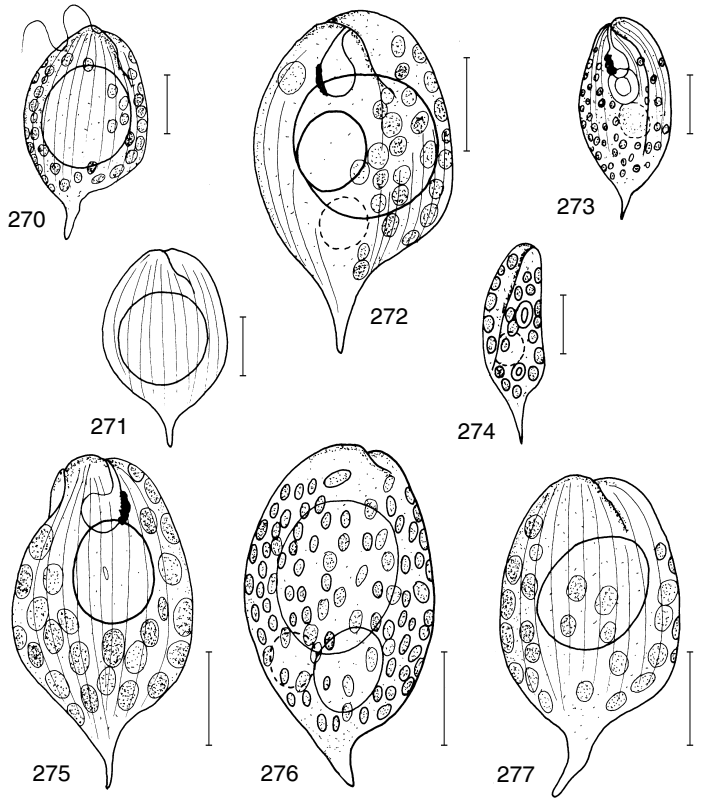
****Phacus hamelii*** Allorge & Lefèvre 1930 (Figs 273–274)

Syn.: *Ph. pleuronectes* (Ehrenberg) Dujardin var. *hamelii* Popova 1947

Cell 31.5–37.0 µm long, 14.5–18.8 µm wide, elliptical in outline, saucer-like, each with sharp cauda at the posterior end. Found in site – **27**: p(+); **28**: m(+); **41**: p(+); **59**: p(2); **64**: p(+); **77**: p(1); pH 6.6–8.4.

Distribution in Poland – Previously recorded by Dreżepolski (1948) near Gniezno and Winiary.

General distribution – EUROPE: France (Allorge & Lefèvre 1930), Hungary (Hortobágyi



Figs 270–277. 270–272. *Phacus obolus* Pochmann; **273–274.** *Ph. hamelii* Allorge & Lefèvre; **275–276.** *Ph. caudatus* Hübner var. *caudatus*; **277.** *Ph. caudatus* var. *tenuis* Swirenko.

1966; Uherkovich & Lantos 1987); ASIA: Indonesia (Conrad 1938); SOUTH AMERICA: Brazil (Menezes 1986).

Habitats – Planktonic, known from ponds, lakes, swamps, puddles, and rice-fields.

Phacus caudatus Hübner var. ***caudatus*** (Pochmann 1941) (Figs 275–276)

Cells 31.1–41.0 μm long, 17.5–21.7 μm wide, ovoid, slightly twisted, each with curved cauda at the posterior end. Found in site – **26**: p(+); **27**: p(+); **64**: m(1); **86**: p(1) & m(1); pH 7.0–7.7.

Distribution in Poland – Previously recorded in Kraków-Częstochowa Upland by Czosnowski (1948).

General distribution – Cosmopolitan.

Habitats – Ponds, lakes, swamps, puddles and "Elżbieta" spring with partly rotted leaves. In salt water of Panama Canal (Prescott 1955). Saprobity – Mesosaprobic (Kolkwitz & Marsson 1908), catharobic (Lemmermann 1913), oligosaprobic (Swirenko 1939), catharobic-mesosaprobic (Pochman 1941), β-mesosaprobic (Cyrus & Sladeček 1973).

**Phacus caudatus* var. *tenuis* Swirenko 1939 (Fig. 277)

Cells 34.5–37.0 µm long, 15.1–21.5 µm wide, ovoid, each with long curved cauda at the posterior end. Found in site – **26**: p(3); **27**: m(+); **28**: p(2); **64**: p(1); **86**: m(2); pH 6.5–7.5.

Distribution in Poland – Previously recorded by: Stawiński (1969) in various water bodies near Bielsko-Biała, and Kotlińska (1976) in Lake Rusałka.

General distribution – EUROPE: Ukraine (Swirenko 1939; Asaul 1975), Russia (Popova & Safonova 1976), Czech Republic (Wołowski 1992c), Slovakia (Wołowski & Hindák 1996).

Habitats – Planktonic and benthic in ponds, lakes, puddles, stagnant waters, and "Elżbieta" spring with partly rotted leaves. Saprobity – Oligosaprobic (Swirenko 1939).

***Phacus carinatus* Pochmann 1941 (Fig. 287; Plate XXVI: 1)

Syn: *Ph. triqueter* (Ehrenberg) Dujarden *sensu* Playfair 1921

Cells 44–49.0 µm long, 34.0–37.5 µm wide, broadly oval with strong keel on the back. Posterior end with strongly bent cauda. Pellicle spiraly striated; two large paramylon grains. Found in site – **53**: m(1); pH 8.2.

General distribution – Very rare, known from EUROPE: Hungary (Uherkovich & Lantos 1987) AUSTRALIA (Playfair 1921).

Habitats – Lakes, small stagnant water bodies, village ponds.

Phacus triqueter (Ehrenberg) Dujardin (Pochmann 1941) (Figs 278–279)

Syn.: *Euglena triqueter* Ehrenberg

Cells ca 40.0 µm long, 24.0–27.0 µm wide, oval, triangular shaped in cross section, slightly twisted, each with short oblique cauda at the posterior end. Found in site – **64**: p(1); pH 7.9.

Distribution in Poland – Previously recorded in the Kraków-Częstochowa Upland by Czosnowski (1948).

General distribution – Cosmopolitan.

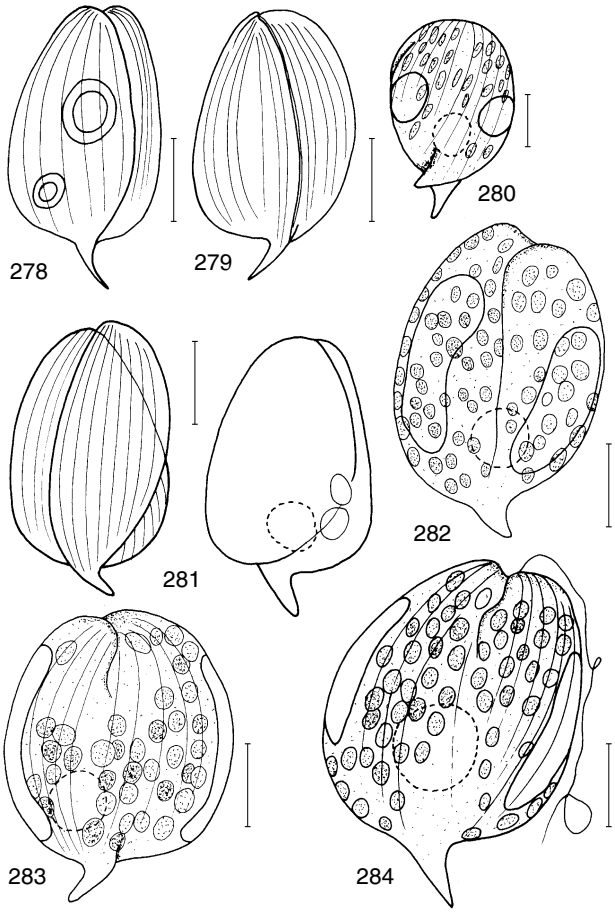
Habitats – Benthic and planktonic, in lakes, ponds, swamps, small rivers; also in salt water of Panama Canal (Prescott 1955). Saprobity – Catharobic to oligosaprobic (Lemmermann 1913), β-mesosaprobic (Cyrus & Sladeček 1973).

***Phacus contortus* Bourrelly 1952 (Fig. 280)

Cells 37.0–40.0 µm long, 23.3 µm wide, irregular ovoid, twisted, each with thick cauda at the posterior end. Found in site – **27**: p(+); **41**: p(+); **70**: p(+); pH 7.5–8.2.

General distribution – EUROPE: Hungary (Bourrelly 1952; Uherkovich 1967), Czech Republic (Wołowski 1992c); AFRICA: Ivory Coast (Bourrelly 1961b); SOUTH AMERICA: Argentina (Garcia de Emiliani 1981; Tell & Conforti 1986), Bolivia (Thérézien 1989), Chile (Parra *et al.* 1982), Guadeloupe (Bourrelly 1952) and Venezuela (Yacubson 1980–1981).

Habitats – Planktonic, in fishponds, ditches, lakes.



Figs 278–284. 278–279. *Phacus triqueter* (Ehrenberg) Dujardin; **280.** *Ph. contortus* Bourrelly; **281.** *Ph. anomalus* (Fritsch & Rich) Pochmann; **282–283.** *Ph. alatus* Klebs var. *alatus*; **284.** *Ph. alatus* var. *maximus* Hübner.

Phacus anomalus (Fritsch & Rich) Pochmann 1941 (Fig. 281; Plate XXVIII: 7–8)

Syn.: *Ph. curvicauda* Swirenko fo. *anomalus* Fritsch & Rich

Cells 32.5–37.0 µm long, 18.0–19.5 µm wide, pyriform in outline, irregular pancake-like, each with curved cauda at the posterior end. Found in site – **61**: p(+); pH 7.2.

Distribution in Poland – Previously recorded by: Stawiński (1969) in various water bodies at Bielsko-Biała, Oleksowicz (1986) in ponds and in five dystrophic lakes in Tuchola Forest and Wołowski (1992a) in a fishpond in the Ojców National Park (the Kraków-Częstochowa Upland).

General distribution – EUROPE: Denmark (Nygaard 1949), Hungary (Hortobágyi 1957), Russia (Popova & Safonova 1976), Ukraine (Asaul 1975); ASIA: Malaya (Prowse 1958), Indonesia; AFRICA (Popova & Safonova 1976); SOUTH AMERICA: Argentina (Tell & Conforti 1986), Brazil (Menezes 1986), Bolivia (Thérézien 1989).

Habitats – Lakes, ponds, fishponds, ditches, puddles, swamps.

Phacus alatus Klebs 1883 var. ***alatus*** (Figs 282–283; Plate XXVII: 5–8)

Cells 26.5–38.0 µm long, 24.0–28.0 µm wide, broadly oval, slightly twisted, each with curved cauda at the posterior end. Found in site – **3**: p(1); **9**: p(1); **41**: p(1); **86**: p(1) & m(3); pH 6.8–7.5.

Distribution in Poland – Previously recorded in the Kraków-Częstochowa Upland (Czosnowski 1948), known from fishponds at Gołysz (Krzeczkowska-Wołoszyn 1966, 1977), from fishponds at Landek and Komorów village near Bielsko-Biała (Stawiński 1969), and from Toszycki stream near Pyskowice (Skalska 1979)

General distribution – EUROPE: Germany (Klebs 1883; Pochmann 1941), Latvia (Skuja 1926), Hungary (Uherkovich 1967, 1982), Ukraine (Asaul 1975), Russia (Popova & Safonova 1976), Romania (Péterfi 1986); NORTH AMERICA: U.S.A. (Walton 1915).

Habitats – Lakes, fishponds, small rivers, swamps, ephemeral waters. Saprobity – Catharobic to oligosaprobic (Lemmermann 1913), polisaprobic (Swirenko 1939).

****Phacus alatus*** var. ***maximus*** Hübner (Popova 1955) (Fig. 284; Plate XXVII: 9–11)

Cells 35.5–43.0 µm long, 25.5–29.0 µm wide, broadly oval, each with strong curved cauda at the posterior end. Found in site – **3**: p(1); **9**: p(1); **68**: m(1); **86**: m(4); pH 6.6–7.5.

Distribution in Poland – Previously recorded by Stawiński (1969) from various water bodies near Bielsko-Biała and Kadłubowska *et al.* (1972) from the fishpond "Okręt" near Lódź.

General distribution – EUROPE: Russia (Popova 1955; Popova & Safonova 1976), Ukraine (Asaul 1975); ASIA: China, Indonesia; NORTH AMERICA: Canada (Popova & Safonova 1976).

Habitats – Lakes, ponds, slow-flowing rivers, ephemeral waters. Saprobity – β-mesosaprobic (Popova & Safonova 1976).

*****Phacus viguieri*** Allorge & Lefèvre 1930 (Fig. 285)

Cell ca 26.7 µm long, 22.5 µm wide, widely ovate, with short, oblique cauda at the posterior end. Pellicle spirally striated. Two large and a few small paramylon grains. Found in site – **70**: p(+); pH 7.5.

General distribution – EUROPE: France (Allorge & Lefèvre 1930), Germany (Pochmann 1941); ASIA: Western Siberia (Popova & Safonova 1976); SOUTH AMERICA: Argentina (Tell & Conforti 1986).

Habitats – Benthic in lakes and ditches and planktonic in ponds.

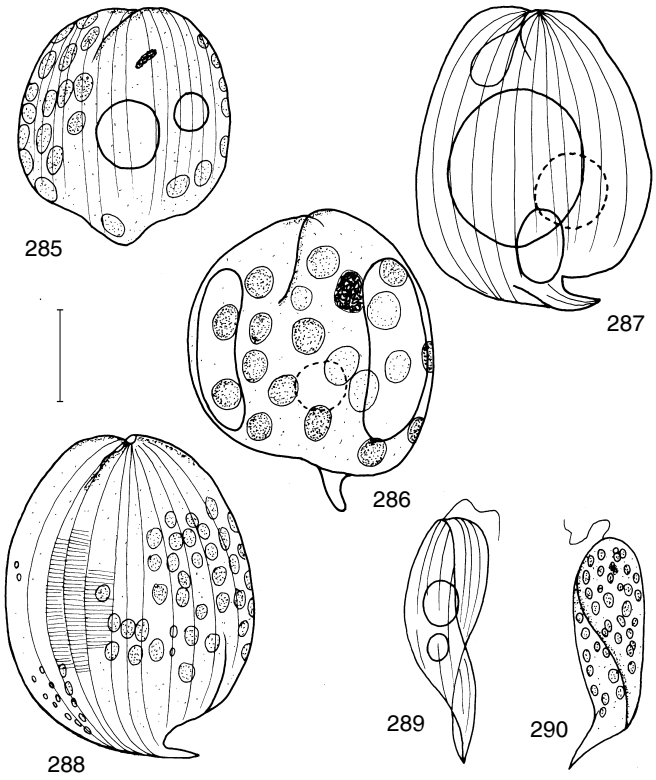
****Phacus curvicauda*** Swirenko 1915 var. ***curvicauda*** (Figs 288; Plate XXVI: 6–7)

Cells 42.0–55.9 µm long, 18.5–34.0 µm wide, broadly oval, each with short bent cauda at the posterior end. Found in site – **9**: p(1); pH 7.2.

Distribution in Poland – Common.

General distribution – Cosmopolitan.

Habitats – Small and stagnant water bodies. Saprobity – Oligosaprobic-mesosaprobic (Swirenko 1939).



Figs 285–290. 285. *Phacus viguieri* Allorge & Lefèvre; **286.** *Ph. curvicauda* Swirenko var. *robusta* Allorge & Lefèvre; **287.** *Ph. carinatus* Pochmann; **288.** *Ph. curvicauda* Swirenko var. *curvicauda*; **289–290.** *Ph. raciborskii* Drežepolski.

****Phacus curvicauda** var. ***robusta*** Allorge & Lefèvre (Starmach 1983) (Fig. 286)

Cells ca 33.5 µm long, 26.5 µm wide, broadly oval-shaped, slightly twisted, each cell with two large paramylon grains and cauda short and bent. Found in site – **87**: m(+); pH 7.

General distribution – Rare. EUROPE: France (Allorge & Lefèvre 1930), Hungary (Uherkovich & Lantos 1987).

Habitats – Village ponds, lakes and "Elżbieta" spring among partly rotted leaves.

***Phacus raciborskii** Drežepolski 1925 (Figs 289–290; Plate XXVIII: 5–6)

Cells 34.0–41.0 µm long, 10.5–16.5 µm wide, irregular, short, fusiform, twisted, each with short sharp cauda at the posterior end. Found in site – **25**: p(1); **26**: p(+); **86**: p(2); pH 6.8–8.4.

Distribution in Poland – Previously recorded by: Czosnowski (1948) from Piaski Wielkie near Kraków; A. Siemińska and J. Siemińska (1967) from Goczałkowice reservoir, and Stawiński (1969) in various water bodies near Bielsko-Biała.

General distribution – Cosmopolitan.

Habitats – Plankton and benthos of lakes, ponds, small rivers; also in salt water of Panama Canal (Prescott 1955).

Phacus longicauda (Ehrenberg) Dujardin var. ***longicauda***

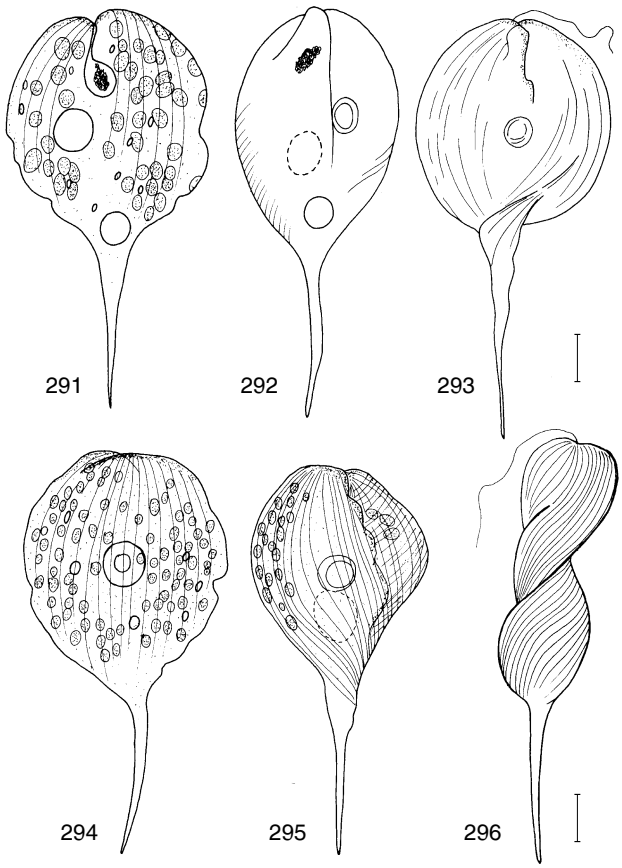
(Figs 291–294; Plate XXVIII: 9)

Syn.: *Euglena longicauda* Ehrenberg; *Ph. longicaudus* (Ehrenberg) Butschli

Cells 81.0–97.0 µm long, 22.0–41.0 µm wide, broadly oval to oval, sometimes corrugated at the rim, each with long straight cauda at the posterior end. Found in site – **27**: p(+); **64**: p(1); **75**: p(1); **76**: p(1); pH 7.5–8.0.

Distribution in Poland – Previously recorded in the Kraków-Częstochowa Upland in the Rivers Vistula and Biała Przemsza (Starmach 1938), in the River Pilica (Kadłubowska 1964), and in fishponds (Szklarczyk-Gazdowa 1965).

General distribution – Cosmopolitan.



Figs 291–296. 291–294. *Phacus longicauda* (Ehrenberg) Dujardin var. *longicauda*; **295.** *Ph. circumflexus* Pochmann; **296.** *Ph. helicoides* Pochmann.

Habitats – Planktonic, small water bodies, in mineralized and humic water; also in salt water of Panama Canal (Prescott 1955). Saprobity – Oligosaprobic (Kolkwitz & Marsson 1908), catharobic to oligosaprobic (Lemmermann 1913), oligosaprobic (Swirenko 1939), α-β-mesosaprobic (Cyrus & Sladeček 1973).

**Phacus circumflexus* Pochmann 1941 (Fig. 295)

Syn.: *Ph. longicauda* (Ehrenberg) Dujardin fo. *vix torta* Kisselev 1931, *Ph. longicauda* var. *torta* Skvortzov *in* Allorge & Lefèvre 1930

Cells ca 82.0 µm long, 37.0 µm wide, broadly ovoid, slightly twisted, with folded rim, each with long cauda at the posterior end. Found in site – **27**: p(+); **64**; p(+); pH 7.5–8.4.

Distribution in Poland – Previously recorded by Kotlińska (1976) in Lake Rusałka.

General distribution – EUROPE: Czech Republic (Wołowski 1992c); AFRICA: Senegal (Compère 1991); ASIA: India, Uzbekistan (Pochmann 1941); Cambodia (Yamagishi & Hirano 1973); SOUTH AMERICA: Argentina (Yacubson 1965; Tell & Conforti 1986).

Habitats – Ponds and puddles.

**Phacus helicoides* Pochmann 1941 (Fig. 296)

Syn.: *Ph. longicauda* var. *torta* Lemmermann, *Ph. torta* (Lemmermann) Skvortzov var. *tortuosa* Skvortzov

Cells 81.5–94.0 µm long, 33.5–38.0 µm wide, strongly twisted, each with long straight cauda at the posterior end. Found in site – **2**: p(+); **13**: p(1); **64**: p(1); pH 7.0–10.0.

Distribution in Poland – Common.

General distribution – Cosmopolitan.

Habitats – Ponds, lakes, ditches; also in salt water in Panama Canal (Prescott 1955). Saprobity – Oligosaprobic (Swirenko 1939), β-mesosaprobic (Cyrus & Sladeček 1973).

**Phacus similis* Christen 1962a (Figs 297–302; Plate XXVIII: 1–4)

Syn.: *Euglena smulkowskiana* Zakryś 1986

Cells 30.0–37.0 µm long, 12.3–16.5 µm wide, longitudinally, twisted two or three times and flattened. Canal opening slightly incised at the antherior end. At the posterior end of each cell there is a hyaline cauda. One or two large paramylon grains. Pellicle helically striated. Found in site – **86**: m(2); pH 6.8–7.0.

Distribution in Poland – Previously recorded by Zakryś (1986) from a polluted pond in the village Świerczek near Szydłowiec, but wrongly described as *E. smulkovskiana* (Zakryś 1986: 524, *pl. IV, figs 6–6a*).

General distribution – EUROPE: France (Bourrelly 1963; Capdeville 1985), Switzerland (Christen 1962a), Germany (Ettl 1968), Austria (Wawrik 1979), Czech Republic (Wołowski 1992c); SOUTH AMERICA: Argentina (Tell & Conforti 1986).

Habitats – Village and fishponds.

Notes – The species is similar to *Ph. longicauda* var. *helicoides* but the latter is twisted irregularly and densely.

Sectio MONOMORPHINA

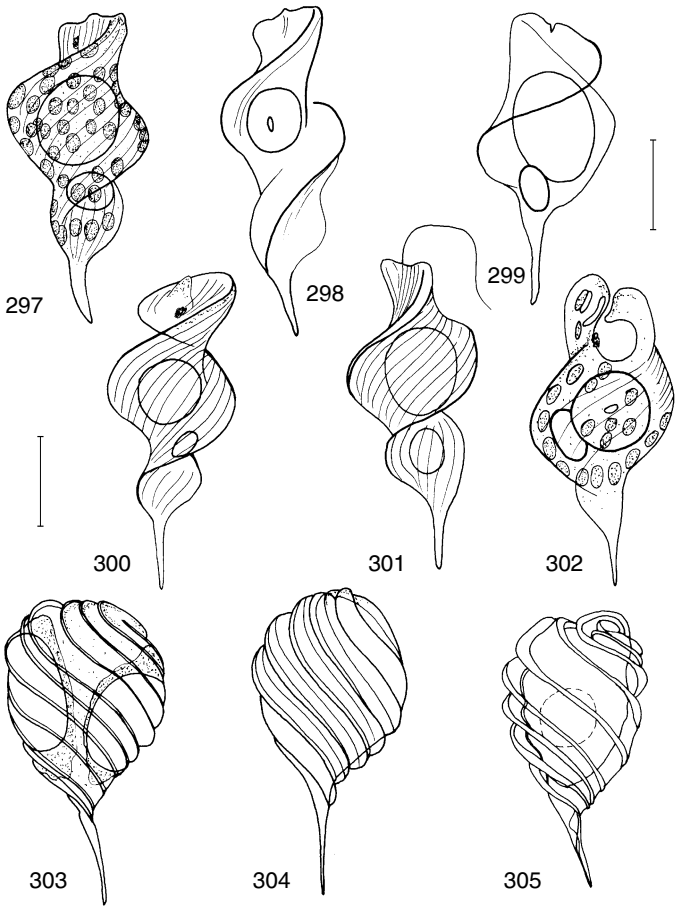
****Phacus splendens** Pochmann 1941 (Fig. 303; Plate XXIX: 1–2)

Syn.: *Monomorphina splendens* Popova 1947

Cells 26.4–36.5 µm long, 9.4–13.5 µm wide, broadly ovoid each slightly narrowing at the posterior end to a very short, conical cauda. Two peripheral chloroplasts, with pyrenoids; one large paramylon grain. Pellicle spirally striated. Found in site – **27**: p(+); **70**: p(1); pH 7.5–8.1.

General distribution – EUROPE: France (Pochmann 1941) Ukraine (Asaul 1975), Russia (Popova & Safonova 1976); AFRICA (Bourrelly 1961b).

Habitats – Ponds, small rivers, lakes.



Figs 297–305. 297–302. *Phacus similis* Christen; **303.** *Ph. splendens* Pochmann; **304–305.** *Ph. trypanon* Pochmann.

****Phacus trypanon*** Pochmann 1941 (Figs 304–305; Plate XXIX: 3)

Syn.: *Ph. turgidulus* Pochmann

Cells 30.0–33.5 µm long, 14.8–15.5 µm wide, oval-pyriform, obliquely ribbed, each slightly truncate at the anterior end, with long sharp cauda at the posterior end. Found in site – **64**: p(+); **70**: m(+); pH 8.5.

Distribution in Poland – Previously recorded by: Czosnowski (1948) from the Tatra Mts, and Burchardt (1977) from plankton in Lake Pątnowskie.

General distribution – EUROPE: Holland, Germany (Pochmann 1941), Hungary (Hortobágyi 1957, 1963), Czech Republic (Fott & Komárek 1960), Romania (Péterfi 1964); AFRICA: Ivory Coast (Bourrelly 1961b), Chad (Iltis 1972); SOUTH AMERICA: Bolivia (Thérézien 1989).

Habitats – Planktonic in ponds, brackish puddles.

****Phacus pyrum*** (Ehrenberg) Stein var. ***pyrum*** (Starmach 1983) (Figs 306–308)

Syn.: *Monomorphina pyrum* (Ehrenberg) Mereschk.

Cells 28.3–51.0 µm long, 12.0–21.1 µm wide, broadly fusiform, each with long sharp cauda at the posterior end, pellicle spirally ribbed. Found in site – **23**: p(3); **26**: p(+–1); **27**: p(+–2); **41**: p(+); **52**: p(2); **59**: p(2); **64**: p(+–2); **65**: p(1); **69**: p(1); **92**: m(+); **93**: p(2); pH 6.8–8.9.

Distribution in Poland – Very common.

General distribution – Cosmopolitan, very common.

Habitats – Swamps, ditches, planktonic in lakes and ponds. According to Prescott (1955) in salt water in Panama Canal. Saprobity – Oligosaprobic (Kolkwitz & Marsson 1908), catharobic to oligosaprobic (Lemmermann 1913), oligosaprobic (Swirenko 1939), α-oligosaprobic to β-mesosaprobic (Zelinka & Marvan 1961).

****Phacus costatus*** Conrad 1914 (Figs 309–310; Plate XXIX: 10)

Syn.: *Monomorphina pyrum* var. *costata* Popova 1951

Cell 23.0–30.5 µm long, 11.5–14.5 µm wide, narrowly fusiform with sharp cauda at the posterior end. Pellicle spirally ribbed. Found in site – **64**: p(+); pH 7.5.

Distribution in Poland – Previously recorded by: Stawiński (1969) near Bielsko-Biała, Skalska (1975) from Kochłówka stream in the Silesian region, and Krzeczkowska-Wołoszyn (1977) from a fishpond at Gołysz.

General distribution – EUROPE: Belgium (Conrad 1914), Sweden (Skuja 1956), Hungary (Uherkovich 1959, 1971), Latvia, Russia (Popova & Safonova 1976), Ukraine (Asaul 1975), Czech Republic (Wołowski 1992c); ASIA: Western and Eastern Siberia (Popova & Safonova 1976).

Habitats – Planktonic in lakes, ponds, and swamps.

****Phacus pseudonordstedtii*** Pochmann 1941 (Fig. 311; Plate XXIX: 4)

Syn.: *Monomorphina pyrum* var. *pseudonordstedtii* Popova & Safonova 1976

Cells 30.4–40.5 µm long, 17.5–20.0 µm wide, broadly oval, flattened, with small depression at the anterior end, straight thin cauda at the posterior end. Pellicle spirally ribbed. Found in site – **25**: p(+); **26**: p(+); **27**: p(+); pH 7.4–8.1.

Distribution in Poland – Previously recorded by Stefko (1976) from Lake Maltańskie in Poznań.

General distribution – EUROPE: Germany (Pochmann 1941), Hungary (Hortobágyi 1957, 1973; Uherkovich 1967, 1971; Hegewald *et al.* 1975; Kiss 1985), Russia (Popova & Safonova 1976), Ukraine (Asaul 1975); AFRICA: Chad (Compère 1975); ASIA: Malaya (Prowse 1958), Western Siberia (Popova & Safonova 1976), Jamaica (Hegewald 1977).

Habitats – Planktonic in stagnant water bodies, ponds, lakes, and swamps. Saprobity – Catharobic (Lemmermann 1910).

****Phacus strongylus*** Pochmann 1941 (Fig. 312; Plate XXIX: 9)

Syn.: *Ph. setosus* Francé

Cells 31.5–30.0 µm long, 14.5–14.8 µm wide, oval, slightly twisted, each with straight sharp cauda at the posterior end. Pellicle spirally ribbed. Found in site – **64**: m(+); pH 7.6.

Distribution in Poland – Previously recorded by: Pochmann (1941) from Silesia, Burchardt (1977) in Lake Pątnowskie, and Burchardt *et al.* (1979, 1981) from reservoirs in Pławniowice near Poznań and Lake Rosnowskie in Poznań.

General distribution – EUROPE: France (Bourrelly 1947), Russia (Popova & Safonova 1976); ASIA: Manchuria (Pochmann 1941).

Habitats – Lakes, ditches, ponds.

Notes – According to Popova and Safonova (1976) the taxon is very similar to *Ph. pyrum*.

****Phacus mirabilis*** Pochmann 1941 (Fig. 313; Plate XXIX: 11–14)

Syn.: *Monomorphina mirabilis* Safonova 1976 (*in* Popova & Safonova 1976)

Cells 37.8–44.1 µm long, 18.5–21.0 µm wide, almost pyriform, each with thin cauda at the posterior end. Pellical spirally ribbed. Found in site – **35**: p(+); **64**: p(+); pH 7.5.

Distribution in Poland – Previously recorded from Winiary and Gniezno (Drężepolski 1948), in salt marshes near Łęczyca (Pliński 1971, 1973), in reservoir at Pławniowice near Poznań (Burchardt *et al.* 1979), from Lake Malta (Stefko 1976), and in River Widawka at Łódź (Ligowski 1986).

General distribution – EUROPE: Germany (Pochmann 1941), Romania (Péterfi 1962), Ukraine (Asaul 1975), Russia (Popova & Safonova 1976).

Habitats – Planktonic, in ponds, lakes, salt ponds, marshes, and puddles.

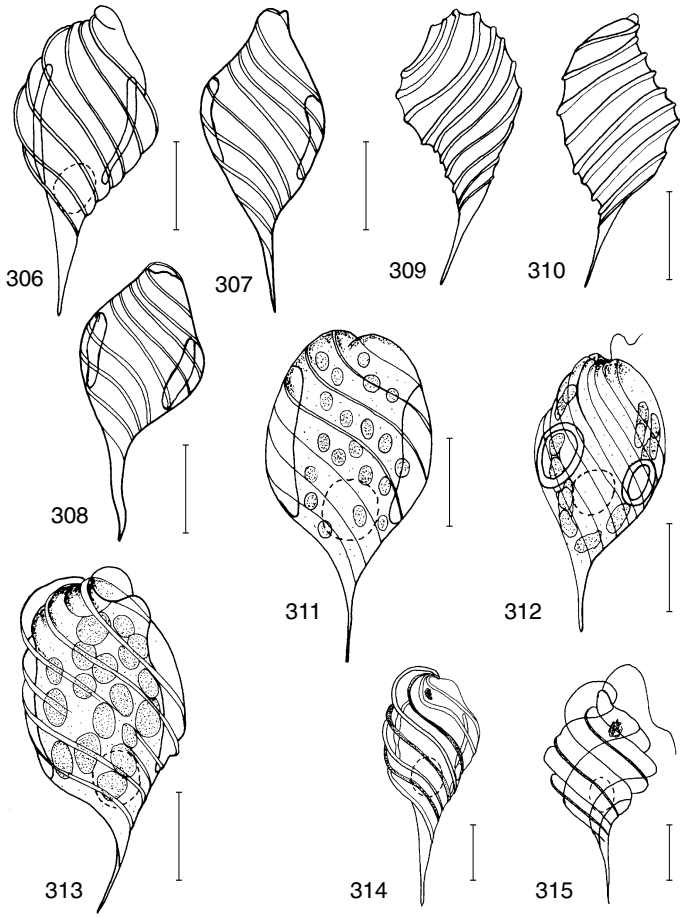
*****Phacus pulcherrimus*** (Conrad) Pochmann 1941 (Figs 314–315; Plate XXIX: 7–8)

Syn.: *Ph. pyrum* (Ehrenberg) Stein fo. *pulcherrima* Conrad 1938

Cells ca 41.5–43.5 µm long, 14.5–17.5 µm wide, longitudinally spindle-shaped each with straight cauda at the posterior end. Pellicle with ridges twisted to the left, thick and slender alternately. Two large paramylon grains, lying peripherally opposite one another. Found in site – **27**: p(+); pH 8.2.

General distribution – EUROPE: Belgium (Conrad 1938); SOUTH AMERICA: Argentina (Tell & Conforti 1986).

Habitats – Ponds and lakes.



Figs 306–315. 306–308. *Phacus pyrum* (Ehrenberg) Stein var. *pyrum*; **309–310.** *Ph. costatus* Conrad; **311.** *Ph. pseudonordstedtii* Pochmann; **312.** *Ph. strongylus* Pochmann; **313.** *Ph. mirabilis* Pochmann; **314–315.** *Ph. pulcherrimus* (Conrad) Pochmann.

****Phacus megalopsis*** Pochmann 1941 (Figs 316–317; Plate XXIX: 5–6)

Syn.: *Monomorphina megalopsis* Safonova 1976 (*in* Popova & Safonova 1976)

Cells 35.8–46.4 µm long, 10.5–18.8 µm wide, almost pyriform, each with thin cauda at the posterior end. Pellicle spirally ribbed. Found in site – **27**: p(+); **53**: m(+); pH 7.5–8.4.

Distribution in Poland – Previously recorded from Ochaby fishponds (Stawiński 1969), and in Lake Rusałka (Kotlińska 1976).

General distribution – EUROPE: Germany (Pochmann 1941), Russia (Popova & Safonova 1976), Ukraine (Asaul 1975), Hungary (Uherkovich 1977); SOUTH AMERICA: Argentina (Tell & Conforti 1986).

Habitats – Planktonic and benthic, in ponds, swamps, and lakes.

Sectio CHLOROPELTIS

**Phacus monilatus* Stokes var. *suecicus* Lemmermann 1904 (Fig. 318)

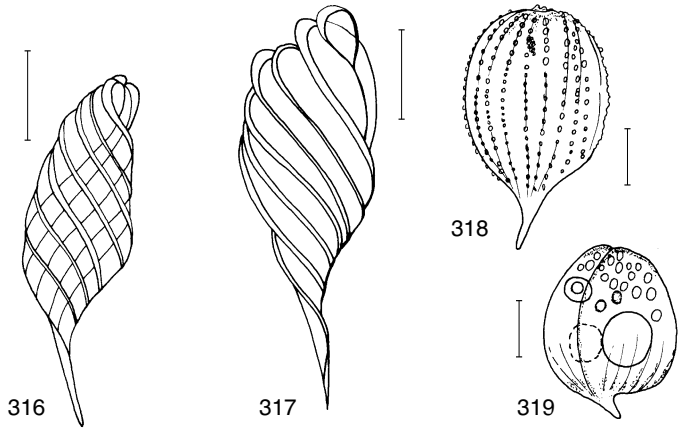
Syn.: *Ph. suecica* Lemmermann 1910, 1913

Cells 41.5–44.5 µm long, 24.1–29.4 µm wide, club shaped, each with sharp cauda at the posterior end. Pellicle covered with small granules. Found in site – **23**: p(1); **92**: p(1); pH 6.8.

Distribution in Poland – Previously recorded by: Lemmermann (1905) from Silesia, Stawiński (1969) from Ochaby fishponds and Goczałkowice reservoir.

General distribution – EUROPE: Germany (Lemmermann 1904), Latvia (Skuja 1926), Ukraine, (Asaul 1975), Russia (Popova & Safonova 1976), Bulgaria (Kiryakov 1983); ASIA: Western Siberia, Indonesia, China, Malaysia (Popova & Safonova 1976), Japan (Yamagishi 1977); NORTH AMERICA (Huber-Pestalozzi 1955); SOUTH AMERICA: Argentina (Tell & Conforti 1986), Bolivia (Thérézien 1989), Venezuela (Deflandre 1928).

Habitats – Plankton and benthos from swamps, lakes, ponds and small rivers. Saprobity – Catharobic (Lemmermann 1910).



Figs 316–319. 316–317. *Phacus megalopsis* Pochmann; **318.** *Ph. monilatus* Stokes var. *suecicus* Lemmermann; **319.** *Hyalophacus ocellatus* Pringsheim.

HYALOPHACUS Pringsheim 1936

Hyalophacus ocellatus Pringsheim 1936 (Fig. 319; Plate XXVI: 8)

Syn.: *Phacus pleuronectes* (Ehrenberg) Dujardin var. *hyalinus* Klebs 1889

Cells 26.5–36.0 µm long, 20.0–24.0 µm wide, broadly ovate, each rounded at the anterior end, at posterior end with a curved cauda. Found in site – **25**: m(1); **86**: m(1–2); pH 6.8–8.8.

Distribution in Poland – Previously recorded in the Kraków-Czestochowa Upland from "Elżbieta" spring of Wiercica stream, with partly rotted leaves (Wołowski 1991a).

General distribution – Cosmopolitan.

Habitats – Ponds, rice-fields, small rivers, plankton of lakes, swamps, and springs.

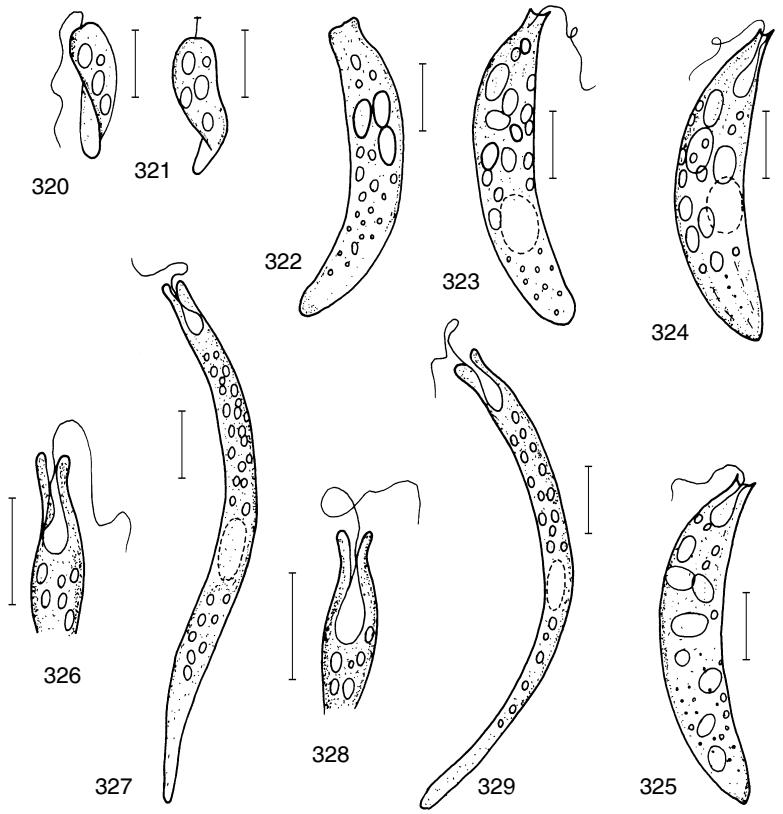
RHABDOMONADALES

MENOIDIUM Perty 1852

*****Menoidium minimum*** Matvienko 1939 (Figs 320–321)

Syn.: *Rhabdomonas minima* Huber-Pestalozzi 1955

Cells 16.2–18.8 μm long, 5.0 μm wide, lanceolate-fusiform, falcate or sinusoidal; each slightly narrowed and bluntly truncated at the anterior end; posterior end slightly tapered. Euglenoid movement slight. Pellicle smooth. Canal opening apical with small depress-



Figs 320–329. 320–321. *Menoidium minimum* Matvienko; **322.** *M. pellucidum* Perty var. *pellucidum*; **323–325.** *M. pellucidum* var. *steinii* Popova; **326–329.** *M. tortuosum* (Stokes) Senn var. *tortuosum*.

ion. Emergent flagellum longer than the cell. Nucleus central, ovoid. Paramylon grains generally small, ovoid, but 2–4 are longer and elliptical. Found in site – **56**: p(1); pH 6.5.

General distribution – EUROPE: Czech Republic, England, Sweden, Switzerland, Russia, Ukraine (Vetrova 1980); ASIA: Western Siberia (Popova & Safonova 1976); CENTRAL AMERICA: Guadeloupe (Vetrova 1980).

Habitats – Stagnant and slow-flowing waters, lakes, ponds, puddles. Saprobity – α-mesosaprobic.

Menoidium pellucidum Perty var. ***pellucidum*** (Popova 1966) (Fig. 322)

Cells 44.0–46.5 µm long, 8.4–9.5 µm wide, laterally flattened, curved. Found in site – **52**: p(+); **86**: m(1); pH 7.0–8.9.

Distribution in Poland – Recorded in the Kraków-Częstochowa Upland (Wołowski 1991c). Previously found by Dreżepolski (1948) who did not mention the site.

General distribution – Cosmopolitan.

Habitats – Lakes, ponds, ditches, puddles and "Elżbieta" spring with partly rotted leaves. Saprobity – α-mesosaprobic (Cyrus & Sladeček 1973).

Menoidium pellucidum var. ***steinii*** Popova 1952 (Figs 323–325)

Cells 43.5–45.4 µm long, 7.5–13.5 µm wide, laterally flattened, curved, each cell slightly tapered at the anterior end and extended with one or two tiny teeth. Found in site – **86**: m(2–3); pH 7.0.

Distribution in Poland – Previously recorded (Wołowski 1991c) in the Kraków-Częstochowa Upland in Elżbieta spring of Wiercica stream.

General distribution – Cosmopolitan.

Habitats – Stagnant and slow-flowing waters, small water bodies, rather overgrown, peat bogs, and "Elżbieta" spring with partly rotted leaves. Saprobity – α-mesosaprobic (Vetrova 1980).

Menoidium tortuosum (Stokes) Senn var. ***tortuosum*** (Popova & Safonova 1976) (Figs 326–329)

Syn.: *Atractonema tortuosa* Stokes, *Astasia tortuosa* (Stokes) Popova 1951

Cells (67.5-)71.0–82.5 µm long, (3.5-)4.5–8.5 µm wide, narrowly lanceolate-fusiform, falcate or twisted like an S. Found in site – **25**: m(1); **86**: m(1–2); pH 6.8–8.4.

Distribution in Poland – Recorded in the Kraków-Częstochowa Upland in "Elżbieta" spring of Wiercica stream (Wołowski 1991c).

General distribution – EUROPE: Sweden (Skuja 1948), Switzerland (Huber-Pestalozzi 1955), Ukraine (Asaul 1975; Vetrova 1980), Russia (Popova & Safonova 1976), Hungary (Uherkovich & Franken 1980); NORTH AMERICA: U.S.A. (Stokes 1885); AUSTRALIA (Playfair 1921); ASIA: Western Siberia (Popova & Safonova 1976).

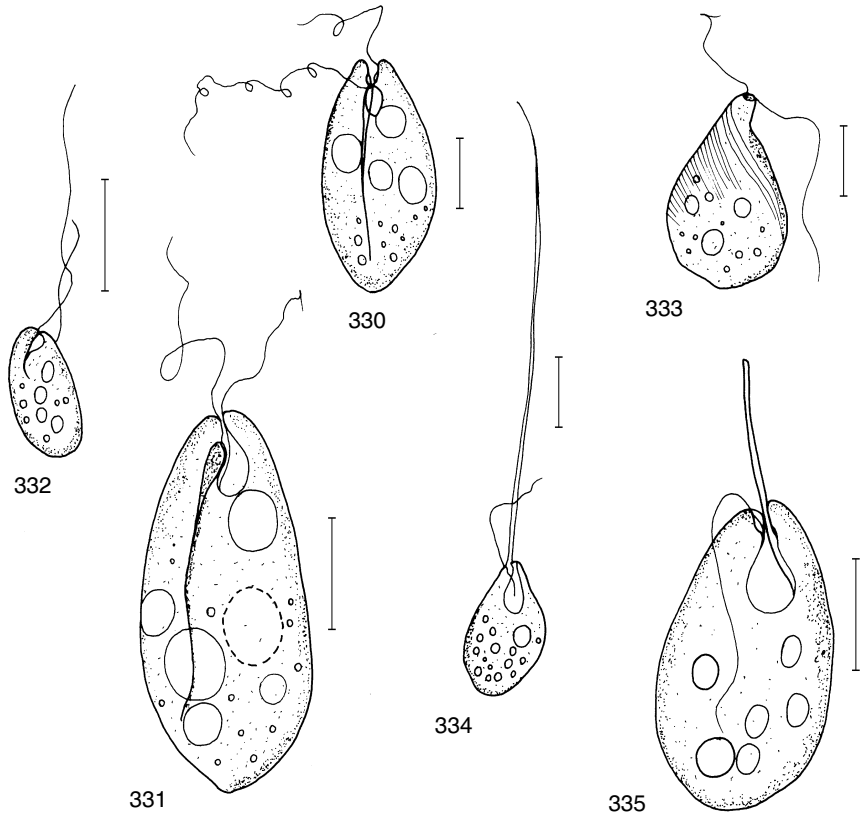
SPHENOMONADALES

ANISONEMA Dujardin 1841

**Anisonema acinus* Dujardin (Larsen 1987) (Figs 330–331)

Cells 33.5–34.5 µm long, 15.5–16.0 µm wide, elliptical-ovate, flattened, rigid. No euglenoid movement. Pellicle finely striated. Canal opening subapical. Two unequal heterodynamic flagella, during swimming the shorter directed anteriorly, the longer trailing posteriorly; the shorter is about as long as the cell, the longer is 2–3 times longer than the cell. Nucleus oval, towards posterior or shifted to one side. Found in site – **86**: m(+); pH 6.8.

Distribution in Poland – Previously recorded by Drężepolski (1948) from pond at Winiary.
General distribution – Cosmopolitan.



Figs 330–335. 330–331. *Anisonema acinus* Dujardin; **332.** *A. ovale* Klebs; **333.** *Heteronema globuliferum* (Ehrenberg) Stein; **334–335.** *Pseudoperanema macromastix* (Conrad) Larsen.

Habitats – Stagnant and flowing fresh water, salty water, on the bottom of ponds, puddles, and springs with dead leaves. Saprobity – α-β-mesosaprobic (Cyrus & Sladečk 1973; Vetrova 1980).

****Anisonema ovale*** Klebs (Vetrova 1980) (Fig. 332)

Cell 12.0 µm long, 5.5 µm wide, ovoid, slightly flattened and rigid, anterior and posterior ends rounded. No euglenoid movement. Pellicle smooth. Canal opening subapical, in a small depression. Two unequal emergent flagella, the shorter as long as the cell, the longer nearly 1.5 times longer than the cell length. Nucleus shifted to the anterior. Found in site – **86**: m(+); pH 6.8.

Distribution in Poland – Previously recorded in the Lake Miedwie and River Ostarwica by Rozmiarek (1983).

General distribution – Cosmopolitan.

Habitats – Stagnant and slow-flowing water, puddles, ditches, polluted waters. Saprobity – α-β-mesosaprobic (Cyrus & Sladeček 1973; Vetrova 1980).

Notes – Only one specimen was found.

HETERONEMATALES

HETERONEMA Dujardin 1841

*****Heteronema globuliferum*** (Ehrenberg) Stein 1878 (Fig. 333)

Cell 26.5 µm long, 14.5 µm wide, longitudinally-oval. Pellicular striation distinct, S-shaped helix. Two emergent flagella, one 2–2.5 times the cell length, the other 1.5 times the cell length. Ingestion organelle well developed but sometimes difficult to observe. Nucleus situated in the posterior part of the cell. Euglenoid movement squirming. Found in site – **35**: p(+); pH 6.8.

General distribution – EUROPE: Hungary (Hortoágyi 1947), Russia (Popova 1951), Ukraine (Asaul 1975; Vetrova 1980); NORTH AMERICA: U.S.A. (Walton 1915); SOUTH AMERICA; CENTRAL AMERICA; AUSTRALIA (Larsen & Patterson 1990).

Habitats – Fresh water, fishponds, puddles, lakes, tropical marine sediments, fishponds and field ponds.

EUGLENAMORPHALES

PSEUDOPARANEMA Christen 1962

*****Pseudoperanema macromastix*** (Conrad) Larsen 1987 (Figs 334–335)

Syn.: *Peranema macromastix* Conrad 1942

Cells 23.3–28.2 µm long, 13.0–18.0 µm wide, elliptical with rounded ends, each cell shortly tapered at the anterior end, at the posterior end rounded, slightly narrowed. Pel-

licular striations coarse. Two emergent unequal flagella, heterodynamic; the longer is thicker and directed anteriorly during swimming, twice the cell length, the shorter is thinner and pressed closely to the cell. Canal opening subapical. Euglenoid movement violent in non-swimming cells. Found in site – **28**: p(1); **27**: m(+); **86**: m(+); pH 6.6–6,8.

General distribution – EUROPE: Belgium (Conrad 1942), Hungary (Hortobágyi 1963), Romania (Péterfi 1965), Ukraine (Asaul 1975; Vetrova 1980), Russia (Popova & Safonova 1976), Denmark (Larsen 1987).

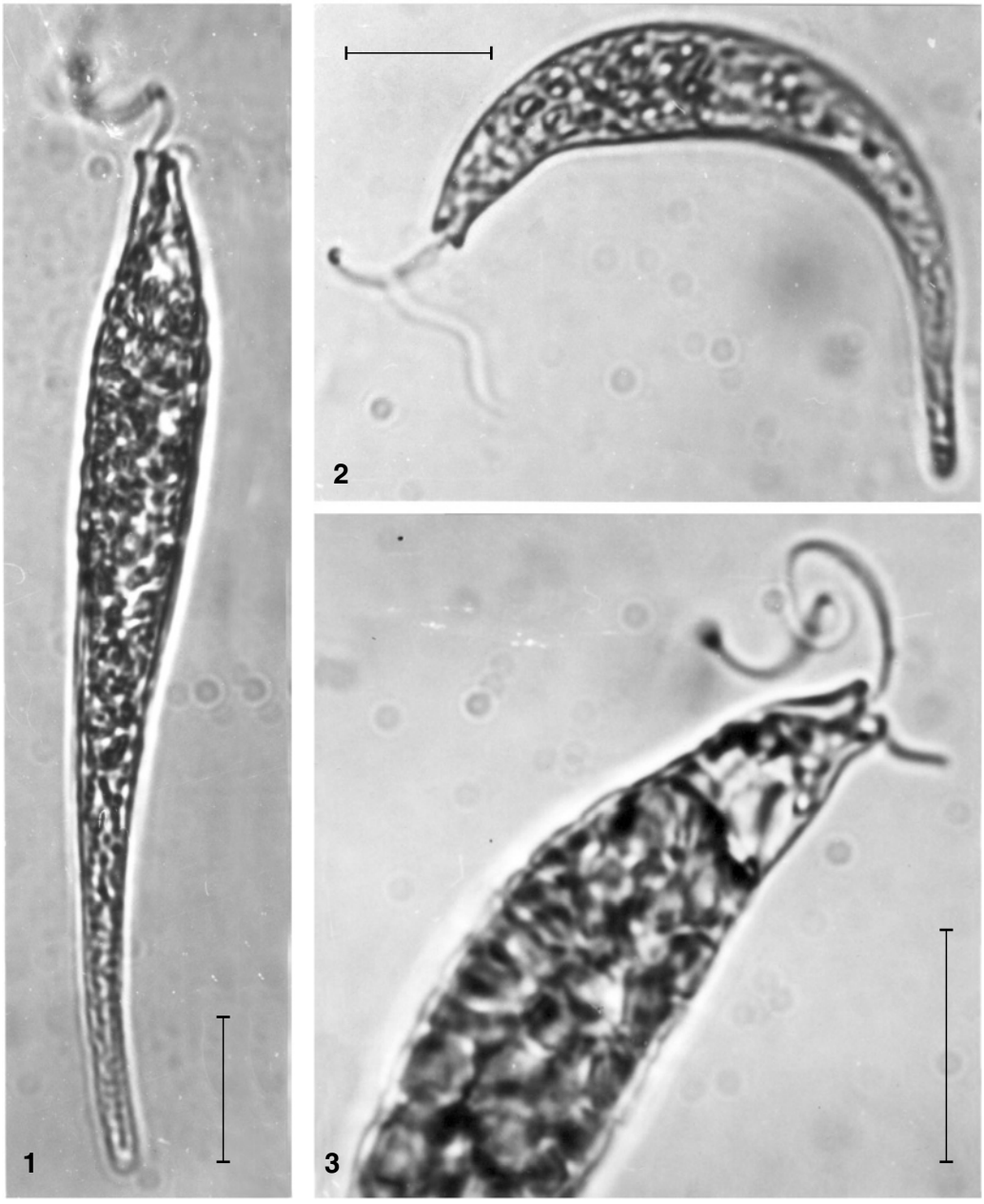


Plate I. 1–3. *Distigma proteus* Ehrenberg.

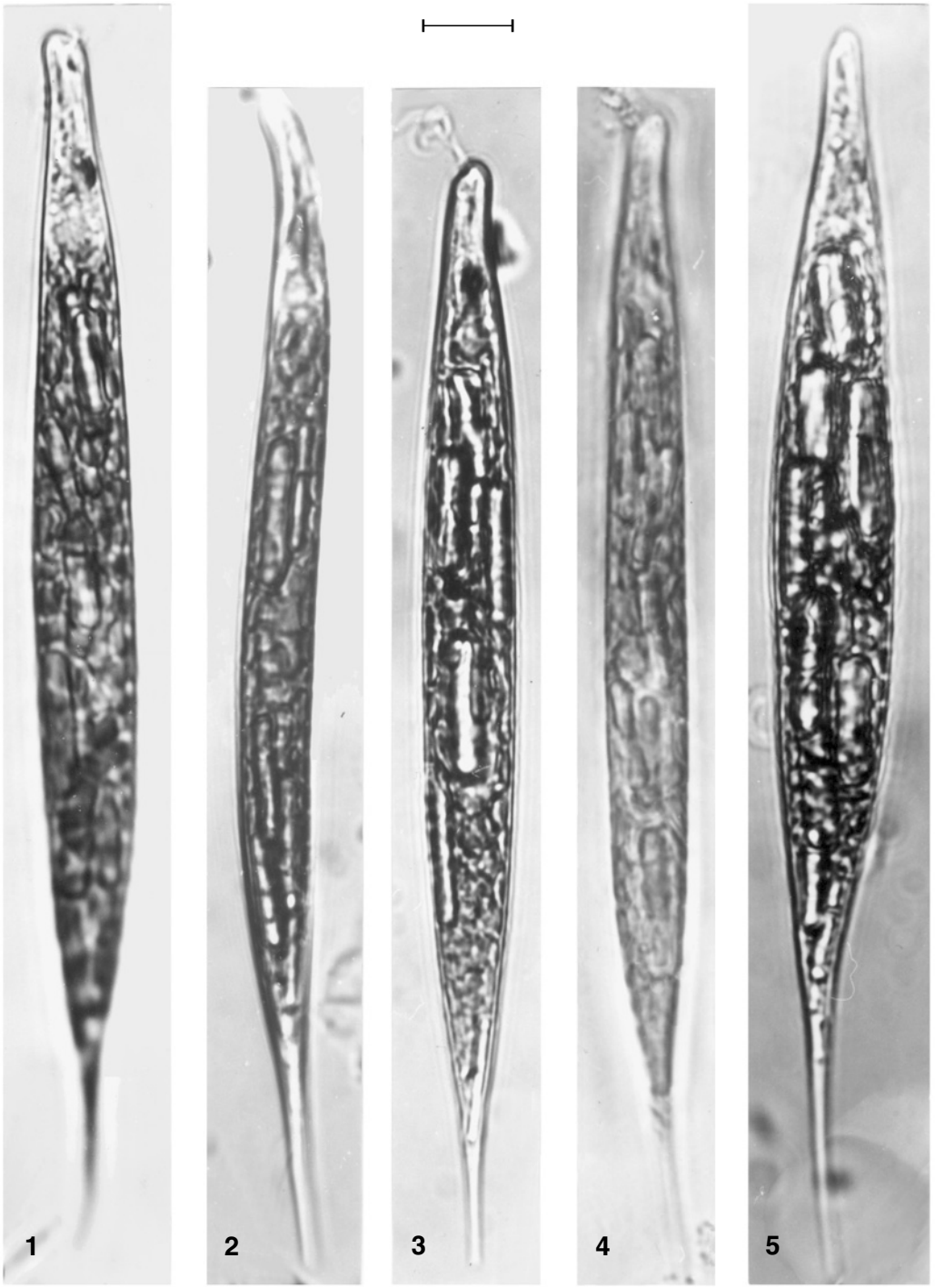


Plate II. 1–5. *Euglena acus* Ehrenberg var. *acus.*

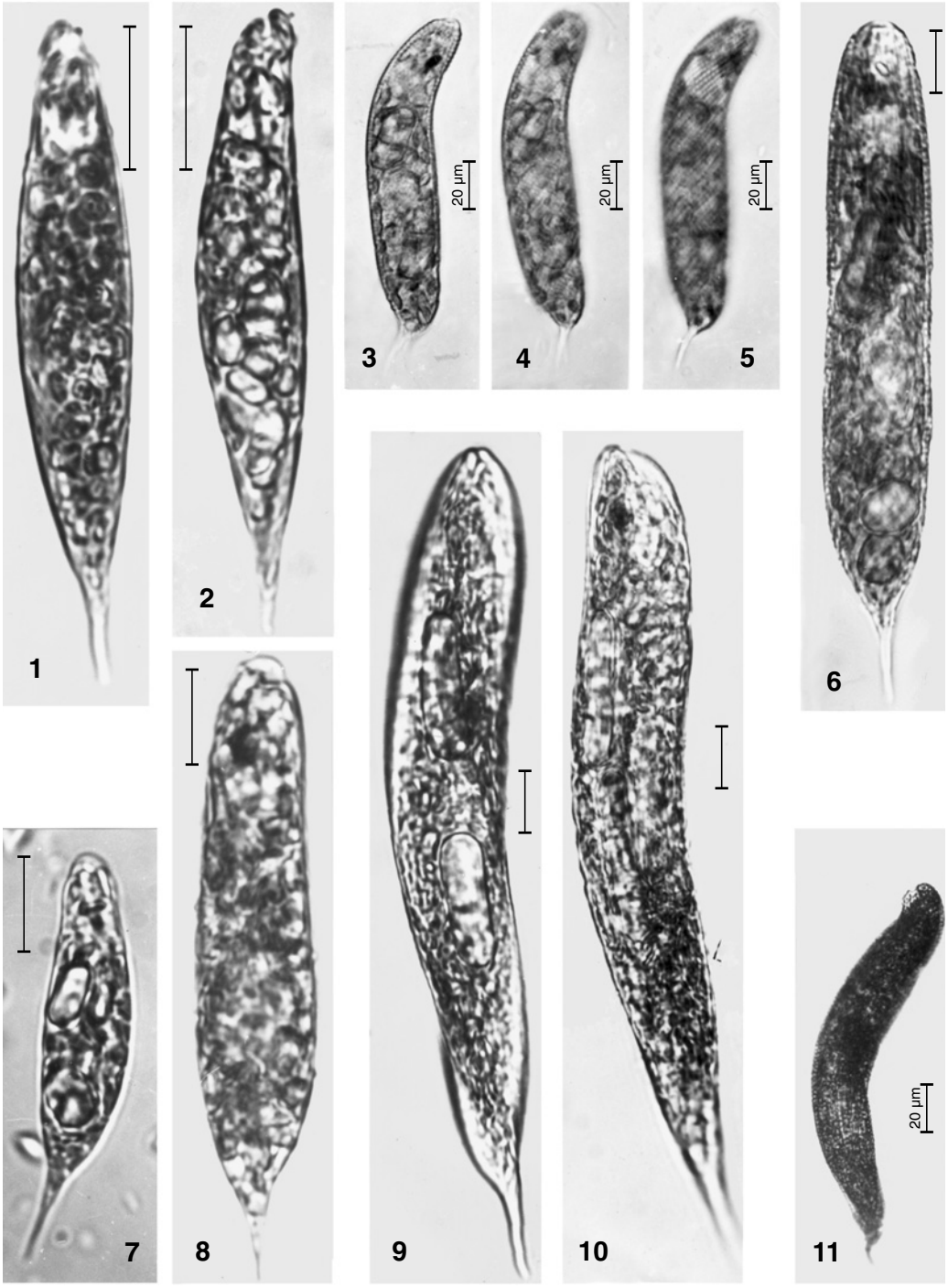


Plate III. 1–2. *Euglena gasterosteus* Skuja; **3–6.** *E. spirogyra* Ehrenberg var. *spirogyra*; **7.** *E. limnophila* Lemmermann var. *swirenkoi* Popova; **8.** *E. limnophila* var. *limnophila*; **9–10.** *E. oxyuris* Schmarda fo. *oxyuris*; **11.** *E. spirogyra* Ehrenberg var. *lacticlavius* Hübner.

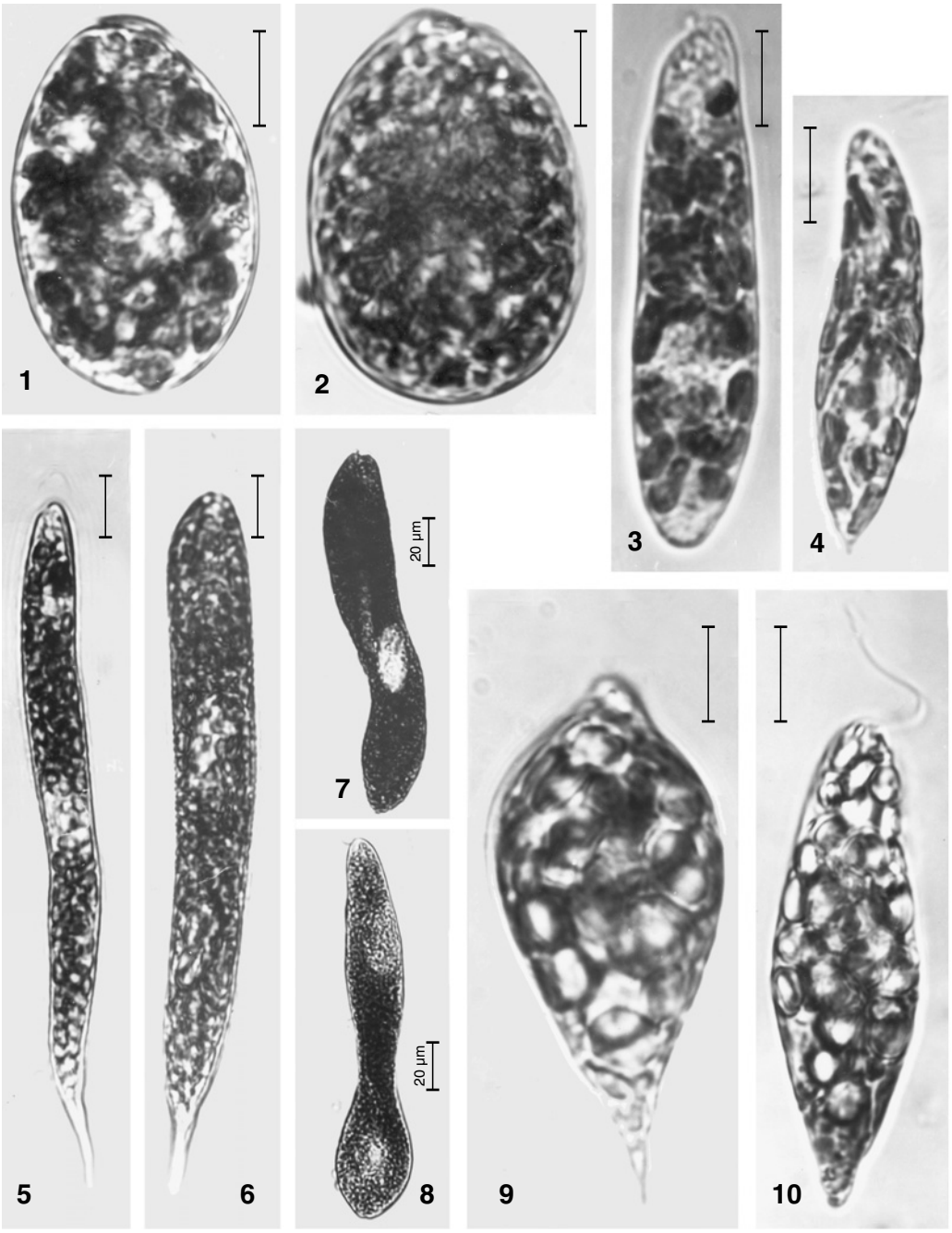


Plate IV. 1–2. *Euglena texta* (Dujardin) Hübner var. *texta*; **3.** *E. chlamydophora* Mainx; **4.** *E. proxima* Dangeard; **5.** *E. sima* Wermel; **6.** *E. pavlovskoënsis* (Elenkin & Poljanskij) Popova; **7.** *E. ehrenbergii* Klebs; **8.** *E. truncata* Walton; **9–10.** *E. hemichromata* Skuja.

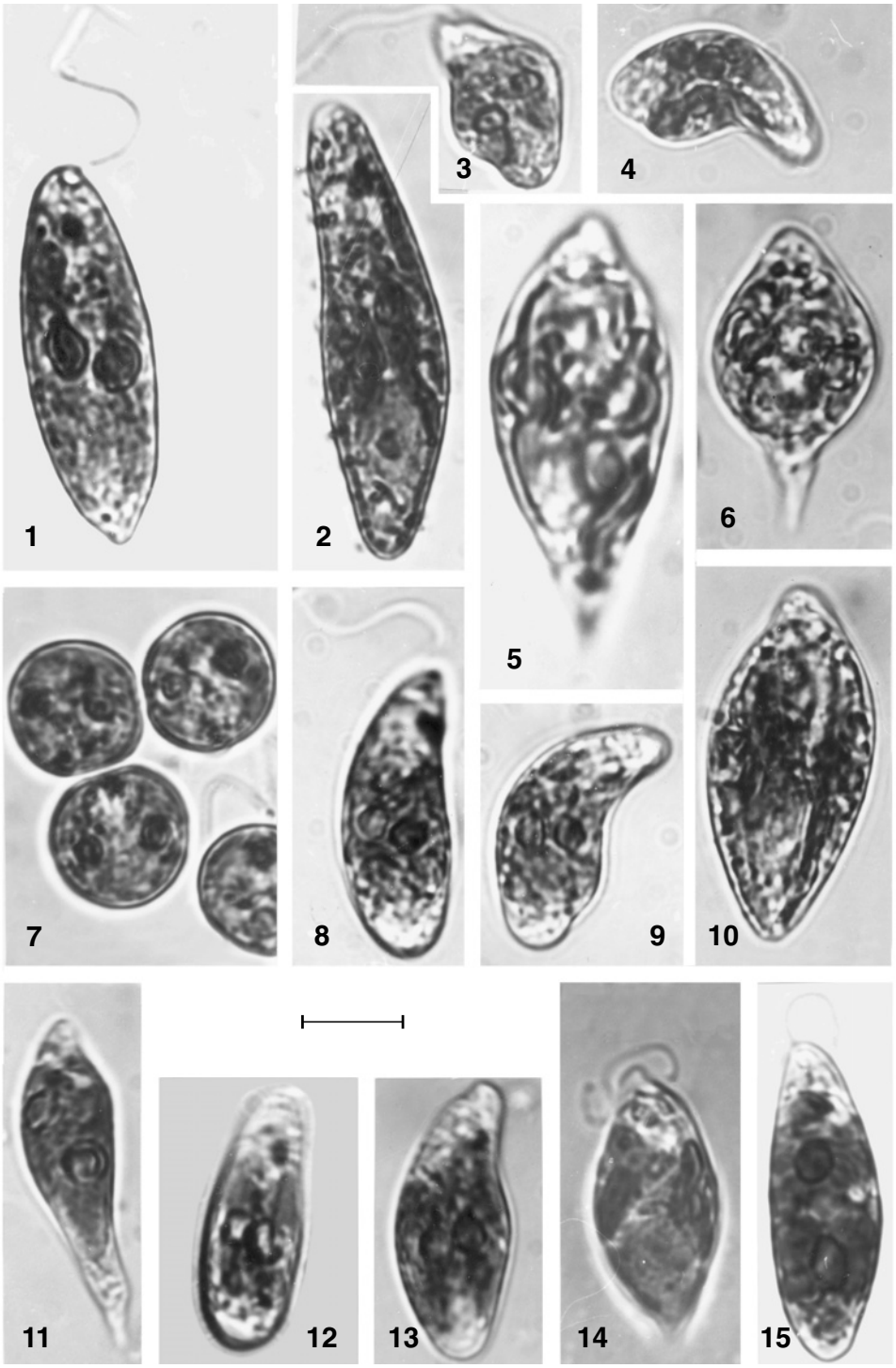


Plate V. 1–13. *Euglena agilis* Carter; **14.** *E. archeoplastidiata* Chadefaud; **15.** *E. minima* Francé.

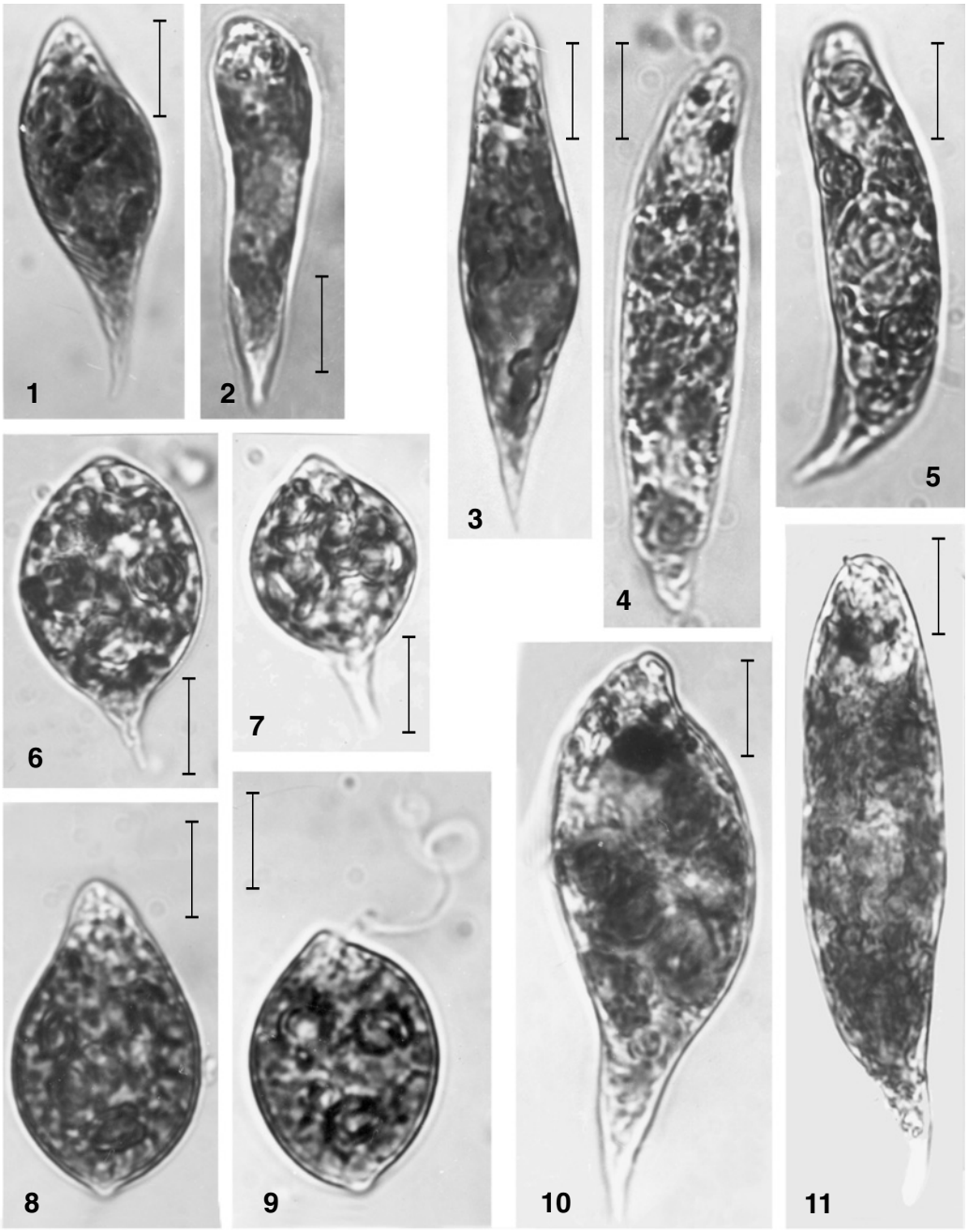


Plate VI. 1–2. *Euglena anabaena* Mainx var. *anabaena*; **3.** *E. gracilis* Klebs fo. *gracilis*; **4.** *E. gracilis* fo. *hiemalis* Popova; **5.** *E. caudata* Hübner var. *caudata*; **6–7.** *E. clavata* Skuja; **8–9.** *E. oblonga* Schmitz; **10–11.** *E. polymorpha* Dangeard.

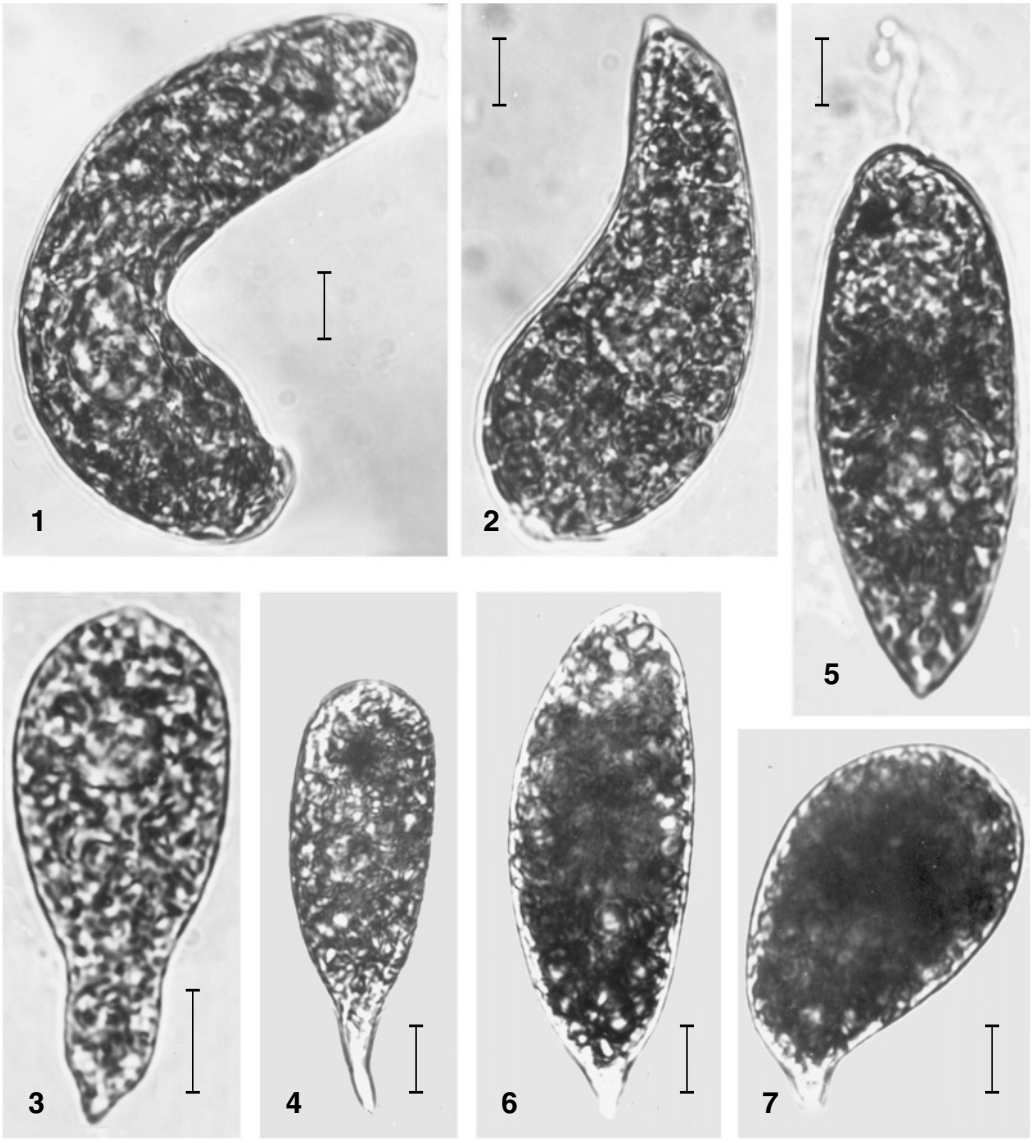


Plate VII. 1–2. *Euglena obtusa* Schmitz; **3.** *E. siemińskiana* Wołowski; **4.** *E. sanguinea* Ehrenberg; **5–7.** *E. splendens* Dangeard.

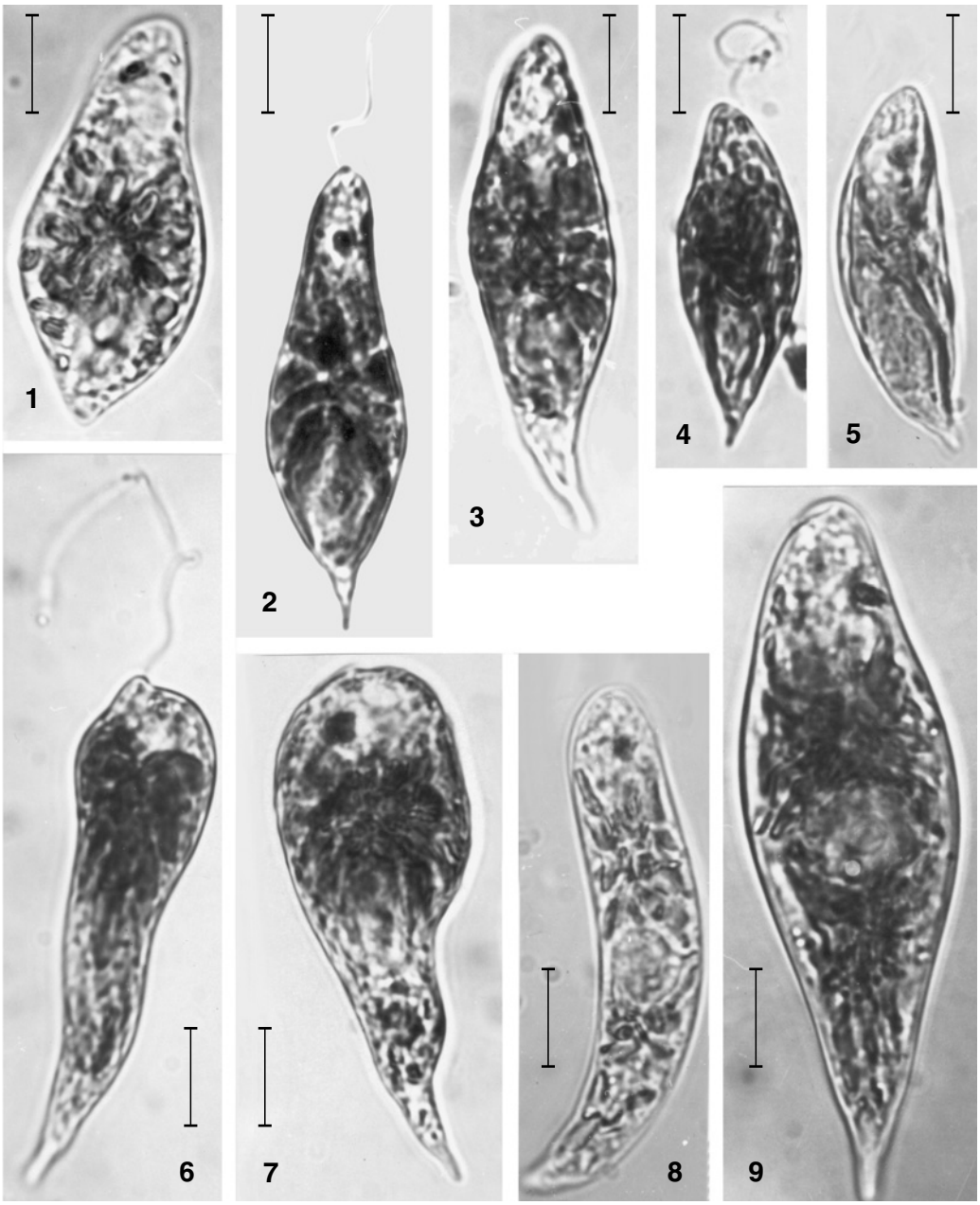


Plate VIII. 1–5. *Euglena viridis* Ehrenberg fo. *viridis*; **6–7.** *E. stellata* Mainx fo. *stellata*; **8.** *E. geniculata* Dujardin var. *terricola* Dangeard; **9.** *E. geniculata* var. *geniculata*.

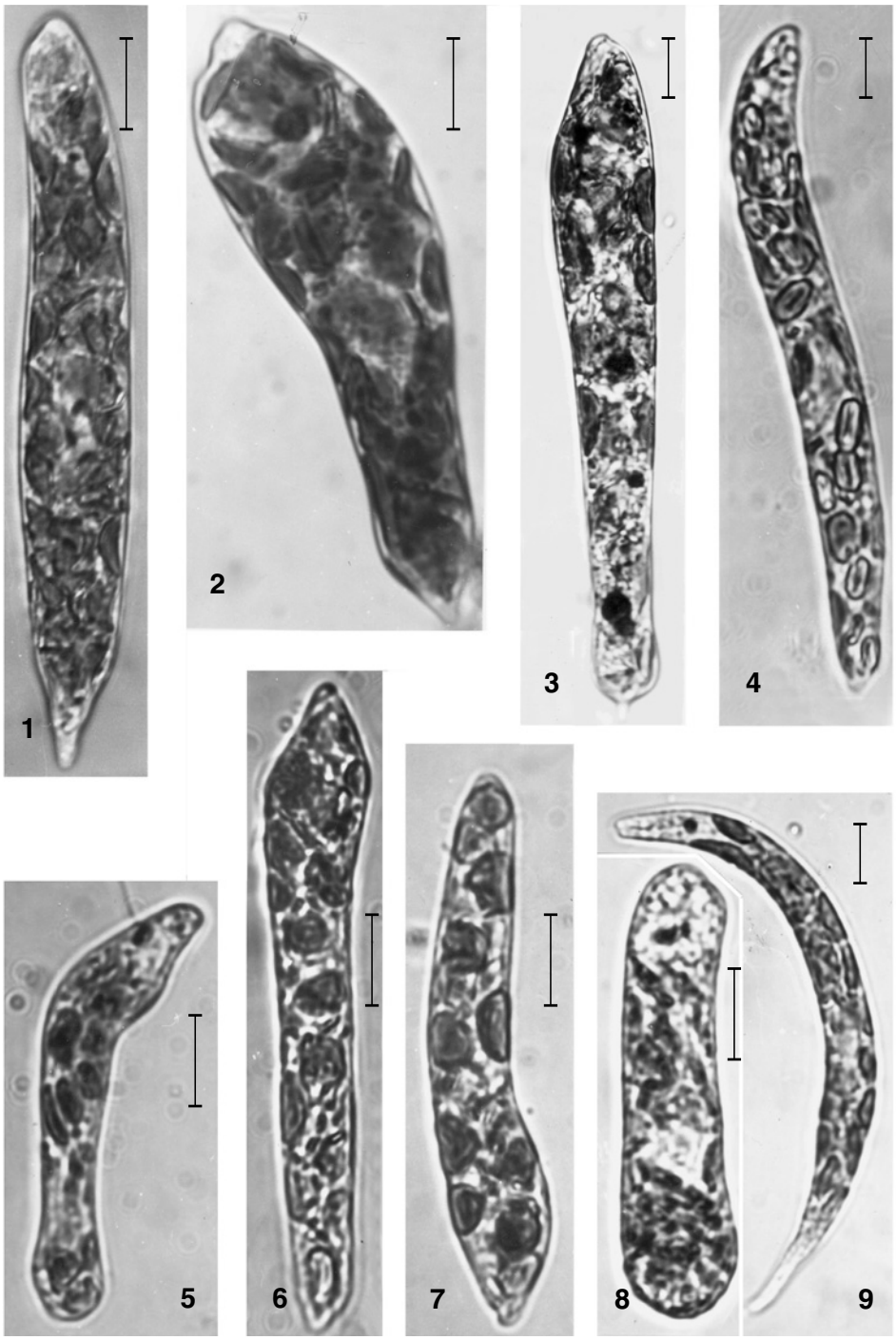


Plate IX. 1–2. *Euglena lucens* Günther; **3.** *E. deses* Ehrenberg fo. *deses*; **4.** *E. deses* fo. *intermedia* Klebs; **5.** *E. hirudo* Drežepolski; **6–7.** *E. deses* fo. *klebsii* (Lemmermann) Popova; **8.** *E. slavjanskiensis* ProškinaLavrenko; **9.** *E. adhaerens* Matvienko.

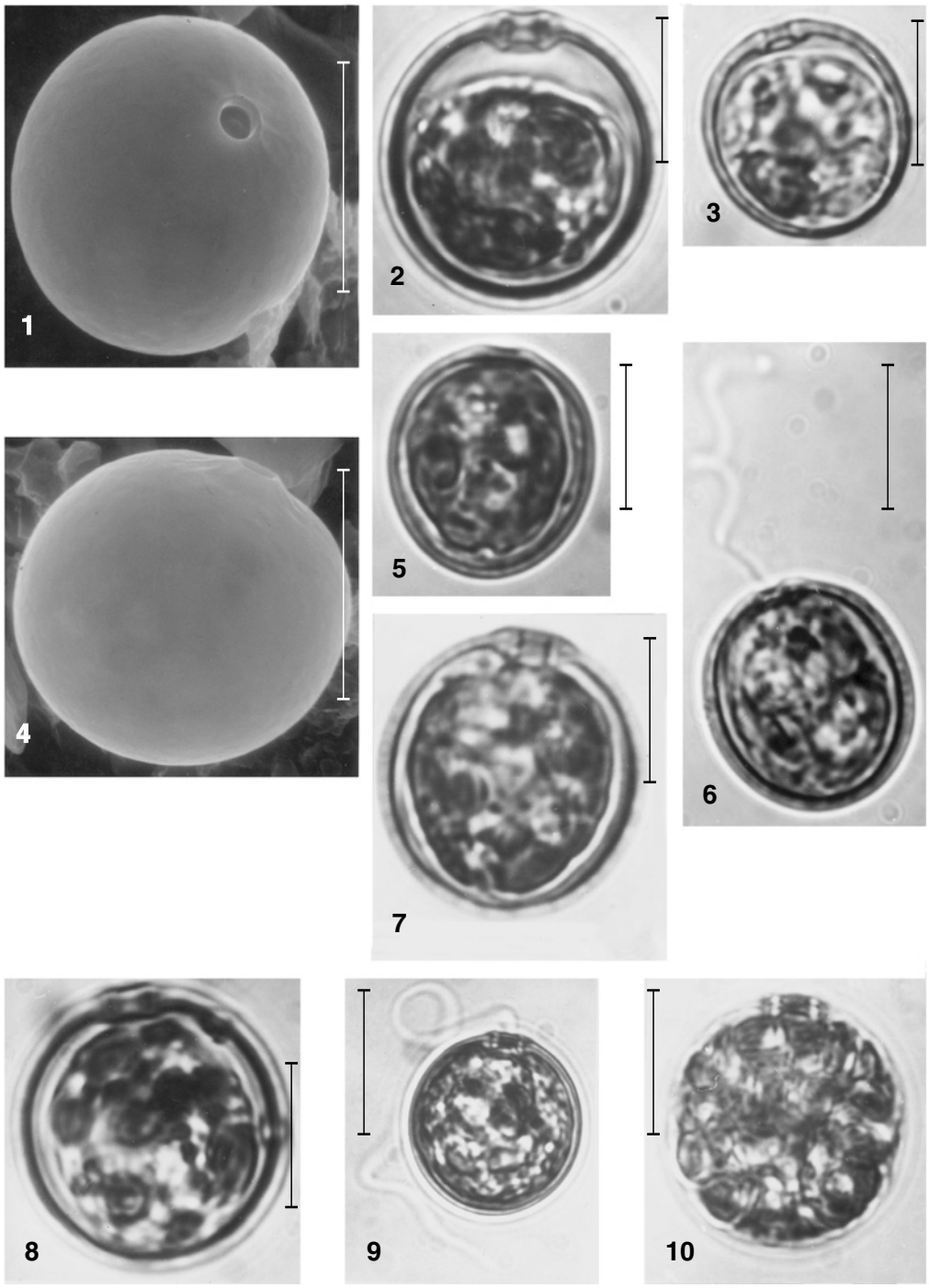


Plate X. 1–3. *Trachelomonas volvocina* Ehrenberg var. *volvocina*; **4.** *T. volvocina* var. *derephora* Conrad; **5–6.** *T. volovcina* var. *subglobosa* Lemmermann; **7.** *T. volvocina* var. *compressa* Dreżepolski; **8–10.** *T. volvocinopsis* Swirenko fo. *volvocinopsis*. SEM: 1 & 4.

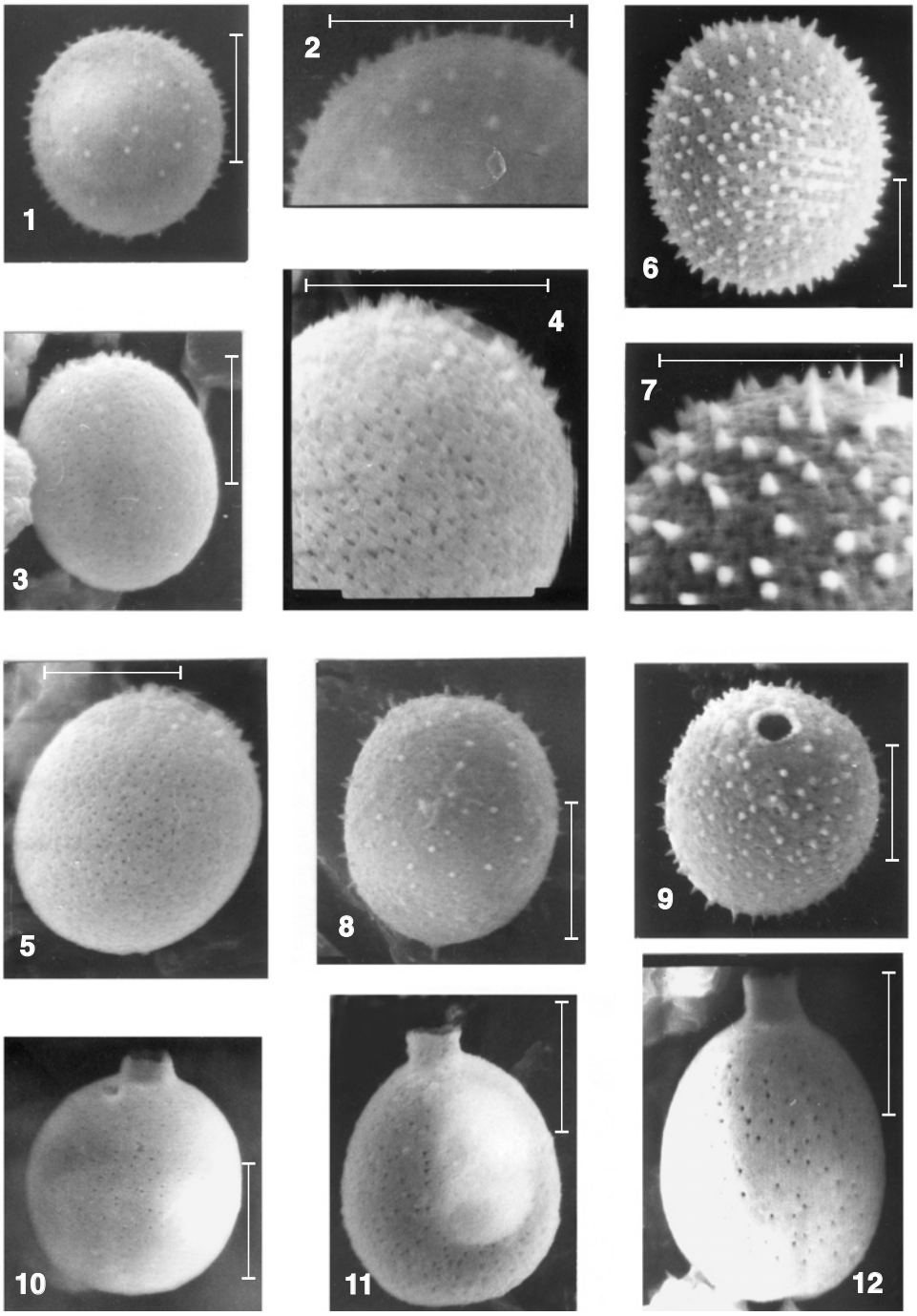


Plate XI. 1–2. *Trachelomonas woycickii* Koczwara, general view and detail of the lorica surface; **3–5.** *T. acanthostoma* Stokes, general view and detail of the lorica surface; **6–7.** *T. globularis* (Awerincew) Lemmermann fo. *globularis,* general view and detail of the lorica surface; **8–9.** *T. globularis* fo. *crenulatocollis* (Szabados) Popova; **10.** *T. lomnickii* Drežepolski; **11–12.** *T. reinhardii* Swirenko. SEM: 1–12.

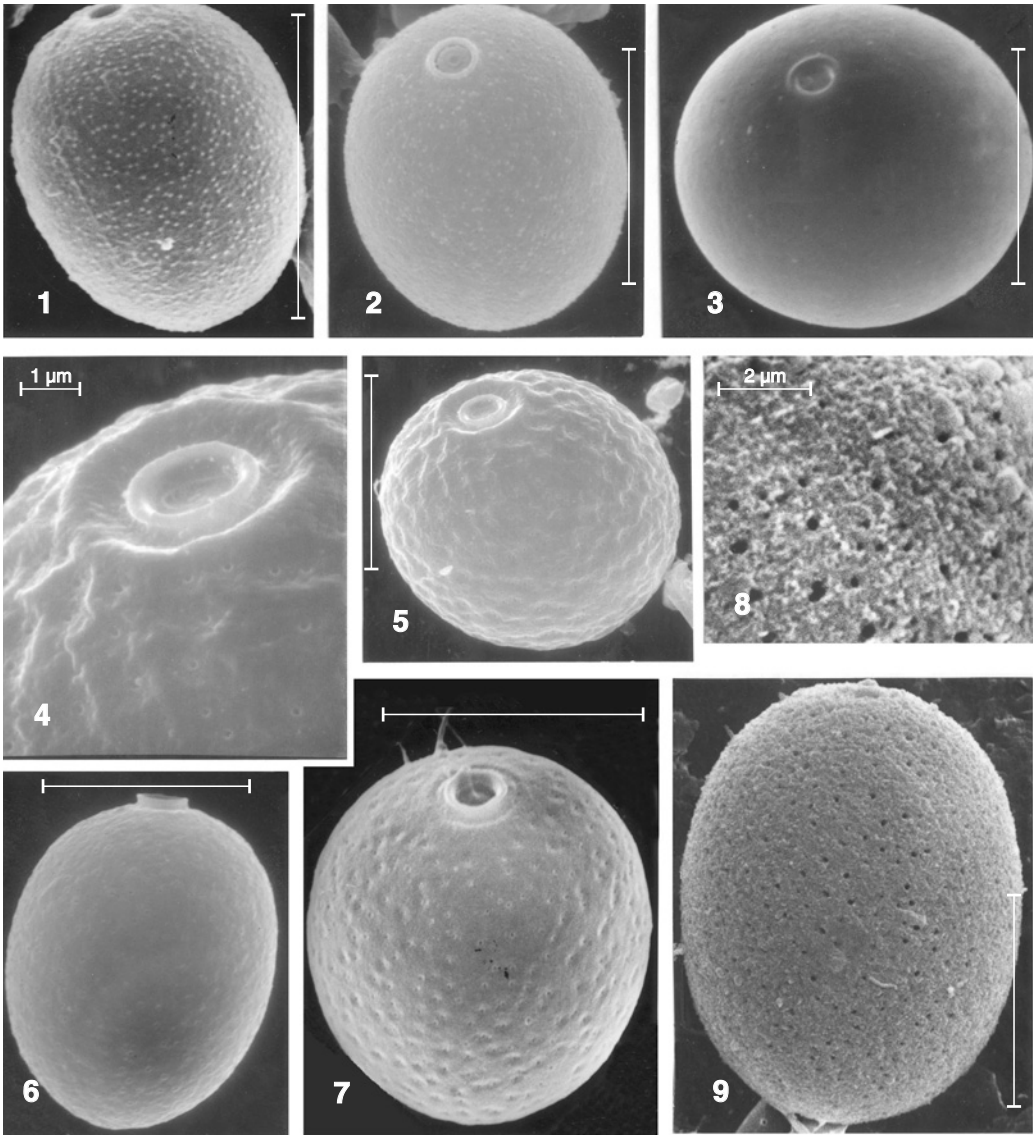


Plate XII. 1–2. *Trachelomonas verrucosa* Stokes fo. *irregularis* Deflandre; **3.** *T. curta* Da Cunha fo. *curta*; **4–5.** *T. nexilis* Palmer, general view and detail of the lorica surface; **6.** *T. oblonga* Lemmermann var. *oblonga*; **7.** *T. pusilla* Playfair; **8–9.** *T. intermedia* Dangeard fo. *intermedia,* general view and detail of the lorica surface. SEM: 1–9.

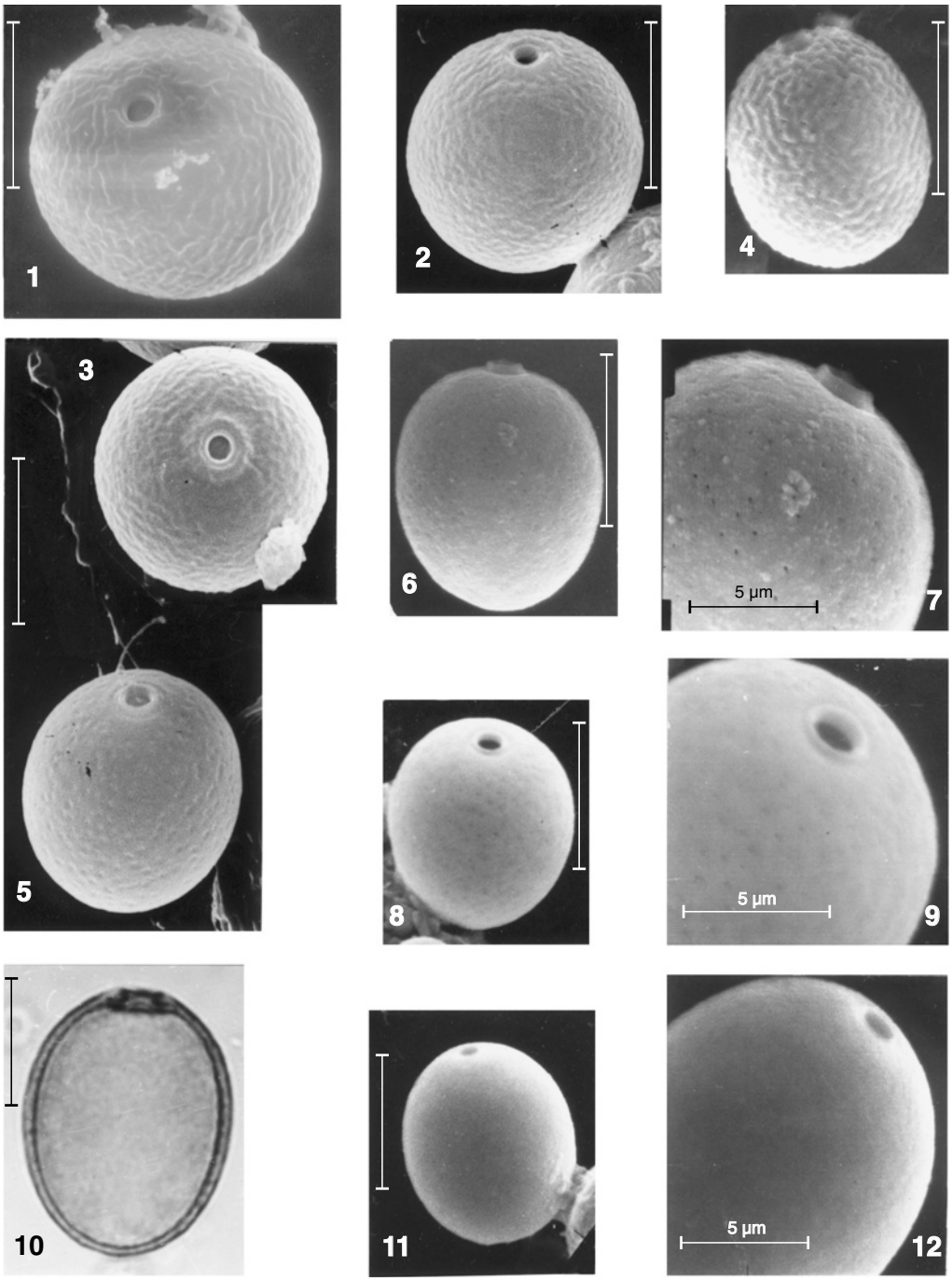


Plate XIII. 1–3. *Trachelomonas rugulosa* Stein; **4.** *T. stokesiana* Palmer fo. *torquata* (Conrad) HuberPestalozzi; **5.** *T. pusilla* Playfair; **6–10.** *T. oblonga* Lemmermann var. *punctata* Lemmermann, general view and detail of the lorica surface; **11–12.** *T. oblonga* var. *pulcherrima* (Playfair) Popova , general view and detail of the lorica surface. SEM: 1–9 & 11–12.

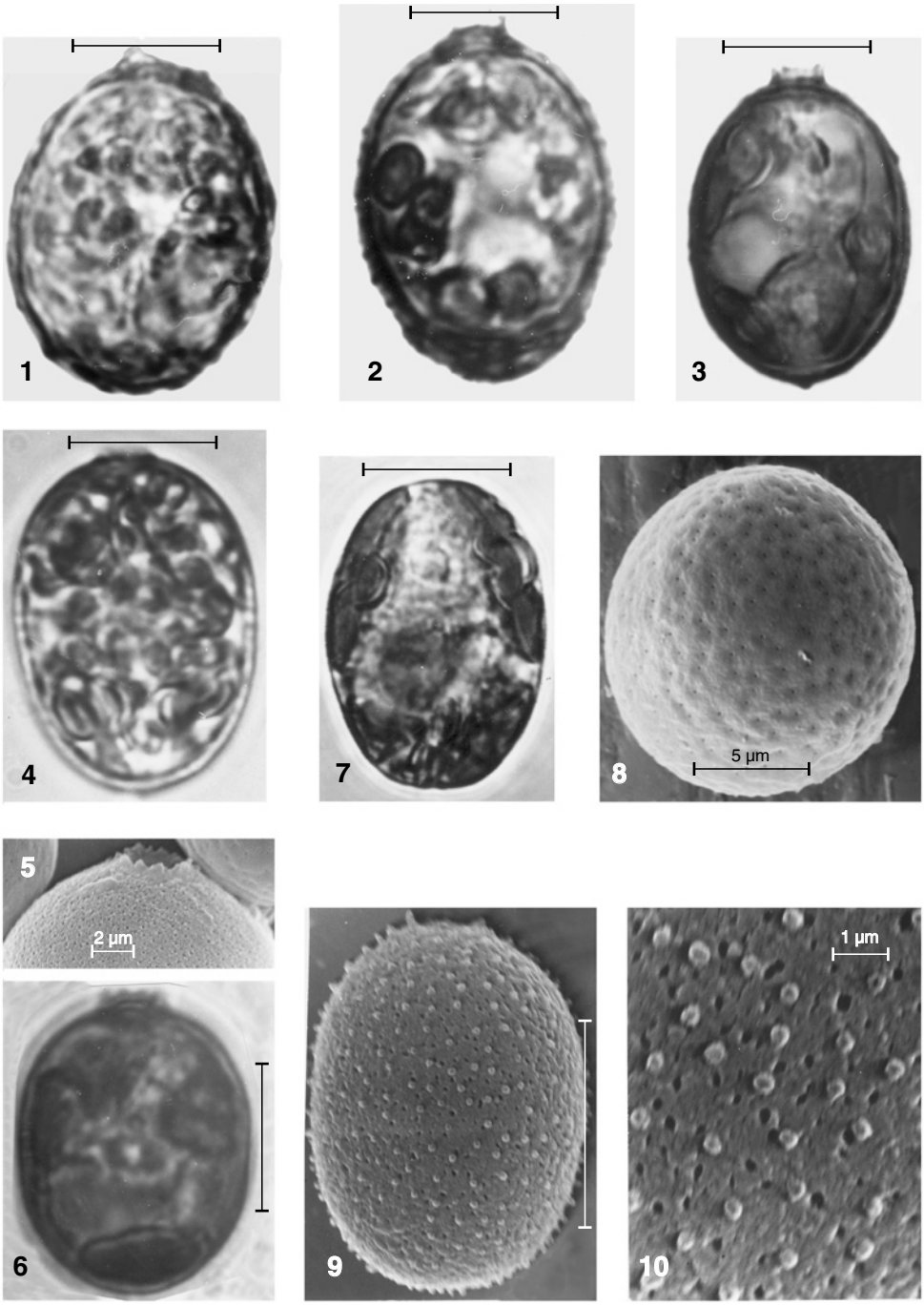


Plate XIV. 1–2. *Trachelomonas poltavica* (Swirenko) Skvortzov; **3.** *T. botanica* Playfair var. *borealis* Playfair; **4–6.** *T. intermedia* Dangeard fo. *crenulatocollis* (Szabados) Popova, general view and detail of the lorica surface; **7.** *T. intermedia* fo. *intermedia*; **8.** *T. compacta* Middelhoek; **9–10.** *T. hispida* (Perty) Stein var. *granulata* Playfair, general view and detail of the lorica surface. SEM: 5 & 8–10.

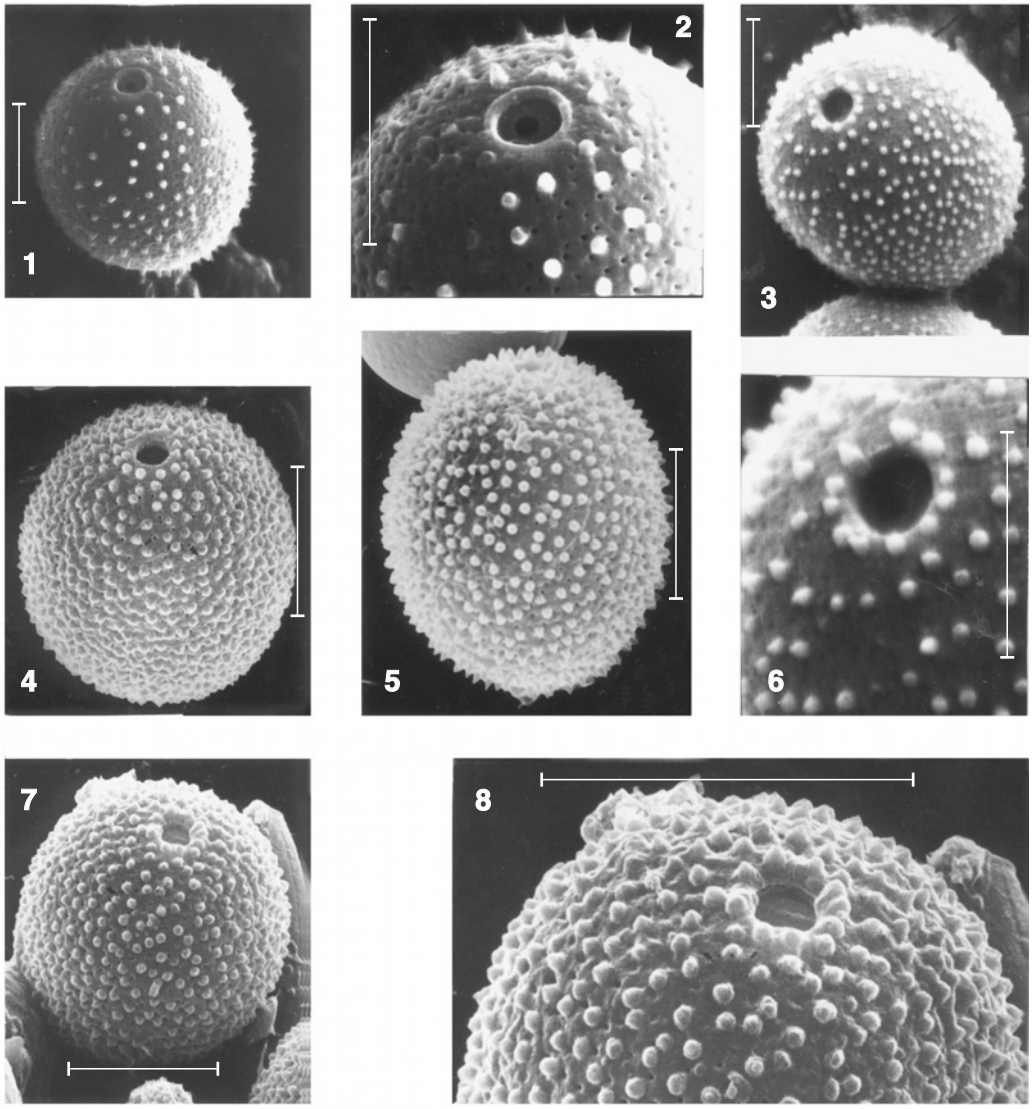


Plate XV. 1–8. *Trachelomonas subverrucosa* Deflandre, general view and detail of the lorica surface (SEM).

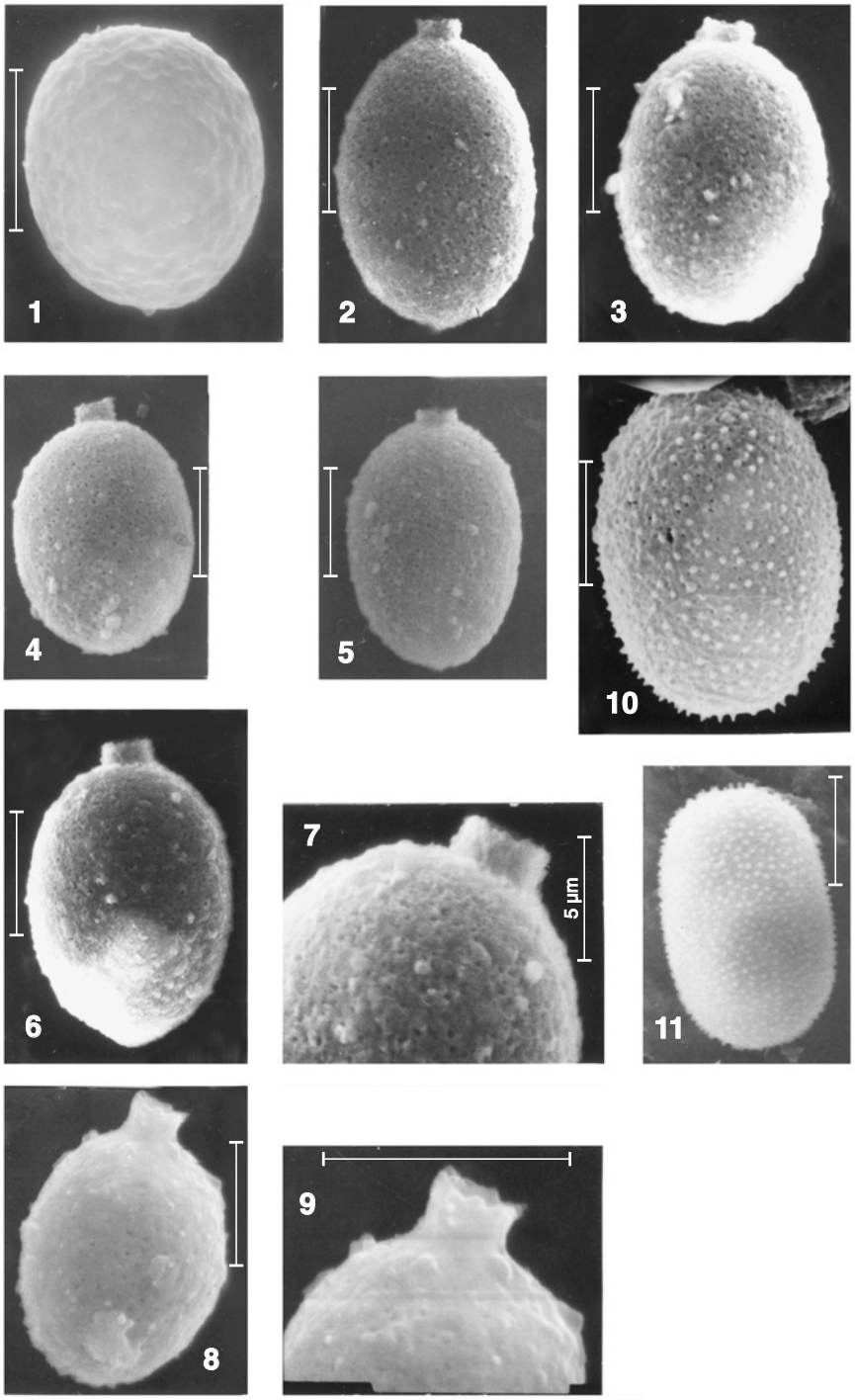


Plate XVI. 1. *Trachelomonas guttata* Middelhoek; **2**–**9.** *T. scabra* Playfair var. *scabra,* general view and detail of the lorica surface; **10.** *T. abrupta* Swirenko var. *abrupta*; **11.** *T. lacustris* Drežepolski var. *klebsii* (Deflandre) Popova (SEM).

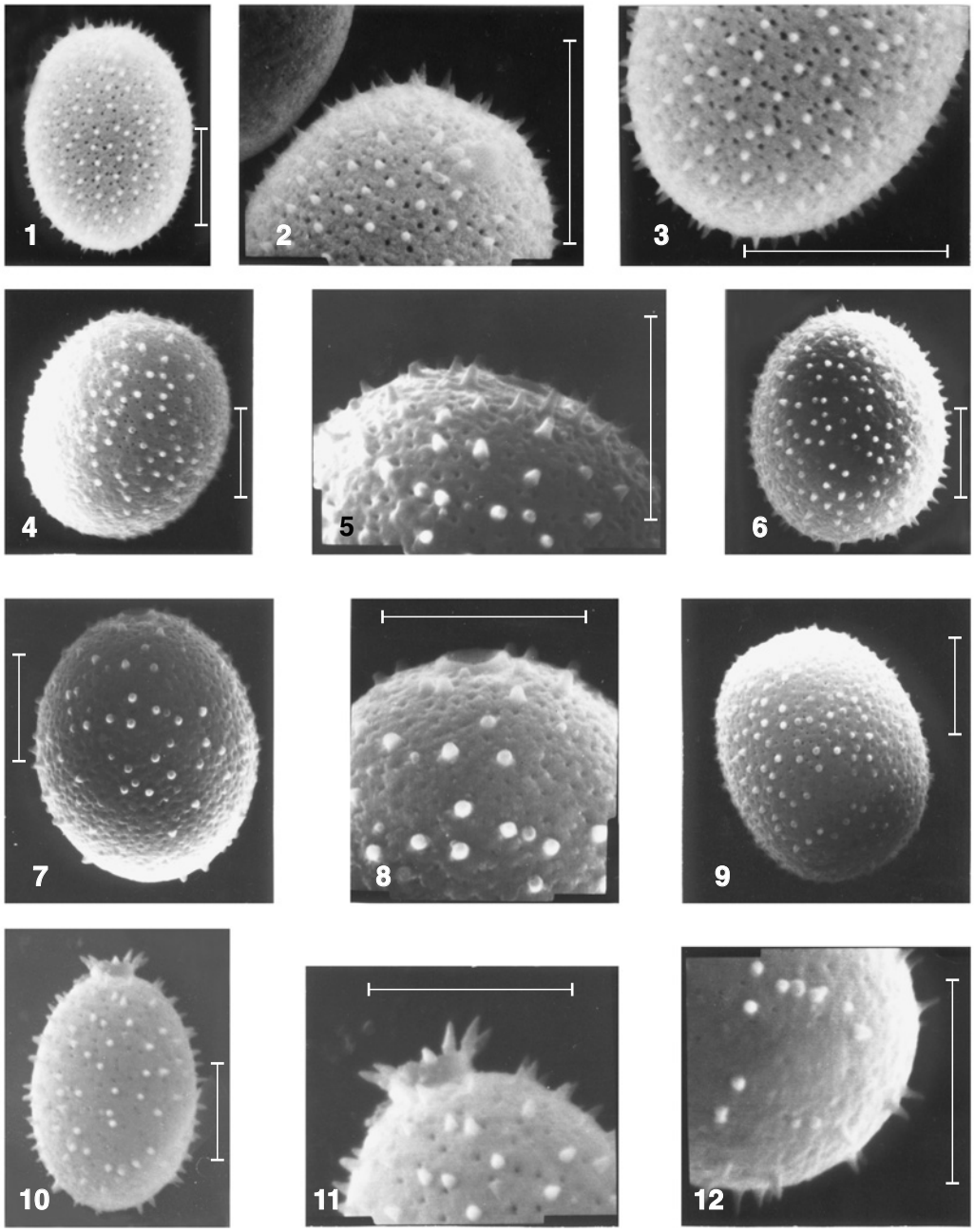


Plate XVII. 1–6. *Trachelomonas hispida* (Perty) Stein var. *hispida,* general view and detail of the lorica surface; **7–9.** *T. hispida* var. *granulata* Playfair, general view and detail of the lorica surface; **10–12.** *T. hispida* var. *coronata* Lemmermann, general view and detail of the lorica surface (SEM).

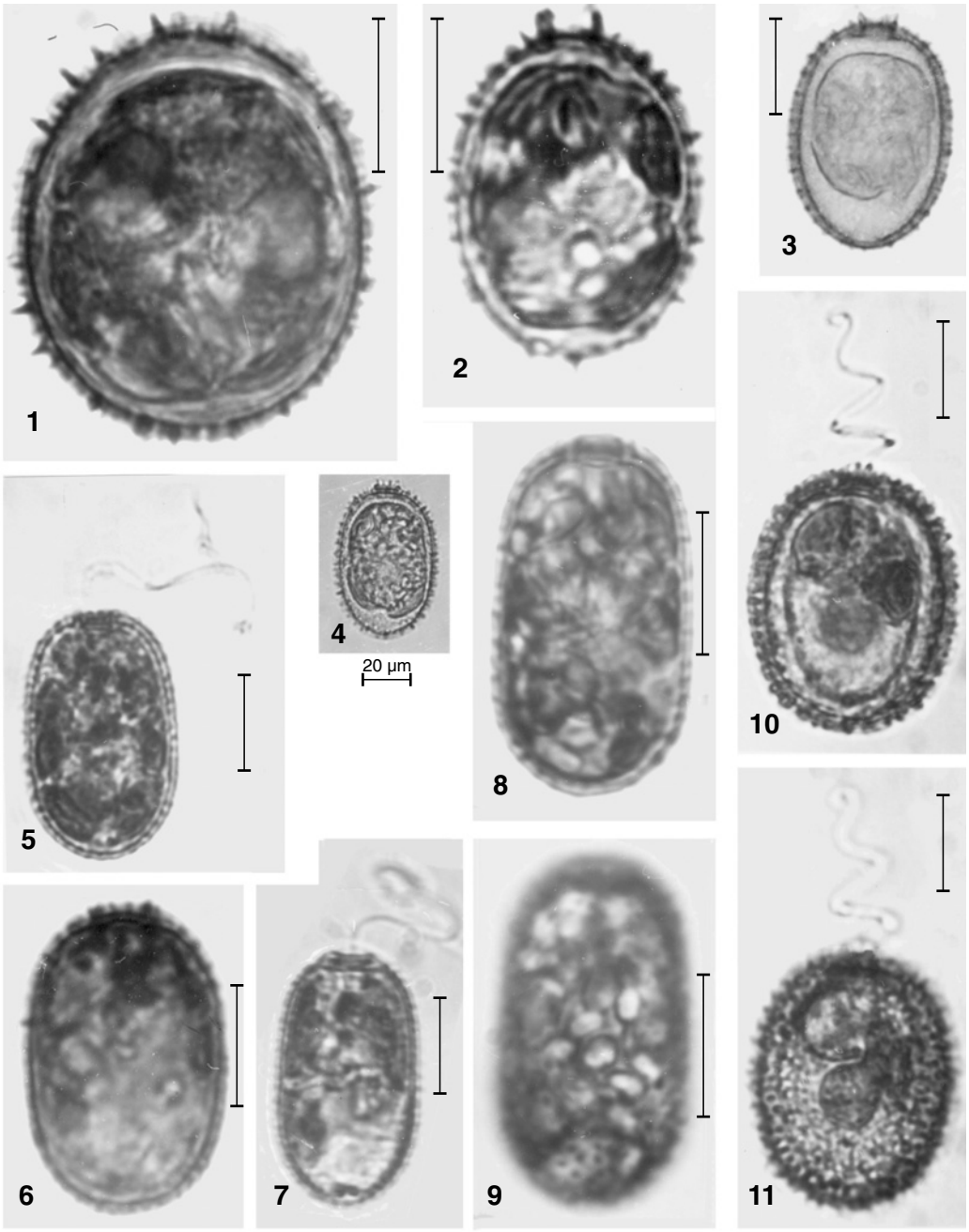


Plate XVIII. 1. *Trachelomonas hispida* (Perty) Stein var. *spinulosa* Skvortzov; **2**–**3.** *T. hispida* var. *crenulatocollis* (Maskell) Lemmermann; **4.** *T. hispida* var. *hispida*; **5.** *T. allia* Drežepolski; **6.** *T. hirta* Da Cunha var. *duplex* Deflandre; **7.** *T. polonica* Drežepolski; **8**–**9.** *T. drežepolskiana* Conrad; **10**–**11.** *T. bacillifera* Playfair var. *minima* Playfair.

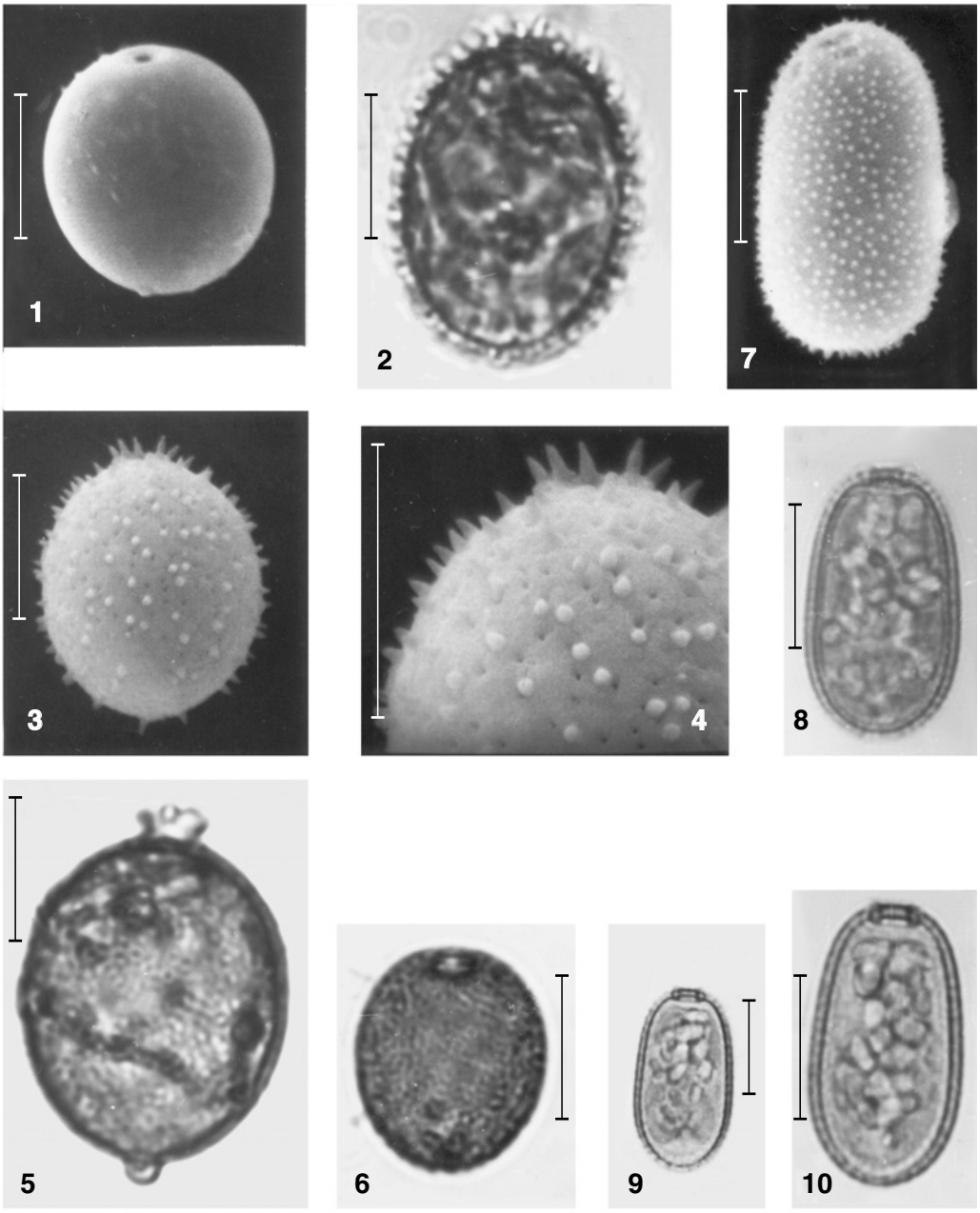


Plate XIX. 1. *Trachelomonas raciborskii* Wołoszyńska var. *incerta* Drežepolski; **2**–**4.** *T. robusta* Swirenko *em.* Deflandre, general view and detail of the lorica surface; **5.** *T. eurystoma* Stein var. *producta* Playfair; **6.** *T. ovoides* Conrad; **7**–**10.** *T. sarmatica* Drežepolski. SEM: 1, 3–4 & 7.

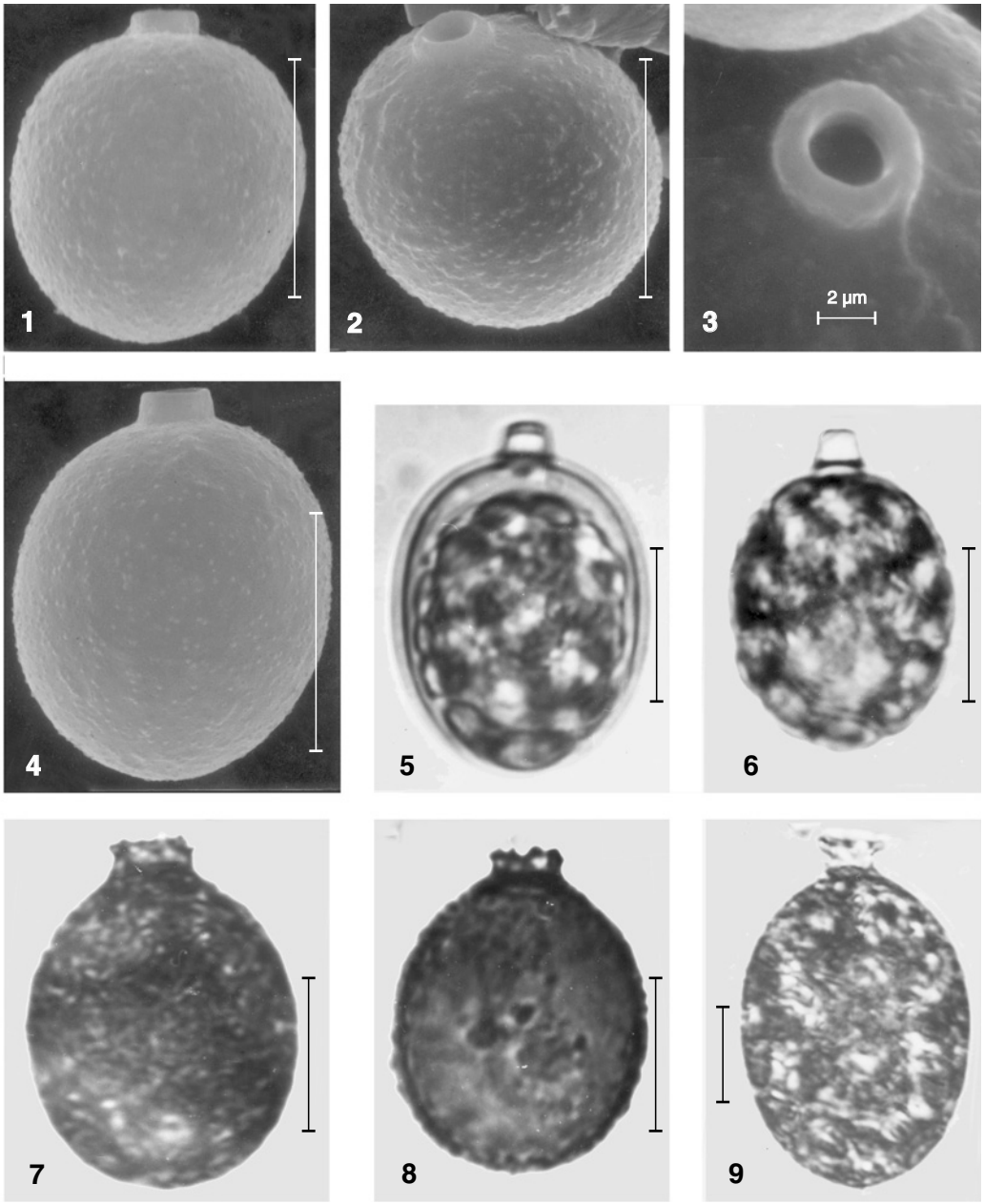


Plate XX. 1–4. *Trachelomonas manginii* Deflandre var. *subpunctata* Safonova, general view and detail of the lorica surface; **5–6.** *T. recticollis* Deflandre; **7–8.** *T. pavlovskoënsis* (Poljanskij) Popova fo. *pavlovskoënsis*; **9.** *T. pavloskoënsis* fo. *ellipsoidea* Popova. SEM: 1–4.

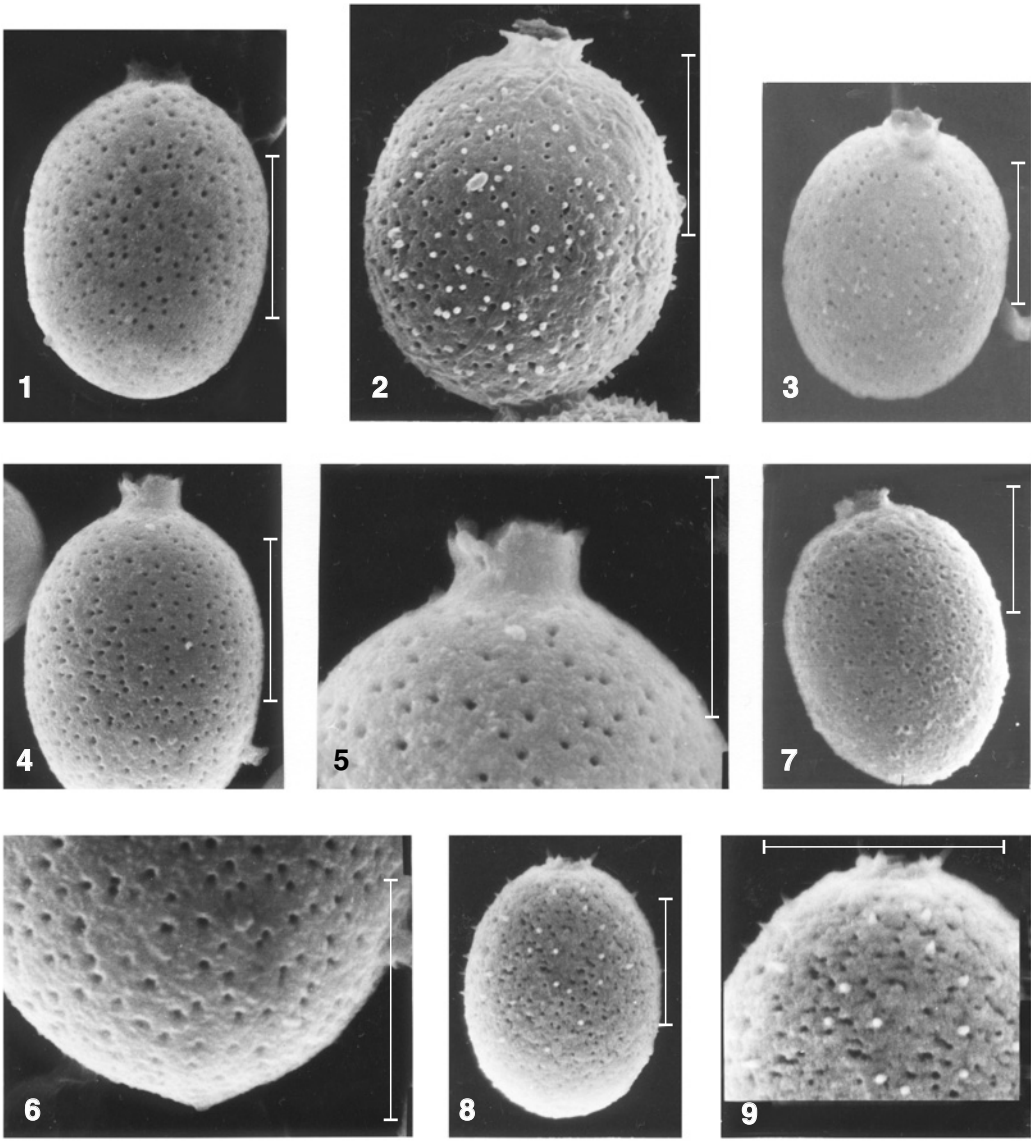


Plate XXI. 1–7. *Trachelomonas planctonica* Swirenko fo. *planctonica,* general view and detail of the lorica surface; **8–9.** *T. planctonica* fo. *ornata* (Skvortzov) Popova, general view and detail of the lorica surface (SEM).

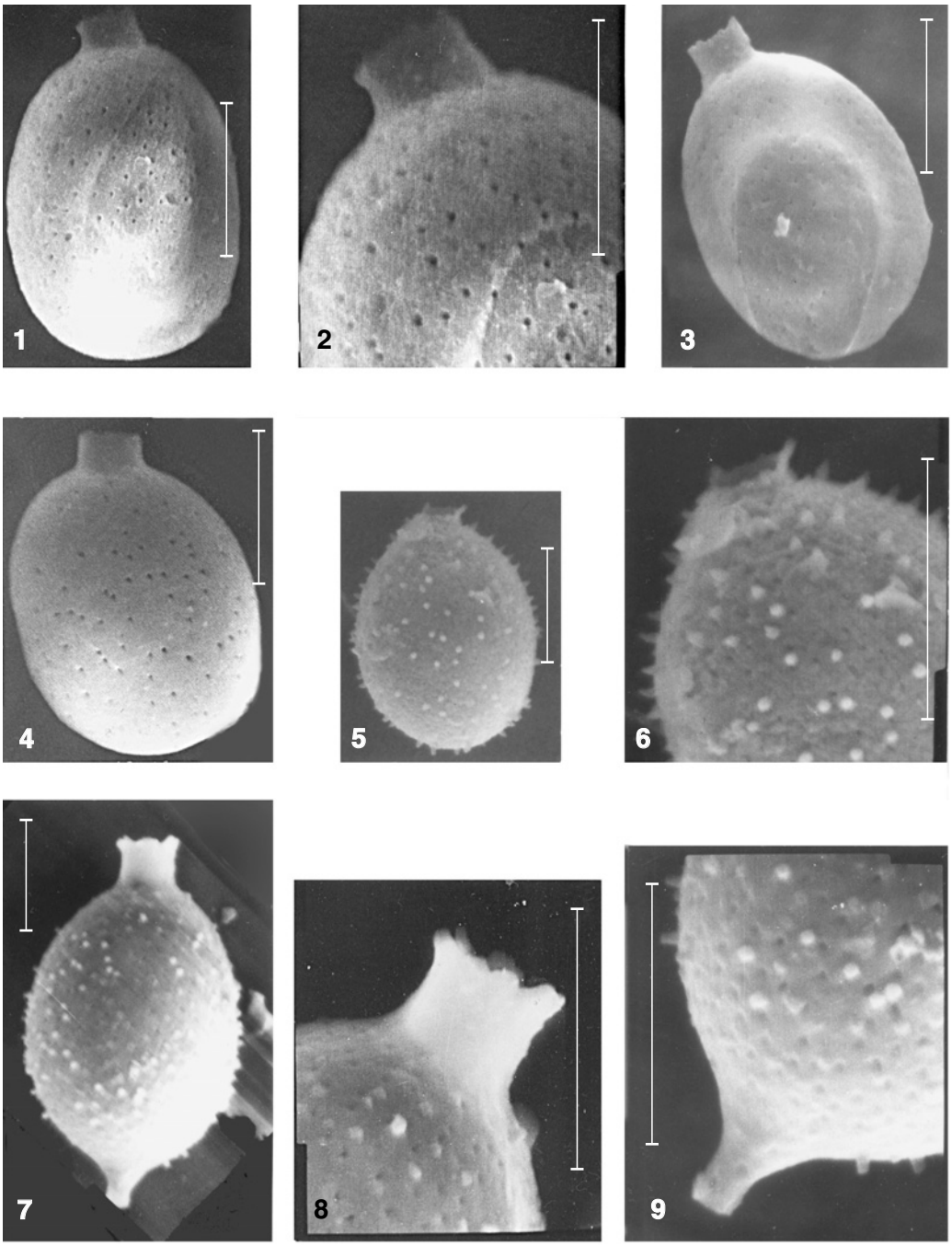


Plate XXII. 1–4. *Trachelomonas similis* Swirenko fo. *similis,* general view and detail of the lorica surface; **5–6.** *T. similis* fo. *spinosa* HuberPestalozzi, general view and detail of the lorica surface; **7–9.** *T. caudata* (Ehrenberg) Stein fo. *caudata*, general view and detail of the lorica surface (SEM).

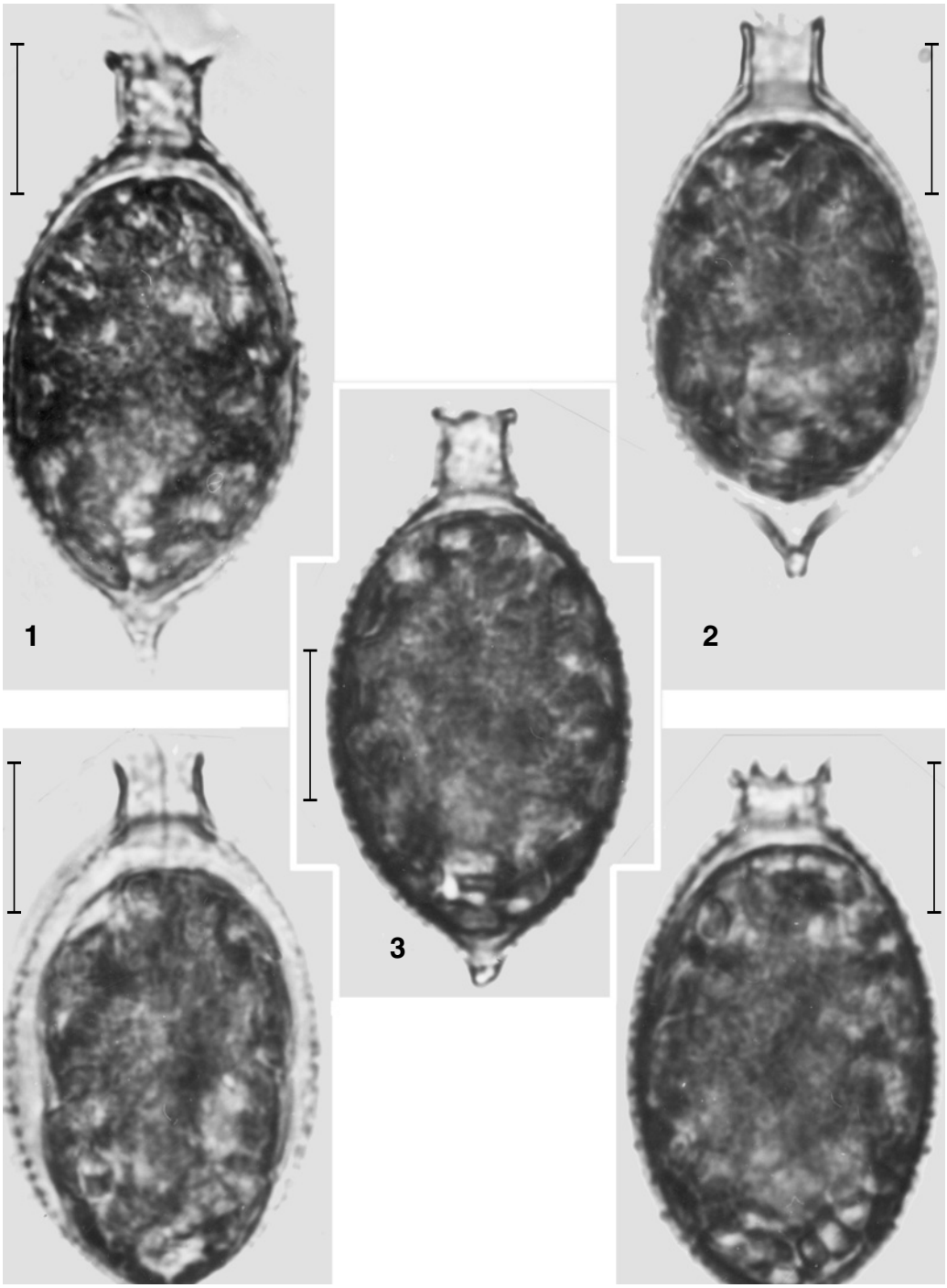


Plate XXIII. 1–5. *Trachelomonas caudata* (Ehrenberg) Stein fo. *caudata*.

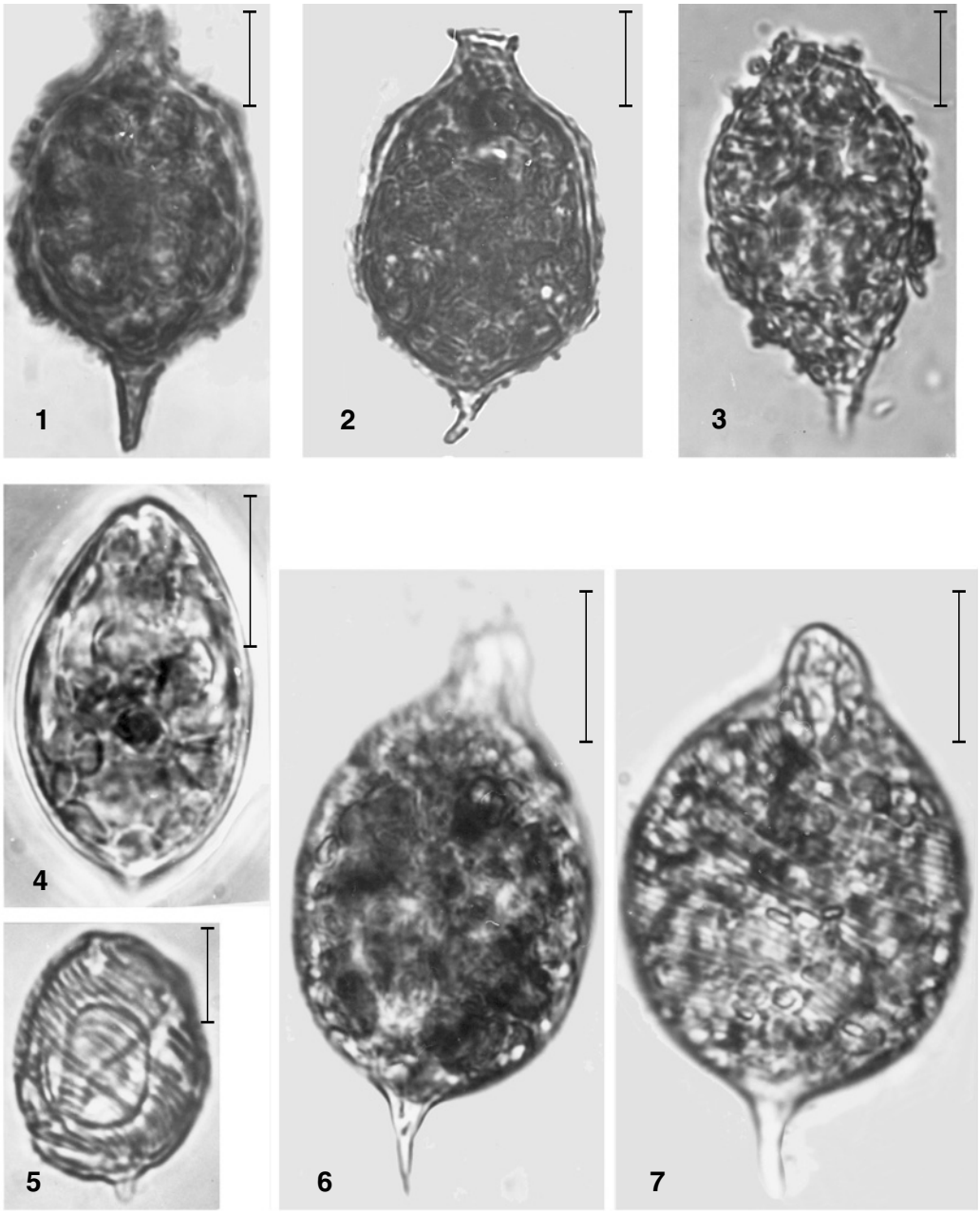


Plate XXIV. 1–2. *Strombomonas acuminata* (Schmarda) Deflandre; **3**. *S. planctonica* (Wołoszyńska) Popova; **4.** *Lepocinclis ovum* (Ehrenberg) Minkievič var. *ovum*; **5.** *L. ovum* var. *palatina* Lemmermann; **6–7.** *L. playfairiana* Deflandre.

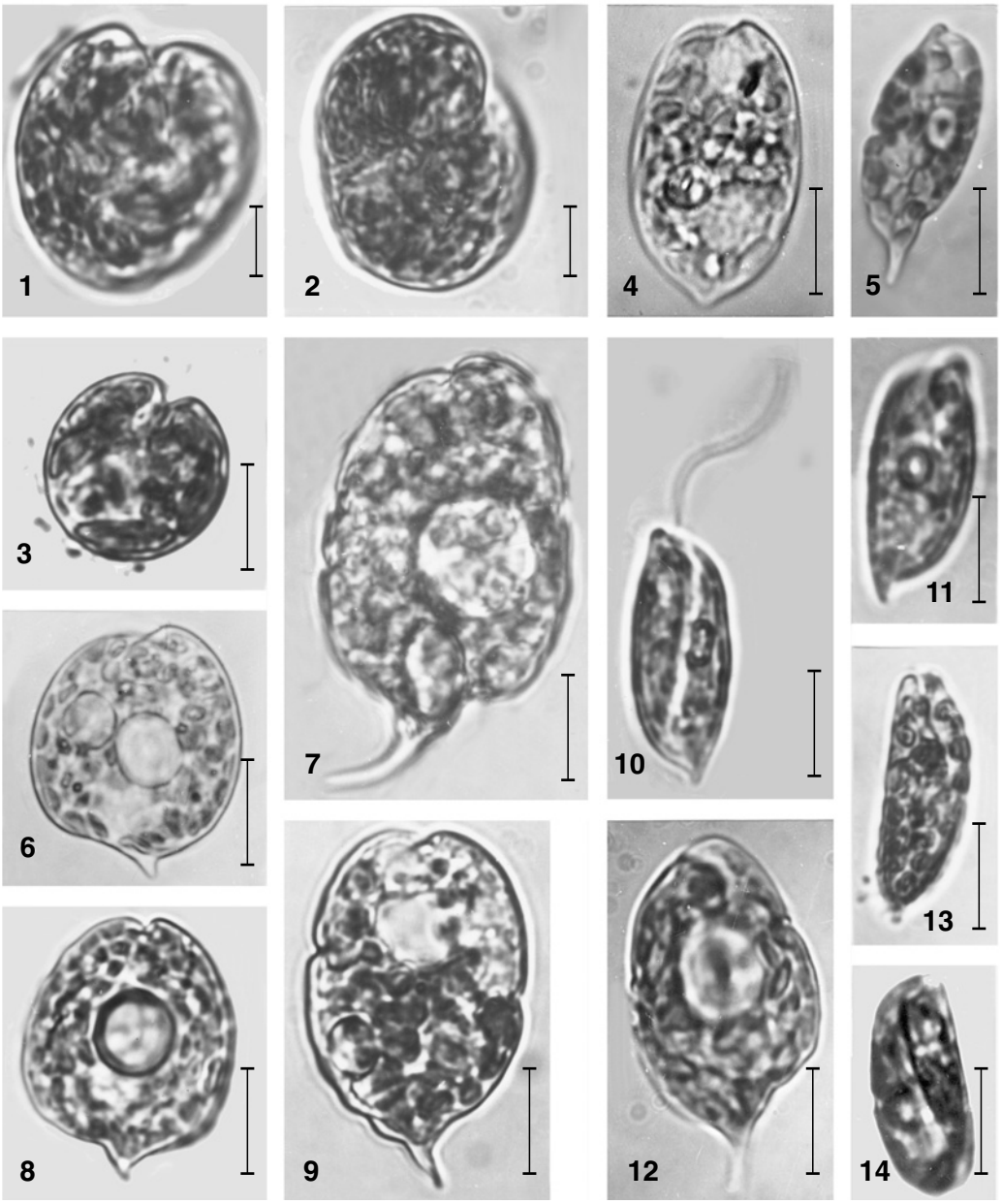


Plate XXV. 1–2. *Phacus stokesii* Lemmermann; **3.** *Ph. corculum* Pochmann; **4–5.** *Ph. parvulus* Klebs; **6.** *Ph. acuminatus* Stokes var. *acuminatus*; **7.** *Ph. undulatus* Pochmann var. *undulatus*; **8.** *Ph. acuminatus* var. *acuminatus*; **9.** *Ph. unguis* Pochmann; **10–11.** *Ph. oscillans* Klebs; **12.** *Ph. brachykentron* Pochmann; **13.** *Ph. pusillus* Lemmermann; **14.** *Ph. dangeardii* Lemmermann.

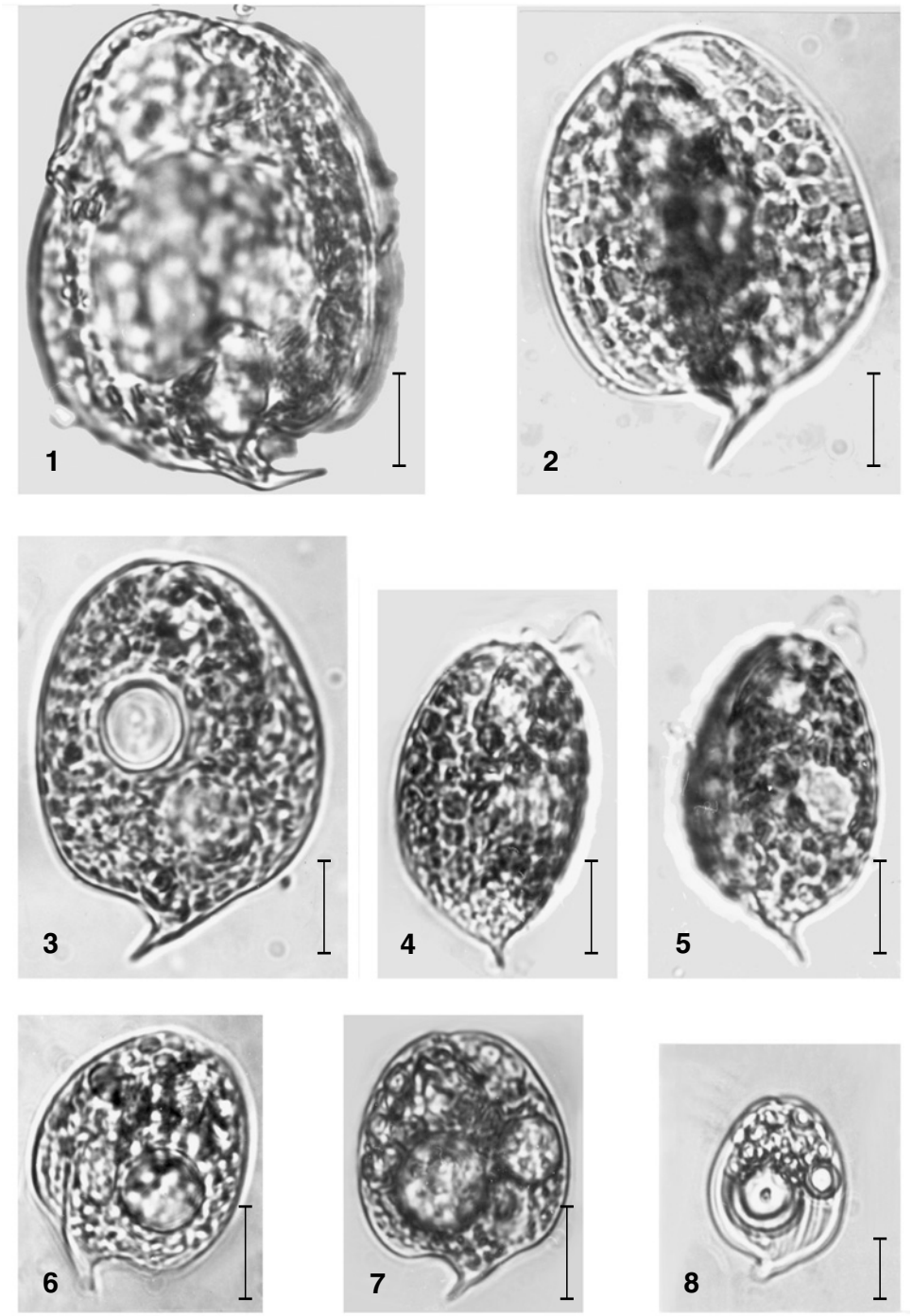


Plate XXVI. 1. *Phacus carinatus* Pochmann; **2.** *Ph. orbicularis* Hübner fo. *orbicularis*; **3.** *Ph. orbicularis* fo. *communis* Popova; **4**–**5.** *Ph. pleuronectes* (Ehrenberg) Dujardin var. *pleuronectes*; **6**–**7.** *Ph. curvicauda* Swirenko var. *curvicauda*; **8.** *Hyalophacus ocellatus* Pringsheim.

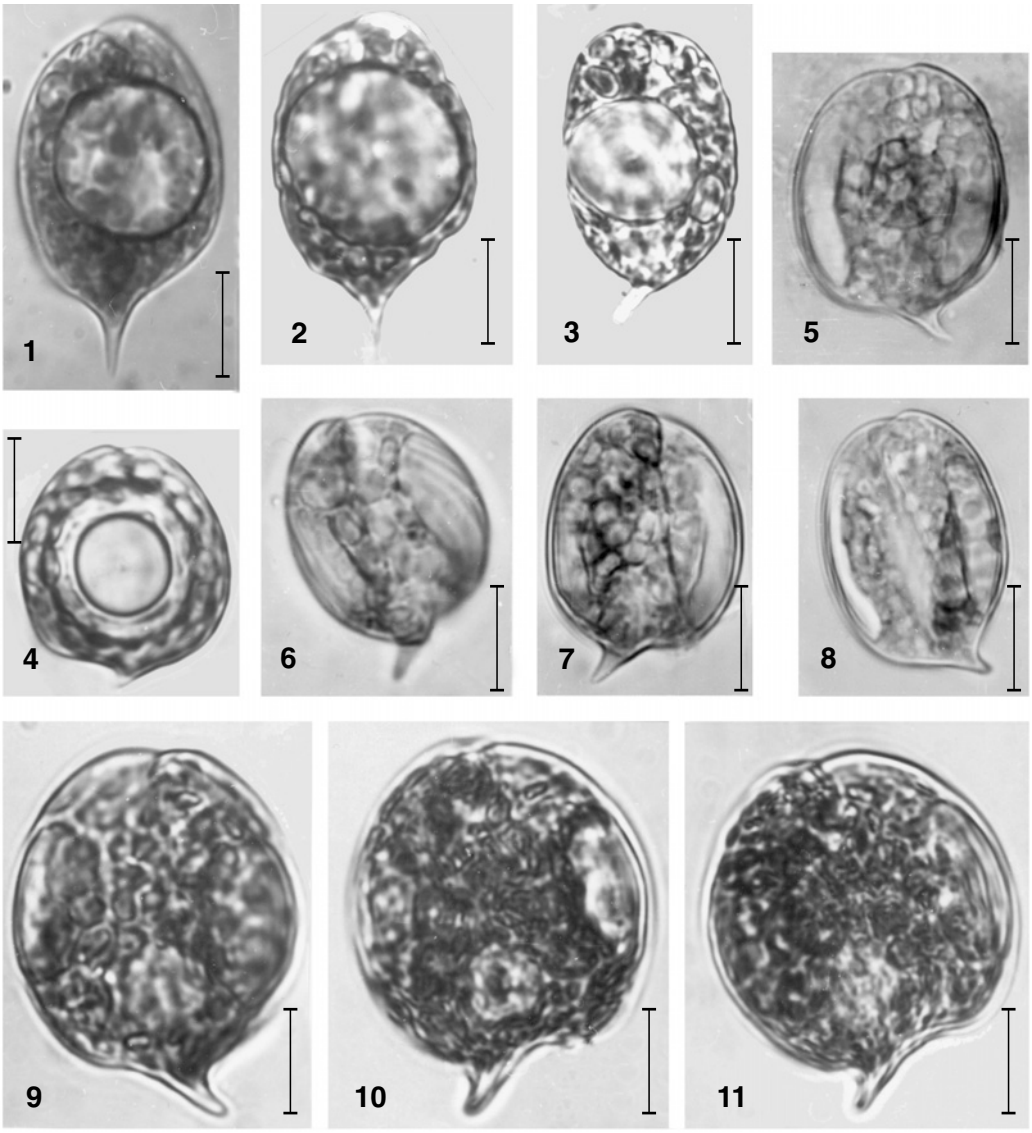


Plate XXVII. 1–2. *Phacus formosus* Pochmann; **3.** *Ph. obolus* Pochmann; **4.** *Ph. circulatus* Pochmann; **5–8.** *Ph. alatus* Klebs var. *alatus*; **9–11.** *Ph. alatus* var. *maximus* Hübner.

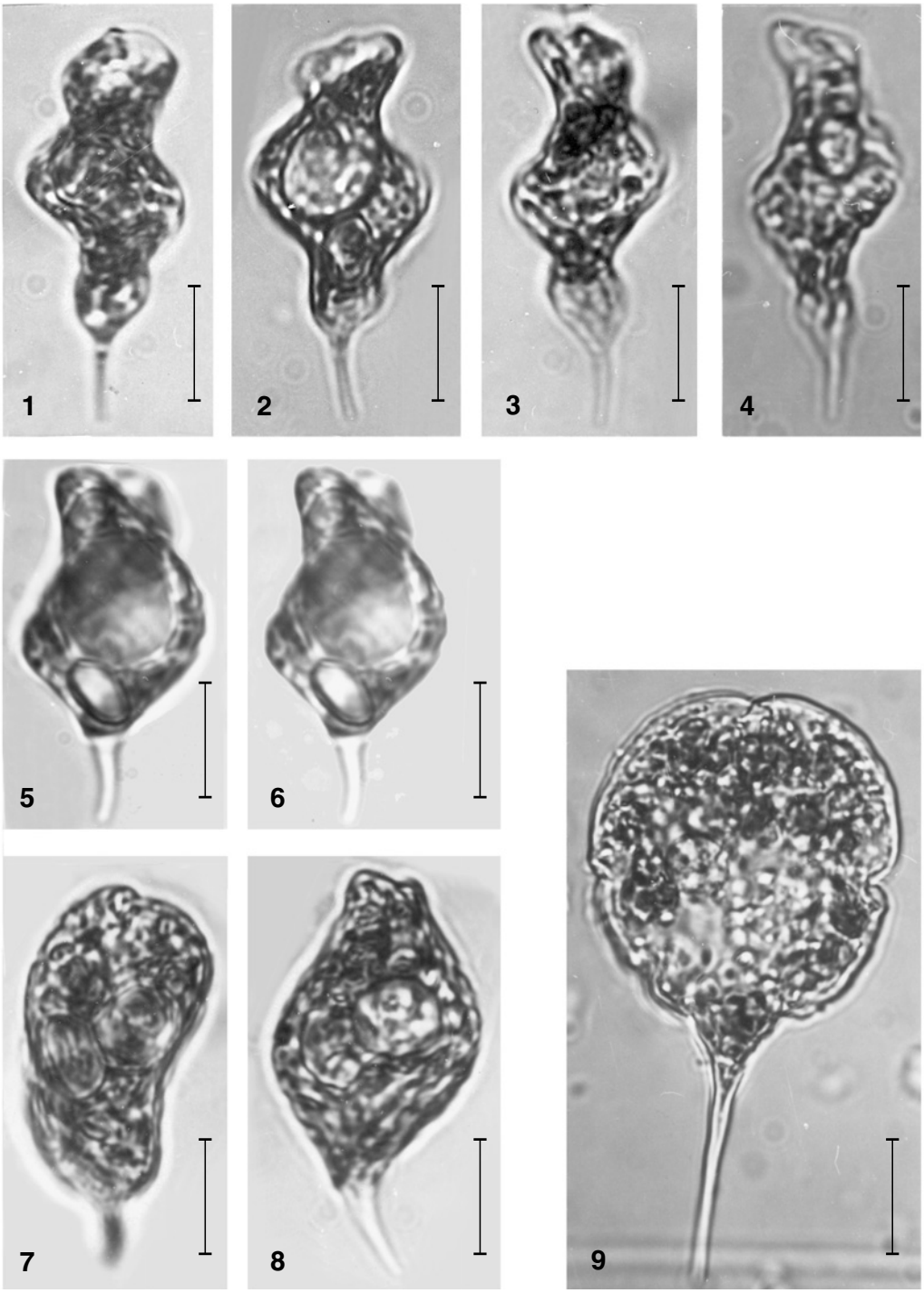


Plate XXVIII. 1–4. *Phacus similis* Christen; **5–6.** *Ph. raciborskii* Drežepolski; **7–8.** *Ph. anomalus* (Fritsch & Rich) Pochmann; **9.** *Ph. longicauda* (Ehrenberg) Dujardin var. *longicauda*.

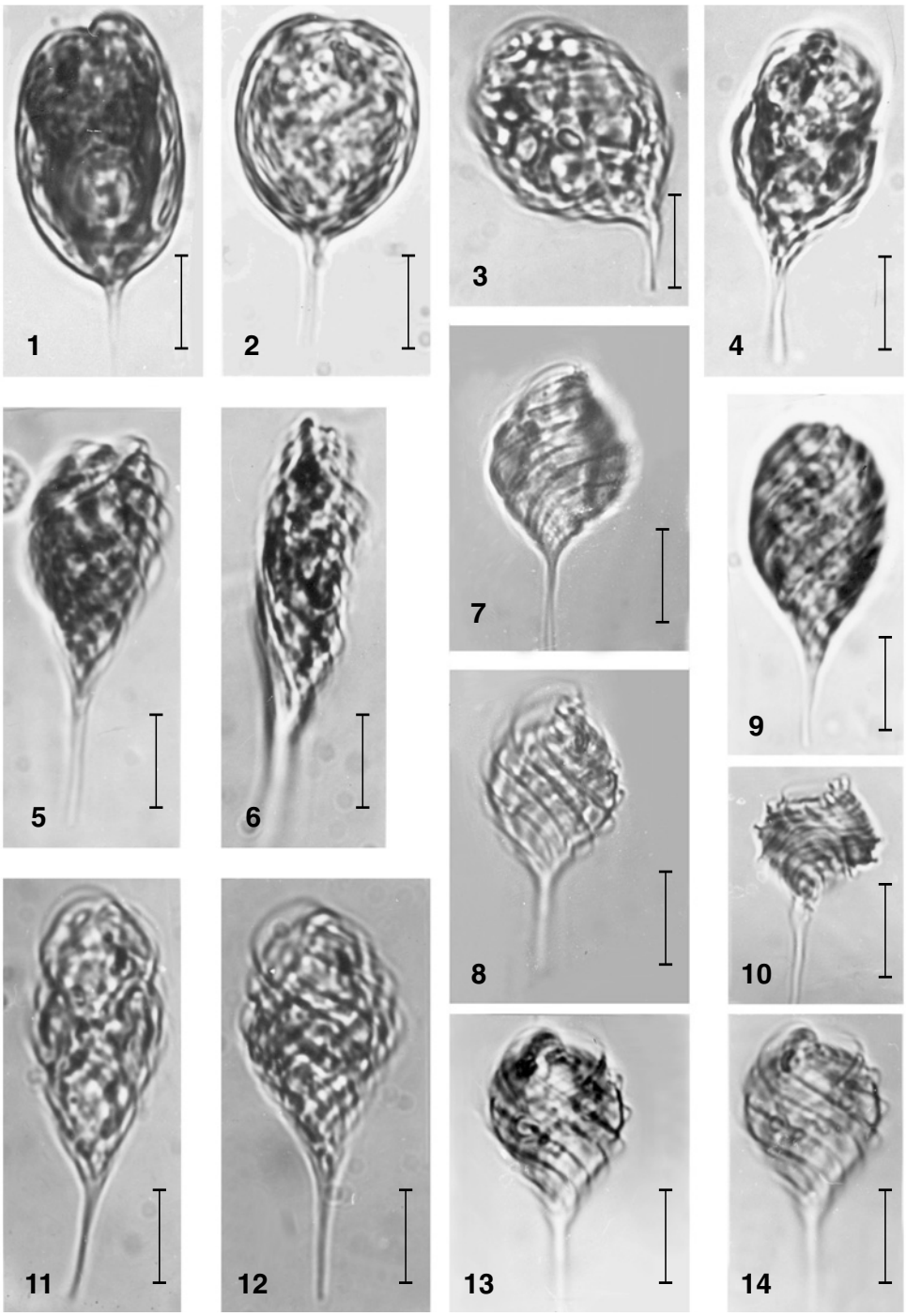


Plate XXIX. 1–2. *Phacus splendens* Pochmann; **3.** *Ph. trypanon* Pochmann; **4.** *Ph. pseudonordstedtii* Pochmann; **5–6.** *Ph. megalopsis* Pochmann; **7–8.** *Ph. pulcherrimus* (Conrad) Pochmann; **9.** *Ph. strongylus* Pochmann; **10.** *Ph. costatus* Conrad; **11–14.** *Ph. mirabilis* Pochmann.

Euglenophyte communities occurring in various types of water body

In the Kraków-Częstochowa Upland numerous karstic ponds occur especially on rocky outcrops where depressions fill with rainwater. For hundreds of years human settlements have grown up around the largest of them to use the water for washing, cleaning, watering cattle, and as a feeding ground for ducks. Hence these village ponds organically polluted. People used to carry drinking water in pails or bring it in barrels from springs or the upper parts of streams, or the (necessarily) deep wells. Water supply services have recently been installed in these places, making use of the springs which reduces the water level in the streams.

Considerably fewer karstic ponds are situated among the fields. They are smaller and their waters are enriched with inflowing organic and inorganic fertilizers. Some of them, such as a pond near Jerzmanowice still marked on the maps, have become shallow or filled in.

Most of the upper parts of the streams have few dense village dwellings nearby but in the past they were used to drive mills and sawmills. Trout ponds were built in the ravine extensions, and carp ponds requiring warmer water were constructed in wider valleys.

Peat bogs, numerous in the past, particularly those still marked on the maps at the edges of the Upland, have almost dried up.

Water bodies in the area together with their euglenophyte communities are generally affected by human activity.

The investigated localities included stagnant water bodies such as karstic village and field ponds, small peat bogs, fish- ponds, garden ponds, artificial water bodies, temporary puddles, hollows made by cattle and poultry and even wet soil. Flowing water such as springs, streams, rivers, as well as sewage and draining ditches have been also taken into consideration.

Karstic ponds

Village ponds

Four selected ponds

33 village karstic ponds were investigated, the samples being mainly taken irregularly. Four of them situated in Bębło, Jerzmanowice, Paczółtowice, and Ściborzyce were used for regular monthly observations during one year (December 1990-January 1991).

The chosen ponds are about 10 to 25 km away from each other. They serve for watering cattle and are feeding grounds for ducks and geese. The pond in Ściborzyce is of somewhat different character because aquatic birds do not feed in it, and it is supplied by water from the spring of the River Dłubnia in Imbramowice.

Bębło pond – The pond in Bębło (site 26) is in the centre of the village, near a local road opposite the Health Service Centre. The pond is ca 6 m in diameter and 50 cm deep. Mats of *Oscillatoria limosa* Agardh regularly occurred on the loam-sandy bed of the

Table 1. BĘBŁO POND: occurence of euglenophyte taxa and physico-chemical properties of water from 1988 to 1991. Key: + – single; 1 – sparse; 2 – frequent; 3 – very frequent; 4 – in masses.

Date	1988	1989		1990												1991
	08.16	01.14	03.21	01.17	02.14	03.14	04.11	05.09	06.12	07.11	08.22	09.19	10.24	11.20	12.19	01.22
Temperature ^{o}C	.	.	.	0.5	0.5	5.2	8.6	27.0	15.0	17.0	14.1	12.0	6.5	3.2	0.5	0.5
pH	.	.	.	7.3	8.0	7.6	7.8	7.6	7.5	7.3	7.0	7.2	7.4	8.0	7.1	7.5
Oxygen mg/l	.	.	.	8.2	16.0	11.9	8.5	4.3	3.0	3.0	1.1	4.4	5.3	7.4	9.5	12.3
Carbonate hardness mVal	.	.	.	2.8	5.2	3.6	3.8	2.9	4.0	3.3	4.3	4.6	4.9	5.2	5.8	7.1
Total hardness mVal	.	.	.	3.6	6.2	4.9	5.1	5.1	4.4	4.4	4.6	4.6	6.0	8.0	8.0	10.9
Calcium Ca mVal	.	.	.	66.0	100.0	93.0	90.0	72.0	80.0	80.0	65.0	82.0	90.0	106.0	128.0	200.0
Chloride Cl mg/l	.	.	.	111.0	220.0	200.0	196.0	238.0	202.0	176.0	156.0	132.0	130.0	141.0	226.0	274.0
Amonia N-NH_4 mg/l	.	.	.	473.2	473.2	473.2	473.2	355.6	473.2	473.2	473.2	473.2	16.9	6.3	13.0	8.4
Phosphate P-PO_4 µg/g	.	.	.	0.9	3.4	3.4	1.0	3.4	3.8	3.8	3.8	3.8	236.6	88.2	182.0	117.6
Distigma proteus	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Euglena agilis	.	.	.	+	.	+	.	1	+	1	+	+	+	+	.	.
– *anabaena* var. *anabaena*	.	.	.	.	.	.	+	.	.	2	.	1	+	+	+	.
– *caudata* var. *caudata*	.	.	.	.	.	+	.	1	+	.	+	+	.	+	.	.
– *chadefaudii*	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *chlamydophora*	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.
– *clavata*	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *deses* fo. *deses*	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
– – fo. *intermedia*	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *ehrenbergii*	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *ettlii*	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
– *geniculata* var. *geniculata*	.	.	.	.	.	.	.	4	+	.	.	.	.	+	.	.
– – var. *terricola*	.	.	.	.	3	.	.	.	+	.	.	.	.	.	.	.
– *hemichromata*	.	+	.	.	.	+	.	+	+	.	.	.	.	+	.	.
– *hirudo*	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
– *limnophila* var. *limnophila*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
– – var. *swirenkoi*	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
– *minima*	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.

– *mutabilis*	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *oblonga*	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
– *oxyuris* fo. *maior*	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *polymorpha*	.	1	.	.	.	+	.	.	.	.	.	.	.	.	.
– *proxima*	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.
– *rustica* var. *rustica*	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
– *sanguinea*	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.
– *sima*	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
– *splendens*	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.
– *stellata* fo. *stellata*	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.
– *tristella*	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
– *viridis* fo. *viridis*	.	1	1	2	2	3	+	+	2	2	.	.	.	.	.
Trachelomonas hispida var. *hispida*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
– *sarmatica*	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+
– *volvocina* var. *volvocina*	.	.	.	.	.	+	.	.	.	.	2	+	.	.	+
– *volvocinopsis* fo. *volvocinopsis*	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Lepocinclis ovum var. *ovum*	.	.	.	.	.	.	.	1	.	.	+	.	+	.	.
– *steinii*	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Phacus caudatus var. *caudatus*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
– – var. *tenuis*	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.
– *oscillans*	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
– *pleuronectes* var. *pleuronectes*	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
– *pseudonordstedtii*	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
– *pyrum* var. *pyrum*	.	.	.	.	.	.	.	.	.	.	1	+	1	.	.
– *raciborskii*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
– *striatus*	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.

pond, especially at the edge, giving the water a specific earthy smell. Duckweed (*Lemna minor*), the only vascular plant, was present in August and October 1990 but covered only 1/5 of the water area.

Single samples were taken from the pond in 1988 and 1989 and only 10 taxa, mainly representatives of the genus *Euglena,* were observed. The majority of them were not present in the later samples.

Among 44 taxa recorded here (Table 1) 29 belonged to *Euglena,* with *E. viridis* fo. *viridis* being the most frequent and often abundant. *E. agilis* was present in small numbers. Abundant but only once present were: *E. clavata, E. geniculata* var. *terricola, E. mutabilis, E. sanguinea, E. stellata* fo. *stellata, Phacus caudatus* var. tenuis and also *E. geniculata* var. *geniculata* which formed a water bloom. Few representatives of *Trachelomonas* (4 taxa) were present; they were observed in the autumn and winter months. *Phacus* was more plentiful (8 taxa); the greatest diversity of taxa was observed in March, October, and November at low water temperature (3.2–6.5°C) and pH 7.4–8.0. Only *E. geniculata* var. *geniculata* formed water blooms at the highest temperature of 27°C and pH 7.6 in May in 1990. The other species from this site (see Table 1) occurred rarely and generally as single specimens.

The physico-chemical water parameters seem to be constant (Figs 336 & 337). The high level of eutrophication favoured the development of *Euglena* species.

Oscillatoria limosa forming mats on the bottom, or floating on the surface of the water as flocks in May and June, was frequently observed in the pond. *Cryptomonas ovata* Ehrenberg. was observed in September and *Chlamydomonas ehrenbergii* Gorosh. were noted in November. *Gymnodinium* sp. and numerous *Chlamydomonas ehrenbergii* were also noted in December. In January 1991 bacteria *Leptothrix sideropus* (Molisch) Benecke also developed. It seems that the occurrence of other algae (sometimes in abundance) did not disturb the development of the euglenophyte communities but the presence of duckweed especially in July and August, correlated with a decline in the numbers of *Euglena.* A fall in temperature and freezing of the shallowed pond seems to affect the number of euglenophytes in December 1990 and January 1991.

Jerzmanowice pond – The pond in Jerzmanowice (site 27) is situated near the bus stop Jerzmanowice III by the main road from Kraków to Olkusz. The pond is ca 12 m in diameter surrounded by a high dyke and without vascular plants. It has a muddy and sandy bottom and at the road-side it is covered with gravel brought during successive repairs to the road. The water in the pond is continually disturbed by feeding ducks coming from a nearby farm.

The first surveys were carried out in autumn 1985, January 1986, and April 1988. Taxonomic analyses then revealed only 11 taxa: 6 taxa of *Trachelomonas*, 4 of *Phacus,* and a single *Euglena*; four taxa, *Trachelomonas verrucosa* fo. *irregegularis, Phacus orbicularis* fo. *orbicularis, Ph. formosus* and *Ph. parvulus,* were not found in later annual observations.

The majority of the 63 taxa found (Table 2) were single specimens, in small numbers, and were present for short periods only. The representatives of genera, such as *Euglena,*

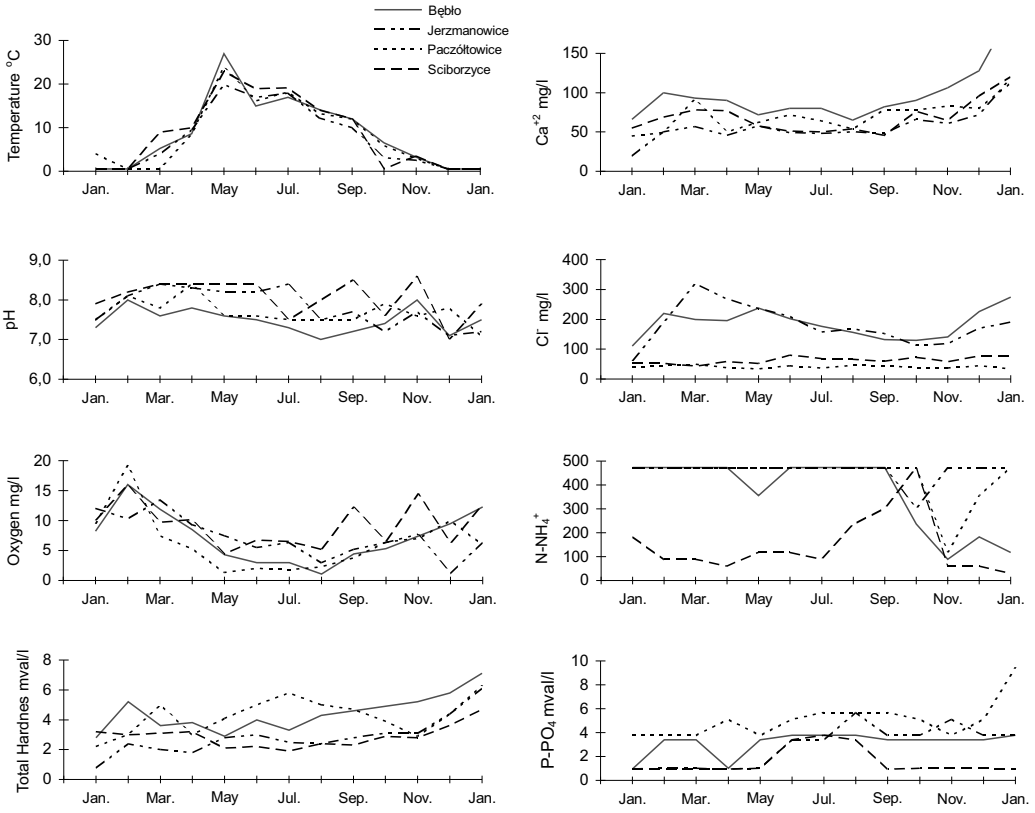


Fig. 336. Physico-chemical parameters in an annual cycle January 1990 – January 1991 in four village karstic ponds.

Trachelomonas, and *Phacus* were more plentiful. *Euglena agilis, Trachelomonas planctonica* fo. *planctonica*, *T. volvocina* var. *volvocina*, and *Phacus pyrum* var. *pyrum* were observed most often and in various numbers. *E. deses* fo. *deses, E. anabaena* var. *anabaena* and *Trachelomonas hispida* var. *hispida* were observed quite often but in small numbers. Some of the common species such as *E. viridis* fo. *viridis, Euglena texta* var. *texta, Trachelomonas volvocinopsis* fo. *volvocinopsis,* and *Phacus inflexus* appeared only once but in great numbers. In September 1990 at a 10°C water temperature and pH 7.7, *Euglena texta* var. *texta* formed a water bloom accompanied by the abundant presence of *Microcystis viridis* and *Scenedesmus* sp.

The greatest diversity of taxa was observed from January to March when the pond surface was covered by ice and the water temperature was below 5°C. During this period *Euglena agilis* was abundant, *E. viridis* fo. *viridis* was only present in January. In April and May when the water temperature was higher there was a marked drop in species quantity and diversity. The next abundant appearance of euglenophytes was from June to September and in December. Taxa of *Euglena* and *Phacus* developed in the winter-spring

Table 2. JERZMANOWICE POND: occurrence of euglenophyte taxa and physico-chemical properties of water from 1988 to 1991. For key see Table 1.

Date	1985	1986	1988	1990												1991
	10.02	01.22	04.12	01.17	02.14	03.14	04.11	05.09	06.12	07.11	08.22	09.19	10.24	11.20	12.19	01.22
Temperature ^{o}C	.	.	.	0.5	0.5	4.0	9.5	19.9	17.0	17.9	12.2	10.0	3.1	2.5	0.5	0.5
pH	.	.	.	7.5	8.1	8.4	8.3	8.2	8.2	8.4	7.5	7.7	7.2	7.7	7.1	7.2
Oxygen mg/l	.	.	.	12.0	10.3	13.5	9.3	7.5	5.5	6.3	3.0	5.2	6.3	7.7	1.2	6.3
Carbonate hardness mVal	.	.	.	0.8	2.4	2.0	1.8	2.8	3.0	2.5	2.4	2.8	3.1	3.1	4.4	6.1
Total hardness mVal	.	.	.	1.2	3.0	2.8	2.4	3.2	3.0	2.5	2.4	3.0	3.9	4.1	4.6	6.2
Calcium Ca mVal	.	.	.	20.0	50.0	57.0	46.0	58.0	49.0	48.0	50.0	48.0	66.0	61.0	72.0	118.0
Chloride Cl mg/l	.	.	.	60.0	190.0	320.0	268.0	236.0	210.0	157.0	168.0	152.0	113.0	118.0	170.0	190.0
N-NH_4 mg/l	.	.	.	473.2	473.2	473.2	473.2	473.2	473.2	473.2	473.2	473.2	301.0	473.2	473.2	473.2
P-PO_4 µg/g	.	.	.	0.9	1.0	1.0	0.9	1.0	3.4	3.4	5.7	5.7	3.8	5.1	3.8	3.8
Euglena acus var. *acus*	.	.	.	.	.	.	.	+	+	2	+	2	.	.	.	.
– *agilis*	.	.	.	+	3	3	2	+	.	.	.	+	+	.	3	.
– *anabaena* var. *anabaena*	.	.	.	+	+	+	.	.	.	.	.	+	.	.	+	.
– *caudata* var. *caudata*	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
– *deses* fo. *deses*	.	.	.	2	+	.	.	.	.	+	+	+	.	.	+	.
– – fo. *intermedia*	.	.	.	.	.	+	.	.	.	.	+	.	+	.	.	.
– – fo. *klebsii*	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.
– *ehrenbergii*	.	.	.	.	+	.	.	.	.	+	+	2	.	.	.	.
– *geniculata* var. *geniculata*	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
– *gracilis* fo. *gracilis*	.	.	.	2	.	.	.	.	.	.	.	1	.	.	.	.
– *granulata*	.	.	.	+	.	1	.	.	.	.	.	.	.	.	.	.
– *hemichromata*	.	.	.	.	+	+	.	.	.	.	+	.	+	.	.	.
– *hirudo*	.	.	.	.	+	.	+	.	2	+	.	.	.	.	.	.
– *minima*	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
– *oxyuris* fo. *oxyuris*	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.
– *spirogyra* var. *spirogyra*	1	.	.	.	.	.	.	.	.	.	.	3	.	.	+	.
– *texta* var. *texta*	.	.	.	.	.	.	.	.	.	.	1	4	+	.	+	.
– *tripteris* var. *tripteris*	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
– – var. *maior*	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.

– *tristella*	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
– *viridis* fo. *viridis*	.	.	.	3	+	+	.	.	.	.	.	.	.	.	+	.
Strombomonas acuminata	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Trachelomonas botanica var. *borealis*	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
– *globularis* fo. *crenulatocollis*	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
– *hispida* var. *hispida*	.	.	.	.	.	+	.	+	.	.	.	1	+	.	.	+
– – var. *crenulatocollis*	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.
– – var. *spinulosa*	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Trachelomonas lomnickii	1	.	.	.	.	.	.	1	.	+	.	.	.	.	.	.
– *nexilis*	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
– *oblonga* var. *oblonga*	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
– *planctonica* fo. *planctonica*	.	.	1	+	+	.	.	+	.	+	1	1	2	1	+	+
– – fo. *oblonga*	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
– – fo. *ornata*	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.
– *scabra* var. *scabra*	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
– *similis* fo. *similis*	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
– *verrucosa* fo. *irregularis*	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
– *volvocina* var. *volvocina*	.	.	1	.	.	.	1	.	.	+	2	1	+	+	2	2
– – var. *subglobosa*	.	1	1	.	+	.	.	.	.	.	.	.	.	.	.	.
– *volvocinopsis* fo. *volvocilopsis*	.	2	2	3	.	.	.	.	.	.	.	.	.	.	.	1
Colacium vesiculosum fo. *cyclopicola*	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Lepocinclis ovum var. *ovum*	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.
Phacus acuminatus var. *acuminatus*	.	.	.	+	.	+	.	.	.	+	.	.	.	.	+	.
– *caudatus* var. *caudatus*	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
– – var. *tenuis*	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
– *circumflexus*	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
– *formosus*	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
– *hamelii*	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
– *helicoides*	.	.	.	.	.	.	.	.	+	.	+	+	.	.	+	.
– *inflexus*	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.
– *longicauda* var. *longicauda*	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
– *megalopsis*	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.

(cont.)

Table 2. Continued.

Date	1985	1986	1988	1990												1991
	10.02	01.22	04.12	01.17	02.14	03.14	04.11	05.09	06.12	07.11	08.22	09.19	10.24	11.20	12.19	01.22
Phacus orbicularis fo. *orbicularis*	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *parvulus*	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *pleuronectes* var. *pleuronectes*	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
– *pseudonordstedtii*	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
– *pulcherrimus*	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
– *pyrum* var. *pyrum*	2	.	.	2	+	.	.	.	1	1	1	.	+	+	+	.
– *skujae*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
– *splendens*	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
– *stokesii*	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
– *striatus*	.	.	.	.	.	.	+	.	+	+	.	.	.	.	.	.
– *triqueter*	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Pseudoperanema macromastix	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.

period and in autumn, whereas in summer the greatest variety of *Trachelomonas* could be observed.

The euglenophyte communities existed on a fairly balanced level during 8 months, differing only in the existing taxa. The pond water was alkaline with rich limestone compounds, a high level of nitrates and phosphates, and was eutrophic.

Together with the observed euglenophytes, other algae, most frequent and numerous, were: *Gymnoidinium viride* Penard, *Anabaena spiroides* Kleban, *Chlorogonium minimum* Playfair, and *Scenedesmus* sp., *Microcystis viridis* and *Anabaena spiroides* were abundant in June 1990 and *Scenedesmus* sp., *Chlamydomonas ehrenbergii, Cryptomonas ovata,* and *Chlorogonium minimum* were abundant in January 1991.

Paczółtowice pond – The pond in Paczółtowice (site 41) is in the centre of the village; it is ca 7 m in diameter and fills the bottom of a large cavity with a steep drop of 5 m from the northern side and a gentle slope from the southeastern side. It has a gravel and sandy bottom and is about 1 m deep in the centre. No vascular plants existed in the pond. Its water serves for watering cattle and as a feeding ground for ducks and geese from nearby farms.

In October 1989 the pond was investigated for the first time and 16 taxa of euglenophytes mainly species of *Euglena* were observed. Half of them did not appear in later investigations (Table 3).

During annual observations 53 taxa of euglenophytes were observed. The most abundant and frequently appearing species was *Euglena agilis* which existed for 11 months forming marked water blooms in May and June and occurring abundantly from September to November. *E. texta* var. *texta* occurred less frequently but was abundant from July to October and in December 1991. Rarely noticed species such as *E. anabaena* var. *anabaena*, *E. archeoplastidiata*, *Trachelomonas scabra* var. *scabra*, and *T. volvocina* var. *volvocina* could be observed here in significant quantities.

Euglena agilis blooms occurred when the water temperature was highest, from 16 to 24°C, and pH 7.6, whereas *E. texta* var. *texta*, and *E. agilis* were both abundant in autumn when the water temperature was lowest, from 0.5 to 12.0°C, and pH 7.5 to 8.0 (Figs 3–5).

The greatest variety of euglenophyte taxa community was observed in February 1990 when the pond was covered by ice, and from September to December when the water temperature was quite low, oxygen level was average, and content of nitrate and phosphate concentration high.

From January to April besides euglenophyte communities, *Chlamydomonas ehrenbergii* occurred in masses. The development of *Cryptomonas ovata* from December to January 1991 correlated with the decrease in number of euglenophytes. The minimal number of them in December may have been caused by the ice which covered the surface of the pond (although ice on surface did not affect other ponds: sites 26, 27, 41 and 64). Rain falling in June, July, and August certainly caused a stirring up of the pond water which correlated with the decrease in the numbers of euglenophytes at this time.

Ściborzyce pond – The pond in Ściborzyce (site 64) the one furthest away from Kraków, is situated near a pig farm, in the past a horse stud, and abuts a cultivated field;

Table 3. PACZÓŁTOWICE POND: occurrence of euglenophyte taxa and physico-chemical properties of water from 1989 to 1991. For key see Table 1.

Date	1989	1990											1991
	02.10	01.17	02.14	03.14	04.11	05.09	06.12	07.11	08.22	09.19	10.24	11.20	12.19	01.22
Temperature ^{o}C	–	4.0	0.5	0.5	8.5	24.0	16.1	18.2	13.3	12.0	5.9	3.0	0.5	0.5
pH	–	7.5	8.1	7.8	8.4	7.6	7.6	7.5	7.5	7.5	7.9	7.6	7.8	7.1
Oxygen mg/l	–	9.4	19.3	7.5	5.3	1.3	2.0	1.8	2.3	3.8	6.4	7.0	10.0	6.0
Carbon hardness mVal	–	2.2	3.0	5.0	3.0	4.1	5.0	5.8	5.0	4.7	3.9	2.9	4.4	6.3
Total hardness mVal	–	2.8	3.0	5.6	3.1	4.1	5.0	5.8	5.0	4.7	4.8	4.6	5.0	6.4
Calcium Ca mVal	–	45.0	49.0	92.0	50.0	62.0	72.0	64.0	54.0	78.0	78.0	83.0	80.0	112.0
Chloride Cl mg/l	–	41.0	45.0	50.0	38.0	34.0	45.0	37.0	46.0	44.0	38.0	37.0	44.0	34.0
Amonia N-NH_4 mg/l	–	473.2	473.2	473.2	473.2	473.2	473.2	473.2	473.2	473.2	473.2	117.6	355.6	473.2
Phosphate P-PO_4 µg/g	–	3.8	3.8	3.8	5.1	3.8	5.1	5.7	5.7	5.7	5.1	3.8	3.8	9.4
Euglena agilis	+	.	+	+	1	4	4	+	.	3	3	3	3	1
– *anabaena* var. *anabaena*	+	.	.	.	.	+	+	.	.	+	1	3	+	.
– *archaeoplastidiata*	.	.	.	.	.	+	.	.	.	.	.	2	.	.
– *caudata* var. *caudata*	2	.	+	.	.	.	.	.	.	.	.	.	.	.
– *chlamydophora*	.	.	.	.	.	.	.	.	.	.	.	+	.	.
– *clara*	.	.	+	.	.	.	.	.	.	.	.	+	+	.
– *deses* fo. *deses*	.	.	.	.	.	+	.	.	+	+	.	+	.	.
– – fo. *intermedia*	.	.	+	.	.	.	.	.	.	.	.	.	.	.
– *ehrenbergii*	.	.	.	.	.	.	.	1	+	2	.	.	.	.
– *geniculata* var. *geniculata*	.	.	.	.	.	.	+	.	.	.	.	.	.	.
– *gracilis* fo. *gracilis*	2	.	+	.	.	.	.	.	.	.	.	.	.	.
– *granulata*	+	.	.	.	.	.	.	.	.	.	.	.	.	.
– *hemichromata*	2	.	.	.	.	.	.	.	.	1	1	.	.	.
– *oxyuris* fo. *oxyuris*	1	.	.	.	.	.	.	.	.	.	.	.	.	.
– *polymorpha*	.	.	.	+	.	.	.	.	.	.	.	.	.	.
– *proxima*	+	.	+	.	.	.	.	.	.	1	.	.	.	.
– *spirogyra* var. *spirogyra*	.	.	.	+	.	+	.	+	.	.	.	.	.	.
– *texta* var. *texta*	.	.	.	.	.	1	.	3	3	3	3	+	2	3
– *tripteris* var. *tripteris*	.	.	.	+	.	.	.	.	.	+	.	.	.	.

– *truncata*	.	.	.	.	.	.	.	2	.	.	.	.	1	.
– *viridis* fo. *viridis*	.	.	+	.	.	.	.	.	.	.	.	+	+	.
Strombomonas planctonica	2	.	.	.	.	.	.	.	.	.	.	.	.	.
Trachelomonas botanica var. *borealis*	.	.	+	.	.	.	.	.	.	.	.	.	.	.
– *drežepolskiana*	.	.	.	.	.	+	.	.	.	2	2	.	.	.
– *globularis* fo. *crenulatocollis*	1	.	.	.	.	.	.	.	.	.	.	.	.	.
– *guttata*	.	.	+	.	.	.	.	.	.	.	.	.	.	.
– *hirta* var. *duplex*	.	.	+	.	.	.	.	.	.	.	.	.	.	.
– *hispida* var. *hispida*	.	.	+	.	+	.	.	.	+	.	.	.	.	.
– – var. *crenulatocollis*	+	.	+	.	.	.	.	.	.	.	.	.	.	.
– – var. *granulata*	.	.	.	.	.	.	+	.	.	.	+	.	.	.
– – var. *spinulosa*	.	.	+	.	.	.	.	.	.	.	.	.	.	.
– *janczewskii* var. *janczewskii*	+	.	1	.	.	.	.	.	.	.	.	.	.	.
– *lacustris* var. *klebsii*	.	.	.	.	+	+	.	.	.	.	+	.	.	.
– *manginii* var. *subpunctata*	+	.	.	.	.	.	.	.	.	.	.	.	.	.
– *oblonga* var. *oblonga*	1	.	.	.	.	.	.	.	.	.	.	.	.	.
– *planctonica* fo. *planctonica*	.	.	1	.	+	.	.	.	.	.	.	.	+	.
– *raciborskii* var. *incerta*	.	.	.	.	.	.	.	.	.	.	+	.	.	.
– *robusta*	.	.	.	.	.	.	.	.	.	.	1	.	.	.
– *rugulosa*	.	.	.	.	.	.	.	.	.	.	1	.	.	.
– *scabra* var. *scabra*	.	.	3	.	.	.	.	.	.	.	.	.	.	.
– *volvocina* var. *volvocina*	.	.	.	.	3	+	.	.	.	+	+	.	+	+
– – var. *derephora*	.	.	.	.	.	.	.	.	.	.	.	+	.	+
– – var. *subglobosa*	.	+	.	.	.	.	.	.	.	.	.	.	.	.
– *volvocinopsis* fo. *volvocinopsis*	.	.	+	.	.	.	.	.	.	1	.	.	.	.
– *woycickii*	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Ascoglena viridis	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Lepocinclis ovum var. *ovum*	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Phacus acuminatus var. *acuminatus*	.	.	+	+	.	.	.	.	.	.	.	1	1	+
– *alatus* var. *alatus*	.	.	.	.	.	.	.	.	+	.	.	.	.	.
– *circulatus*	.	.	.	.	.	.	.	.	.	+	.	.	.	.
– *contortus*	.	.	.	.	.	.	.	.	+	.	.	.	.	.

(cont.)

Table 3. Continued.

Date	1989	1990												1991
	02.10	01.17	02.14	03.14	04.11	05.09	06.12	07.11	08.22	09.19	10.24	11.20	12.19	01.22
Phacus dangeardii	.	.	+	.	.	.	.	.	.	.	.	.	.	.
– *hamelii*	.	.	.	.	.	.	.	.	.	.	+	.	.	.
– *inflexus*	.	.	2	2	.	.	.	.	.	.	.	.	.	.
– *oscillans*	.	.	1	.	.	.	.	.	.	.	.	.	.	.
– *orbicularis* fo. *orbicularis*	.	.	.	.	.	+	.	+	.	.	.	.	.	.
– *parvulus*	1	.	.	.	.	.	.	.	.	.	.	.	.	.
– *pleuronectes* var. *pleuronectes*	.	.	+	.	.	.	.	+	.	.	.	1	.	.
– *pyrum* var. *pyrum*	.	.	+	.	.	.	.	.	.	.	+	.	.	.
– *undulatus* var. *undulatus*	.	.	+	.	.	.	.	.	.	.	.	.	.	.
– *unguis*	.	.	.	1	.	.	.	.	.	.	+	.	.	.

a 4 m wide dyke separates it from the next pond. Its waters come from the spring of the River Dłubnia. The bottom of the pond is slimy.

A preliminary investigation carried out in November 1989 revealed 13 taxa among which 9 were not noted in later observations.

Annual observations showed 50 taxa (Table 4). The *Euglena* taxa appeared in small numbers or singly. Most frequent and abundant were *Trachelomonas volvocina* var. *volvocina*, *T. planctonica* fo. *planctonica* and *Phacus pyrum* var. *pyrum*. *Euglena sanguinea* and *Trachelomonas volvocina* var. *coronata* occurred only once but in abundance. *Euglena* and *Trachelomonas* taxa were most plentiful in spring and autumn, but *Phacus* in summer and autumn.

The rains in August probably affected the number of euglenophyte specimens. The great numbers of other algal species such as *Oscillatoria limosa*, *Anabaena spiroides, Microcystis viridis*, *Pediastrum boryanum* (Turp.) Menegh var. *perforatum* (Racib.) Nit., *Asterionella formosa,* or *Cryptomonas ovata*, and *Scenedesmus* sp., appearing in March, April, June, July, September and December did not significantly affect euglenophyte numbers. In general they were most numerous in April at pH 8.4 and temperature 10°C and in October when the pond was covered by 2 cm thick ice with pH 7.6 and a water temperature of 0.5°C (Figs 3–5).

Comparison of the four selected ponds

Altogether 136 taxa of euglenophytes were observed in the ponds which were investigated annually (Table 5). The most abundant species were *Trachelomonas* (47 taxa), *Euglena* (45), and *Phacus* (37), whereas *Strombomonas* (2) *Lepocinclis* (2), *Ascoglena* and *Colacium* (1 taxon) were occasionally observed. It is surprising that among the colourless euglenophytes *Distigma proteus* and *Pseudoperanema macromastix* appeared only twice.

Among the most abundant and frequently noted representatives of euglenophytes, in the four investigated ponds there were only 10 mutual taxa: *Euglena anabaena* var. *anabaena*, *E. caudata* var. *caudata*, *E. hemichromata*, *E. agilis*, *E. viridis* fo. *viridis*, *Trachelomonas volvocina* var. *volvocina*. *T. volvocinopsis* fo. *volvocinopsis*, *Lepocinclis ovum* var. *ovum*, *Phacus pleuronectes* var. *pleuronectes,* and *Ph. pyrum* var. *pyrum*.

Physico-chemical parameters in the investigated ponds (Figs 336 & 337) were generally similar. The amount of chlorine ions was significantly greater in Bębło (site 26) and Jerzmanowice (site 27) in which numerous representatives of *Euglena* and *Phacus* were seen. The chlorine ions may have come here in farm sewage, or in Jerzmanowice their appearance may be due to the addition of rock salt to winter roads. In Paczółtowice (site 41) and Ściborzyce (site 64), on the other hand, the level of chlorine ions was much less and remained steady during the whole year. *Trachelomonas* were more diversified in these latter two ponds.

Very high levels of $N\text{-}NH_4$ and $P\text{-}PO_4$ were noted, in all these ponds throughout the year, only in Ściborzyce were the levels lower. The concentration of these compounds was probably connected with sewage contamination and the inflow rain water carring fertilizers out of the cultivated fields.

Table 4. ŚCIBORZYCE POND: occurrence of euglenophyte taxa and physico-chemical properties of water from 1989 to 1991. For key see Table 1.

Date	1989	1990												1991
	11.08	01.17	02.14	03.14	04.11	05.09	06.12	07.11	08.22	09.19	10.24	11.20	12.19	01.22
Temperature ^{o}C	.	0.5	0.5	9.0	10.0	23.0	19.0	19.1	14.0	12.1	0.5	3.5	0.5	0.5
pH	.	7.9	8.2	8.4	8.4	8.4	8.4	7.5	8.0	8.5	7.6	8.5	7.0	7.9
Oxygen mg/l	.	10.0	16.0	9.7	10.2	4.4	6.7	6.5	5.2	12.3	6.5	14.5	6.2	12.7
Carbonate-hardness mVal	.	3.2	3.0	3.1	3.2	2.1	2.2	1.9	2.4	2.3	2.9	2.8	3.6	4.7
Total-hardness mVal	.	3.2	3.6	3.6	3.8	3.2	2.4	2.6	3.1	2.8	3.9	3.8	5.0	6.0
Calcium Ca mVal	.	55.0	69.0	78.0	77.0	58.0	51.0	50.0	54.0	46.0	76.0	65.0	96.0	120.0
Chloride mg/l	.	52.0	52.0	43.0	58.0	52.0	80.0	69.0	66.0	60.0	72.0	58.0	78.0	76.0
Amonia N-NH_4 mg/l	.	182.0	88.2	88.2	60.2	117.6	117.6	88.2	236.6	301.0	473.2	60.2	60.2	29.4
Phosphate P-PO_4 µg/g	.	0.9	0.9	0.9	0.9	1.0	3.4	3.8	3.4	0.9	1.0	1.0	1.0	0.9
Euglena adhaerens	.	.	.	.	.	.	.	.	.	.	.	.	+	.
– *agilis*	.	.	1	.	.	.	.	.	.	.	.	+	.	2
– *anabaena* var. *anabaena*	.	.	.	.	.	.	.	.	.	+	+	+	+	.
– *caudata* var. *caudata*	.	.	.	1	.	.	.	.	.	.	.	.	.	+
– *gracilis* fo. *hiemalis*	2	.	.	.	.	.	.	.	.	.	.	.	.	.
– *hemichromata*	.	.	.	+	.	+	.	.	.	.	+	.	.	1
– *obtusa*	1	.	.	.	.	.	.	.	.	.	.	.	.	.
– *oxyuris* fo. *oxyuris*	.	.	.	.	.	.	+	.	.	.	.	.	.	.
– *pavlovskoënsis*	.	.	.	.	.	.	+	.	.	.	.	.	.	.
– *sanguinea*	+	.	.	.	.	3	.	.	.	.	.	.	.	.
– *spirogyra* var. *spirogyra*	.	.	.	.	.	.	.	+	.	1	+	.	.	.
– *texta* var. *texta*	2	.	.	.	2	.	.	.	.	.	.	.	.	.
– *tripteris* var. *tripteris*	1	.	.	.	.	.	.	.	.	.	.	.	.	.
– *viridis* fo. *viridis*	.	.	.	+	.	.	.	1	.	.	.	+	.	.
Trachelomonas acanthostoma	1	.	.	.	.	.	.	.	.	.	.	.	.	.
– *allia*	.	.	.	.	+	.	.	.	.	.	.	.	.	.
– *bacillifera* var. *minima*	+	.	.	.	.	.	.	.	.	.	.	.	.	.
– *botanica* var. *borealis*	.	.	.	.	.	.	.	.	.	+	+	.	.	.
– *compacta*	.	.	.	.	.	2	.	.	.	.	.	.	.	.
– *curta* fo. *curta*	.	.	.	.	.	.	.	.	.	.	+	.	.	.
– *eurystoma* var. *producta*	.	.	.	.	+	.	.	.	.	.	.	.	.	.
– *intermedia* fo. *crenulatocollis*	.	.	+	.	+	.	.	.	.	.	.	.	.	.
– *mirabilis* var. *minor*	.	.	.	.	.	+	.	.	.	.	.	.	.	.

– *oblonga* var. *oblonga*	.	.	.	.	.	.	.	.	.	.	+	+	+	.
– – var. *pulcherrima*	.	.	.	.	.	.	.	.	.	.	.	1	.	.
– *pavlovskoënsis* var. *pavlovskoënsis*	.	.	.	.	1	.	.	.	.	.	.	.	.	.
– *planctonica* fo. *planctonica*	.	2	.	.	2	+	1	.	.	.	+	.	.	+
– – fo. *ornata*	.	.	.	.	.	.	+	.	.	.	.	.	+	.
– *poltavica*	.	.	.	.	.	.	.	.	.	.	+	.	.	.
– *reinhardii*	.	.	.	.	.	.	.	.	.	.	.	.	+	.
– *similis*	.	.	+	.	.	.	.	.	.	+	.	.	.	+
– *similis* var. *spinosa*	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *stokesiana* fo. *torquata*	.	.	.	.	.	.	+	.	.	+	.	.	.	.
– *superba*	.	.	.	.	+	.	.	.	.	.	.	.	.	.
– *volvocina* var. *volvocina*	.	+	.	.	+	+	+	.	1	2	+	+	+	.
– – var. *coronata*	.	.	.	.	.	.	.	.	.	3	.	.	.	.
– – var. *derephora*	.	.	.	+	+	.	.	.	.	.	.	.	.	.
– *volvocinopsis* fo. *volvocinopsis*	1	+	.	.	.	.	.	.	.	.	+	1	.	.
– *woycickii*	+	.	.	.	.	.	.	.	.	.	.	.	.	+
Colacium vesiculosum fo. *cyclopicola*	.	.	.	.	.	.	.	.	.	.	.	1	.	.
Lepocinclis ovum var. *ovum*	.	.	.	.	.	.	.	.	.	.	1	.	.	.
Phacus acuminatus var. *acuminatus*	.	.	.	.	.	.	.	.	.	.	+	.	.	.
– *agilis*	.	.	.	.	.	.	+	.	.	.	.	.	.	.
– *caudatus* var. *caudatus*	1	.	.	.	.	.	.	.	.	.	.	.	.	.
– – var. *tenuis*	1	.	.	.	.	.	.	.	.	.	.	.	.	.
– *corculum*	.	.	.	.	.	.	.	+	.	.	.	.	.	.
– *costatus*	.	.	.	.	.	.	.	+	.	.	2	.	+	.
– *hamatus*	.	.	+	.	.	.	.	.	.	.	+	.	.	.
– *hamelii*	.	.	.	+	.	.	.	.	.	.	.	.	.	.
– *helicoides*	.	.	.	.	.	.	.	1	.	.	.	.	.	.
– *longicauda* var. *longicauda*	.	.	.	.	.	.	.	.	1	.	.	.	.	.
– *mirabilis*	.	.	.	.	.	.	.	+	.	.	.	.	.	.
– *orbicularis* fo. *cingeri*	.	.	+	.	.	.	.	.	.	.	.	.	.	.
– *pleuronectes* var. *pleuronectes*	2	.	.	.	.	.	.	.	.	.	.	.	.	.
– *pyrum* var. *pyrum*	.	.	.	.	+	1	.	+	+	2	2	+	+	.
– *strongylus*	.	.	.	.	.	.	.	.	.	.	+	.	.	.
– *triqueter*	.	1	.	.	.	.	.	.	.	.	.	.	.	.
– *trypanon*	.	.	.	+	.	.	.	.	.	.	.	.	.	.

Table 5. Comparison of euglenophyte taxa occurring (+) in four selected village ponds.

Taxa	Selected village ponds			
	Bębło	Jerzmanowice	Paczółtowice	Ściborzyce
Distigma proteus	+	.	.	.
Euglena acus var. *acus*	.	+	.	.
– *adherens*	.	.	.	+
– *agilis*	+	+	+	+
– *anabaena* var. *anabaena*	+	+	+	+
– *archaeoplastidiata*	.	.	+	.
– *caudata* var. *caudata*	+	+	+	+
– *chadefaudii*	+	.	.	.
– *chlamydophora*	+	.	+	.
– *clara*	.	.	+	.
– *clavata*	+	.	.	.
– *deses* fo. *deses*	+	+	+	.
– – fo. *intermedia*	+	+	+	.
– – fo. *klebsii*	.	+	.	.
– *ehrenbergii*	+	+	+	.
– *ettlii*	+	.	.	.
– *geniculata* var. *geniculata*	+	+	+	.
– – var. *terricola*	+	.	.	.
– *gracilis* fo. *gracilis*	.	+	+	.
– – fo. *hiemalis*	.	.	.	+
– *granulata*	.	+	+	.
– *hemichromata*	+	+	+	+
– *hirudo*	+	+	.	.
– *limnophila* var. *limnophila*	+	.	.	.
– – var. *swirenkoi*	+	.	.	.
– *minima*	+	+	.	.
– *mutabilis*	+	.	.	.
– *oblonga*	+	.	.	.
– *obtusa*	.	.	.	+
– *oxyuris* fo. *oxyuris*	.	+	+	+
– – fo. *maior*	+	.	.	.
– *pavlovskoënsis*	.	.	.	+
– *polymorpha*	+	.	+	.
– *proxima*	+	.	+	.
– *rustica* var. *rustica*	+	.	.	.
– *sanguinea*	+	.	.	+
– *sima*	+	.	.	.
– *spirogyra* var.*spirogyra*	.	+	+	+
– *splendens*	+	.	.	.

Table 5. Continued.

Taxa	Selected village ponds			
	Bębło	Jerzmanowice	Paczółtowice	Ściborzyce
– *stellata* fo. *stellata*	+	.	.	.
– *texta* var. *texta*	.	+	+	+
– *tripteris* var. *tripteris*	.	+	+	+
– – var. *maior*	.	+	.	.
– *tristella*	+	+	.	.
– *truncata*	.	.	+	.
– *viridis* fo. *viridis*	+	+	+	+
Strombomonas acuminata	.	+	.	.
– *planctonica*	.	.	+	.
Trachelomonas acanthostoma	.	.	.	+
– *allia*	.	.	.	+
– *bacillifera* var. *minima*	.	.	.	+
– *botanica* var. *borealis*	.	+	+	+
– *compacta*	.	.	.	+
– *curta* fo. *curta*	.	.	.	+
– *drežepolskiana*	.	.	+	.
– *eurystoma* var. *producta*	.	.	.	+
– *globularis* fo. *crenulatocollis*	.	+	+	.
– *guttata*	.	.	+	.
– *hirta* var. *duplex*	.	.	+	.
– *hispida* var. *hispida*	+	+	+	.
– – var. *crenulatocollis*	.	+	+	.
– – var. *granulata*	.	.	+	.
– – var. *spinulosa*	.	+	+	.
– *intermedia* fo. *crenulatocollis*	.	.	.	+
– *janczewskii* var. *janczewskii*	.	.	+	.
– *lacustris* var. *klebsii*	.	.	+	.
– *lomnickii*	.	+	.	.
– *manginii*	.	.	+	.
– *mirabilis*	.	.	.	+
– *nexilis*	.	+	.	.
– *oblonga* var. *oblonga*	.	+	+	+
– – var *pulcherrima*	.	.	.	+
– *pavlovskoënsis* fo. *pavlovskoënsis*	.	.	.	+
– *planctonica* fo. *planctonica*	.	+	+	+
– – fo. *oblonga*	.	+	.	.
– – fo. *ornata*	.	+	.	+
– *polonica*	.	.	.	+
– *raciborskii* var. *incerta*	.	.	+	.

(cont.)

Table 5. Continued.

Taxa	Selected village ponds			
	Bębło	Jerzmanowice	Paczółtowice	Ściborzyce
Trachelomonas reinhardii	.	.	.	+
– *robusta*	.	.	+	.
– *rugulosa*	.	.	+	.
– *sarmatica*	+	.	.	.
– *scabra* var. *scabra*	.	+	+	.
– *similis* fo. *similis*	.	+	.	+
– – var. *spinosa*	.	.	.	+
– *stokesiana* fo. *torquata*	.	.	.	+
– *superba*	.	.	.	+
– *verrucosa* fo. *irregularis*	.	+	.	.
– *volvocina* var. *volvocina*	+	+	+	+
– – var. *coronata*	.	.	.	+
– – var. *derephora*	.	.	+	+
– – var. *subglobosa*	.	+	+	.
– *volvocinopsis* fo. *volvocinopsis*	+	+	+	+
– *woycickii*	.	.	+	+
Ascoglena viridis	.	.	+	.
Colacium vesiculosum fo. *cyclopicola*	.	+	.	+
Lepocinclis ovum var. *ovum*	+	+	+	+
– *steinii*	+	.	.	.
Phacus acuminatus var. *acuminatus*	.	+	+	+
– *agilis*	.	.	.	+
– *alatus* var. *alatus*	.	.	+	.
– *caudatus* var. *caudatus*	+	+	.	+
– – var. *tenuis*	+	+	.	+
– *circulatus*	.	.	+	.
– *circumflexus*	.	+	.	.
– *contortus*	.	+	+	.
– *corculum*	.	.	.	+
– *costatus*	.	.	.	+
– *dangeardii*	.	.	+	.
– *formosus*	.	+	.	.
– *hamatus*	.	.	.	+
– *hamelii*	.	+	+	+
– *helicoides*	.	+	.	+
– *inflexus*	.	+	+	.
– *longicauda* var. *longicauda*	.	+	.	+
– *megalopsis*	.	+	.	.
– *mirabilis*	.	.	.	+

Table 5. Continued.

Taxa	Selected village ponds			
	Bębło	Jerzmanowice	Paczółtowice	Ściborzyce
– *orbicularis* fo. *orbicularis*	.	+	+	.
– – *fo. cingeri*	.	.	.	+
– *oscillans*	+	.	+	.
– *parvulus*	.	+	+	.
– *pleuronectes* var. *pleuronectes*	+	+	+	+
– *pseudonordstedtii*	+	+	.	.
– *pulcherrimus*	.	+	.	.
– *pyrum* var. *pyrum*	+	+	+	+
– *raciborskii*	+	.	.	.
– *skujae*	.	+	.	.
– *splendens*	.	+	.	.
– *stokesii*	.	+	.	.
– *striatus*	+	+	.	.
– *strongylus*	.	.	.	+
– *triqueter*	.	+	.	+
– *trypanon*	.	.	.	+
– *undulatus* var. *undulatus*	.	.	+	.
– *unguis*	.	.	+	.
Pseudoperanema macromastix	.	+	.	.

High and variable levels of water hardness were observed in Bębło and Paczółtowice and oxygen content in summer and autumn was low there.

Despite the small differences in physico-chemical water parameters the communities of existing euglenophytes differed greatly. In Bębło (site 26) *Euglena* species developed splendidly, especially in spring and summer, while *Trachelomonas* and *Phacus* played a minimal part in autumn and winter. In Jerzmanowice (site 27) the number of representatives of particular taxa was balanced: *Euglena* developed in early spring and summer, *Trachelomonas* was abundant in July and October and *Phacus* in June. In Paczółtowice (site 41) the number of observed taxa of *Euglena* and *Trachelomonas* was similar but that of representatives of *Phacus* was smaller and developed most abundantly in early spring and autumn. The Ściborzyce pond (site 64) was dominated by representatives of *Trachelomonas* species which were abundant in spring and autumn when *Euglena* spp, were also important whereas *Phacus* developed well in summer and autumn.

There is no doubt that the most frequently observed euglenophyte communities (Fig. 337) developed well at fairly low temperatures and sometimes under the ice from February to April and in autumn from September to October and in December. Greater variety was observed only in the Jerzmanowice pond from July to September.

The development of euglenophyte communities in these ponds appears rather acciden-

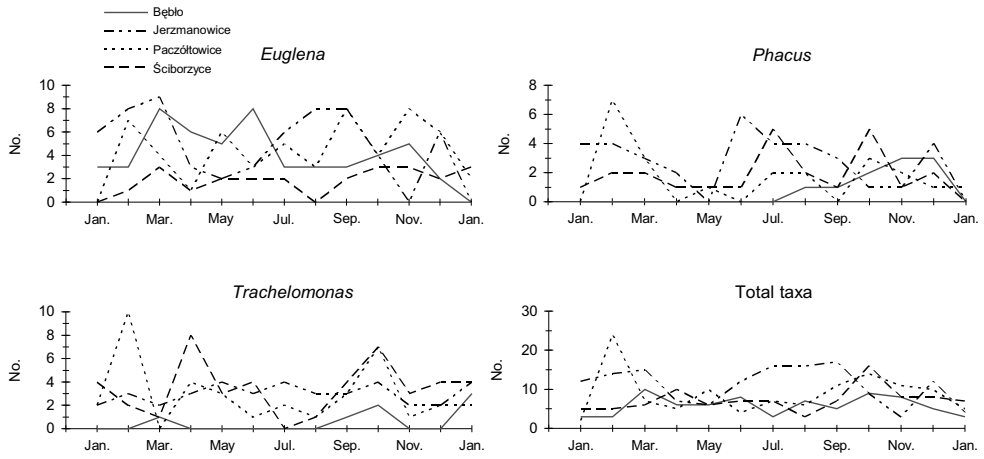


Fig. 337. Number of euglenophyte taxa in the annual cycle in four village karstic ponds.

tal. Constant stirring of the water by water birds, shallowness of the ponds allowing mixing of surface water layers, greater rolling of water by the bank, and the great mobility of euglenophytes are apparently the main causes of their changing frequency. Rainfall in July and August also appeared to affect their occurrence.

It seems unlikely that the abundant development of other algae mentioned before affected the development of the existing euglenophytes.

In all probability, the high pollution level of water bodies by nitrates and phosphates and high level of aquatic oxygen might affect the development of euglenophyte communities, but the relationship between the water physico-chemical properties and the numbers of occurring euglenophytes was not clearly observed.

Other village ponds

29 other karstic village ponds were observed occasionally (1–3 samples) only pH and water temperature being measured there. Euglenophytes were observed neither in plankton nor in mud in 9 of the ponds but 95 taxa of euglenophytes were found in 20 ponds (Table 6). In general, the taxonomic composition of the communities in the 20 ponds resembled those from Bębło, Jerzmanowice, Paczółtowice, and Ściborzyce, but 6 more taxa of colourless euglenophytes were spotted.

On average, in each sample 1–17 taxa were found. The greatest number of taxa observed were *Euglena* (34), *Phacus* (27) and *Trachelomonas* (16). Most frequent and abundant in the investigated ponds were *Euglena viridis* fo. *viridis, E. geniculata* var. *geniculata*, *E. agilis*, *Trachelomonas volvocina* var. *volvocina* and *Phacus pyrum* var. *pyrum*. Taxa such as *E. acus* var. *acus, E. deses* fo. *deses* and fo. *intermedia*, *E. anabaena* var. *anabaena*, *E. limnophila* var. *swirenkoi*, *E. sanguinea, E. texta* var. *texta, Trachelomonas scabra* var. *scabra*, and *Lepocinclis ovum* var. *ovum* were found rarely but when present were plentiful.

A great number of *Euglena* species (11) was observed in plankton in the pond in Modlnica (site 9), at a water temperature of 6.8°C and pH 7.5, whereas in samples taken from the same pond in January 1989 at a temperature of 0.5°C, *E. oxyuris* fo. *maior* which did not occur earlier was found under the ice. There was a similar situation in the pond at Smardzowice (site 53) in which 9 taxa of *Euglena* were found in September 1989 at pH 8.4 and a temperature of 16.6°C, whereas two taxa, including *E. spirogyra* var. *spirogyra* which had not been found earlier, were found in December 1990 at pH 8.2 and a temperature of 6.6°C. The species belonging to the *Rygidae* group might be more resistant to low water temperature. In some investigated ponds there were no representatives of *Euglena,* although the temperature and pH of the ponds were similar to those where many species of *Euglena* were present.

27 taxa within genus *Phacus* were found, *Ph. pyrum* var. *pyrum* being the most frequently encountered. This species was abundant in the pond in Bętkowice (site 23), and in Ściborzyce (site 65) where it formed a water bloom on the surface film in 1986 at pH 7.0 and a temperature of 15.5°C. Quite a number of *Ph. acuminatus* var. *acuminatus* were present in two of the investigated ponds (sites 22 and 65). The remaining taxa were found in single sites in small quantities, often in mud. As with *Euglena,* in many ponds taxa of *Phacus* were not present.

16 taxa from the genus *Trachelomonas* were found in 12 out of the 20 ponds investigated. Only *T. volvocina* var. *volvocina* occurrenced in more than one pond: it was found at four sites, in abundance in plankton at quite low temperatures and in the alkaline waters of the ponds in Żelków (site 12) and Łazy (site 22). *T. scabra* var. *scabra* was also abundant in the pond at Żelków. The most taxonomic diversity within this genus was found here where no taxa of *Euglena* were found.

Taking into consideration the great number of investigated ponds, only a small number of colourless euglenophytes were found – usually represented by a few specimens of *Khawkinea quartana*, *Hyalophacus ocellatus,* and *Pseudoperanema macromastix*; a few *Menoidium* taxa were observed at one site.

The shallow pond in Modlnica overgrown with *Typha latifolia*, had the greatest diversity of species (17 taxa) among the 20 investigated ponds: *Euglena* (12 taxa), *Phacus* (4) and *Trachelomonas* (1) were present in April 1988 at pH 7.5 and a temperature of 6.8°C. In the pond in Strzegowa (site 70) at pH 7.5 and a temperature of 15.0°C there were 8 taxa of *Phacus*, 4 of *Euglena*, and 2 of *Lepocinclis*.

The pond in Żelków (site 12), surrounded by a high dyke and without aquatic vascular plants, was of a different character. At pH 7.1 and a water temperature of 6.0°C only 12 taxa of *Trachelomonas* were observed, accompanied by water blooms of *Microcystis viridis*.

In the investigated ponds with alkaline water the greatest diversity of taxa was observed in Modlnica (site 9), Żelków (site 12), Będkowice (site 23), Strzegowa (site 70), and Smardzowice (site 53). There were however ponds: in Pisary (site 14), Cianowice Duże (site 54), and Gotkowice (site 59) in which small numbers of euglenophytes were found (see Table 6).

There were only three ponds with acidic water. The greatest number of euglenophyte

Table 6. Occurrence of euglenophyte taxa in unselected village ponds. For key see Table 1.

Site no.	8	9		12	13	14		22	23	25			28			52	53		54	59	60	63	65	68	70	73	77
Date	1986 09.09	1988 04.12	1989 01.14	1987 12.19	1988 08.16	1988 04.19	1988 08.16	1988 04.12	1988 04.12	1988 04.12	1989 01.14	1989 03.21	1985 08.26	1985 10.02	1986 04.23	1988 04.19	1989 09.26	1990 10.12	1989 09.26	1988 04.19	1988 04.19	1988 08.22	1986 04.29	1989 09.18	1988 08.22	1988 09.08	1988 09.15
Water pH	6.6	7.5	7.2	7.1	10.1	8.0	8.4	8.6	8.1	8.8	7.5	8.4	6.6	6.0	6.5	8.9	8.4	8.2	8.4	7.3	8.2	6.7	7.0	7.5	7.5	8.0	8.4
Water temperature °C	12.5	6.8	0.5	6.0	22.1	10.5	19.5	10.2	17.0	13.6	2.0	9.5	19.0	13.2	12.0	11.0	16.2	6.6	15.2	8.2	12.0	13.5	15.5	15.0	15.0	15.0	9.2
Euglena acus var. *acus*	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	3	1	.	.	.	.	.	.	.	.	.
– *agilis*	.	2	.	.	.	+	.	.	+	.	.	.	.	.	.	.	2	.	.	.	.	.	.	1	.	2	.
– *anabaena* var. *anabaena*	.	.	.	.	.	.	3	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.
– *caudata* var. *caudata*	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	2	.	.	.	1	.	.	.	.	.	.
– *chlamydophora*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.
– *clara*	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
– *deses* fo. *deses*	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.
– – fo. *intermedia*	.	.	.	.	1	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	1
– – fo. *klebsii*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	2	1	.	.	1	.	.	.
– *ehrenbergii*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	1	.	.
– *gasterosteus*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
– *geniculata* var. *geniculata*	2	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	1	.	.	.	.	.	.	1	1	1	.
– *gracilis* fo. *gracilis*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.
– *granulata*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
– *hemichromata*	.	1	.	.	2	.	.	.	.	3	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *hirudo*	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *limnophila* var. *limnophila*	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– – var. *swirenkoi*	.	1	.	.	.	1	3	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *lucens*	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *minima*	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *multiformis*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.
– *oxyuris* fo. *oxyuris*	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– – fo. *maior*	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *proxima*	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
– *rustica* var. *rustica*	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	2	.
– *sanguinea*	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.

– *spathirhyncha*	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *spirogyra* var. *spirogyra*	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	.	.	1	.	.	.	.	.	.	.
– – var. *fusca*	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *texta* var. *texta*	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.
– *tripteris* var. *tripteris*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.
– – var. *maior*	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *viridis* fo. *viridis*	.	3	.	.	.	.	2	.	2	.	.	1	.	.	.	.	1	.	.	.	2	.	.	.	.	2	.	.	.
Khawkinea quartana	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trachelomonas abrupta var. *abrupta*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *acanthostoma*	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *granulosa* var. *subglobosa*	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *gregussii* var. *danubialis*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
– *hispida* var. *hispida*	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– – var. *spinulosa*	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *oblonga* var. *punctata*	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *planctonica* fo. *planctonica*	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
– *polonica*	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *scabra* var. *scabra*	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *similis* fo. *similis*	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *verrucosa* var. *irregularis*	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *volvocina* var. *volvocina*	.	.	.	3	.	.	.	3	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	2	.	.	.	.	.
– – var. *compressa*	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– – var. *subglobosa*	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *volvocinopsis* fo. *volvocinopsis*	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	1	.	.	.	.	.
Lepocinclis acicularis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
– *nayalii*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.
– *ovum* var. *ovum*	.	.	.	.	.	.	.	3	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– – var. *palatina*	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– – var. *striata*	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *playfairiana*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Phacus acuminatus var. *acuminatus*	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	1	.	.	2	.	.	.	.	.	.	.
– *agilis*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
– *alatus* var. *alatus*	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– – var. *maximus*	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.

(cont.)

Table 6. Continued.

Site no.	8	9		12	13	14		22	23	25			28			52	53		54	59	60	63	65	68	70	73	77
Date	1986 09.09	1988 04.12	1989 01.14	1987 12.19	1988 08.16	1988 04.19	1988 08.16	1988 04.12	1988 04.12	1988 04.12	1989 01.14	1989 03.21	1985 08.26	1985 10.02	1986 04.23	1988 04.19	1989 09.26	1990 10.12	1989 09.26	1988 04.19	1988 04.19	1988 08.22	1986 04.29	1989 09.18	1988 08.22	1988 09.08	1988 09.15
Phacus ankylonoton	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *brachykentron*	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *carinatus*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
– *caudatus* var. *tenuis*	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.
– *contortus*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
– *curvicauda* var. *curvicauda*	1	1	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *hamelii*	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	2	.	.	.	.	.	.	1
– *helicoides*	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *inflexus*	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *megalopsis*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
– *orbicularis* fo. *orbicularis*	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– – fo. *communis*	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *oscillans*	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *parvulus*	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
– *pleuronectes* var. *pleuronectes*	.	2	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.
– *pseudonordstedtii*	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *pusillus*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.
– *pyrum* var. *pyrum*	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	2	.	.	.	2	.	.	4	.	.	.	.
– *raciborskii*	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
– *skujae*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.
– *splendens*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
– *undulatus* var. *undulatus*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
– *vigueri*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
Hyalophacus ocellatus	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Menoidium pellucidum var. *pellucidum*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.
– *tortuosum* var. *tortuosum*	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pseudoperanema macromastix	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.

taxa was observed in the pond in Jerzmanowice (site 28) in which at pH 6.6 and a temperature of 19°C 12 taxa were present among which were 6 *Euglena.* 3 of these taxa were found in the same pond at pH 6.0 and a lower temperature of 13.2°C in samples taken on a different occassion. In the pond in Modlniczka (site 8) at pH 6.6 and a temperature of 12.5°C 5 taxa were noted, and in Wielmoża (site 63) at pH 6.7 and a temperature of 13.5°C only *Euglena sanguinea* was found.

On the basis of these observations it can be stated that low water temperature sometimes appeared to eliminate representatives of the genus *Euglena* because in Modlnica (site 9) in the samples taken from under the ice only *E. oxyuris* fo. *oxyuris* was found, whereas the taxa of *Euglena* found earlier did not occur under the ice (see Table 6.) There were also places such as Żelków (site 12), Łazy (site 22), and Jerzmanowice (site 28) where representatives of the genus *Euglena* were not present.

Field ponds

In comparison with village ponds they are usually smaller in diameter but deeper and with no contact either with cattle or a farm. Seven such ponds were investigated (Table 7). Samples were taken twice from the pond in Dębniki (site 35) and from ponds in Miotełka (sites 55 & 56). The water in the investigated ponds was slightly acidic except for the water in the one in Dębniki (site 36) where it was alkaline (pH 8.0). The water in another pond in Dębniki (site 35) changed its pH from acidic in January 1989 to alkaline in March 1989.

As in village ponds, the greatest diversity was in the genus *Euglena* (18 taxa); *Euglena caudata* var. *caudata, E. deses* fo. *klebsii* and *E. agilis* were most often encountered. *E. texta* var. texta in the pond in Miotełka (site 56) was only once abundant at pH 6.5 and a temperature of 15°C, but in October 1990 at a temperature of 4°C it was present in small numbers. The remaining taxa were noted only once, either in small quantities or singly.

Trachelomonas was represented by 12 taxa and only *T. pavlovskoënsis* fo. *ellipsoidea* was observed in two sites. *T. caudata* fo. *caudata* was abundant in the pond in Miotełka (site 55) in October and then disappeared. The other taxa were in small numbers and in single sites.

Only three taxa of *Phacus* could be found in small numbers in this kind of water body.

An insignificant number of colourless euglenophytes such as *Menoidium minimum*, *M. pellucidum* var. *pellucidum*, and as single specimens *Anisonema acinus* and *Heteronema globuliferum* were found.

The greatest species diversity among the investigated field ponds was in those in Miotełka (site 55: 8 taxa; site 56: 16 taxa). These ponds were situated near the forest far from any kind of farm pollution. At pH 6.5 and a temperature of 15.0°C 16 taxa were found in one sample in one of these ponds (site 56): 11 belonging to genus *Euglena,* 3 to *Trachelomonas*, and one each to *Lepocinclis* and *Menoidium*. There were no *Phacus* representatives.

In these ponds several taxa not present in other sites were found : *Euglena matvienkoii, Trachelomonas caudata* fo. *caudata, T. dubia* fo. *dubia, T. globularis* fo. *globularis, T. recticollis, Menoidium minimum*, and *Heteronema globuliferum*. The majority of the taxa, however, appeared in both field and village ponds.

Table 7. Occurrence of euglenophyte taxa in karstic field ponds. For key see Table 1.

Site no.	28a	35		36	40	55		56		69a
Date	1986 04.23	1989 01.24	1989 03.21	1989 05.21	1989 02.10	1989 09.26	1990 10.12	1989 09.26	1990 10.12	1993 04.27
Water pH	6.3	6.9	8.0	8.0	6.9	6.6	6.5	6.5	6.5	7.3
Water temperature °C	12.0	1.5	9.2	9.2	2.0	16.2	4.0	15.0	4.0	21.0
Euglena acus var. *acus*	.	.	.	1	.	.	.	.	.	+
– *adhaerens*	.	.	.	.	.	.	.	.	2	.
– *agilis*	.	1	.	.	.	.	2	.	.	1
– *caudata* var. *caudata*	.	1	.	.	.	2	.	1	.	.
– *clavata*	.	.	.	.	.	.	.	1	.	.
– *deses* fo. *intermedia*	.	.	1	1	.	.	.	.	.	.
– – fo. *klebsii*	.	.	.	.	2	1	.	2	.	.
– *ehrenbergii*	.	.	.	.	.	.	.	1	.	.
– *gracilis* fo. *gracilis*	.	.	.	.	.	1	.	+	.	.
– *granulata*	.	1	.	.	.	.	.	.	.	.
– *hemichromata*	.	.	.	.	.	.	.	1	.	+
– *matvienkoi*	.	.	1	.	.	.	.	.	.	.
– *mutabilis*	.	.	.	.	.	.	.	2	.	.
– *spirogyra* var. *spirogyra*	.	.	.	.	.	.	.	.	+	.
– – var. *fusca*	.	.	.	.	.	.	.	1	.	.
– – var. *lacticlavius*	.	.	.	.	.	.	.	1	.	.
– *texta* var. *texta*	.	.	.	.	.	.	.	3	1	.
– *viridis* fo. *viridis*	.	.	.	2	.	.	.	.	.	.
Strombomonas acuminata	.	.	.	.	.	2	.	.	.	.
Trachelomonas caudata fo. *caudata*	.	.	.	.	.	4	.	.	.	.
– *dubia* fo. *dubia*	.	.	.	.	.	1	.	.	.	.
– *globularis* fo. *globularis*	.	.	.	.	.	1	.	.	.	.
– *oblonga* var. *oblonga*	.	.	.	.	.	.	.	2	.	.
– *pavlovskoënsis* fo. *ellipsoidea*	.	1	.	2	.	.	.	.	.	.
– *planctonica* fo. *planctonica*	.	.	.	2	.	.	.	.	.	.
– *recticollis*	.	.	.	.	.	.	.	1	.	.
– *volvocina* var. *volvocina*	.	.	.	.	.	.	.	.	.	1
– – *var. coronata*	1	.	.	.	.	.	.	.	.	.
– *volvocinopsis* fo. *volvocinopsis*	.	.	.	.	.	.	.	1	.	.
– *woycickii*	.	.	.	.	.	.	2	.	.	.
Lepocinclis ovum var. *ovum*	.	.	.	.	.	+	.	2	.	.
Phacus alatus var. *alatus*	.	.	.	.	.	.	1	.	.	.
– *longicauda* var. *longicauda*	.	.	.	.	.	.	1	.	.	.
– *mirabilis*	.	+	.	.	.	.	.	.	.	.
Menoidium minimum	.	.	.	.	.	.	.	1	.	.
– *pellucidum* var. *pellucidum*	.	.	.	.	.	.	.	.	+	.
Anisonema acinus	.	.	.	.	.	.	.	.	+	.
Heteronema globuliferum	.	+	.	.	.	.	.	.	.	.

Fishponds

Samples from 22 fishponds were investigated; 29 taxa of euglenophytes were found in 9 ponds: 3 trout ponds and 6 carp ones (Table 8).

Table 8. Occurrence of euglenophyte taxa in fish ponds. For key see Table 1.

Water body type	Trout ponds				Carp ponds					
Site no.	19	61	62		50	51	75	76	92	93
Date	1988 04.12	1989 09.13	1989 09.13	1991 10.09	1989 09.18	1989 09.18	1988 09.15	1988 09.15	1988 08.22	1988 08.22
Water pH	8.0	7.2	8.0	8.0	7.2	7.2	7.6	8.0	6.8	7.2
Water temperature °C	9.0	14.5	16.5	16.5	14.5	15.0	11.8	12.5	18.0	20.0
Euglena acus var. *acus*	.	.	.	.	+	1	.	.	.	.
– *adhaerens*	.	.	+	.	.	.	.	.	.	.
– *caudata* var. *caudata*	.	1	2	.	.	.	.	.	.	.
– *chlamydophora*	.	.	.	.	.	.	+	1	.	.
– *clara*	.	.	.	.	.	.	1	.	.	.
– *deses* fo. *deses*	1	.	.	.	.	.	.	.	.	.
– – fo. *intermedia*	.	.	.	.	.	.	.	.	.	2
– *gracilis* fo. *gracilis*	.	.	.	.	.	1	.	.	.	.
– *mutabilis*	.	2	.	.	.	.	.	.	.	.
– *obtusa*	.	.	1	.	.	.	.	.	.	.
– *polymorpha*	.	.	.	.	.	.	+	.	.	.
– *spirogyra* var. *spirogyra*	.	1	.	2	.	.	.	.	.	.
– – var. *lacticlavius*	.	.	.	.	.	.	.	.	1	.
– *texta* var. *texta*	.	.	.	.	.	.	.	.	.	4
– *tripteris* var. *tripteris*	.	.	.	.	1	1	.	.	.	.
– – var. *maior*	.	.	.	.	.	.	.	.	1	.
– *viridis* fo. *viridis*	.	2	.	.	+	.	.	.	.	.
Trachelomonas ampuliphormis	.	.	.	.	.	.	.	.	+	.
– *bacillifera* var. *minima*	.	+	.	+	.	.	.	.	.	.
– *hispida* var. *coronata*	.	+	2	.	.	.	.	.	.	.
– *volvocina* var. *volvocina*	.	2	.	.	.	.	.	.	.	.
Lepocinclis ovum var. *ovum*	.	.	1	.	+	+	.	.	.	.
Phacus anomalus	.	1	.	.	.	.	.	.	.	.
– *longicauda* var. *longicauda*	.	.	.	.	.	.	.	1	.	.
– *monilatus* var. *suecicus*	.	.	.	.	.	.	.	.	1	.
– *orbicularis* fo. *communis*	.	1	.	.	.	.	.	.	.	.
– *pleuronectes* var. *pleuronectes*	1	.	.	.	.	.	.	.	.	.
– *pyrum* var. *pyrum*	.	.	.	.	.	.	.	.	+	2

In the carp ponds which are here more frequent, 15 taxa were observed among which 10 were represented by the genus *Euglena,* 1 each by *Trachelomonas* and *Lepocinclis,* and 3 by *Phacus.* In the trout ponds 14 taxa were present: 7 of the genus *Euglena,* 4 *Trachelomonas* and 3 *Phacus.* Although the water in all the investigated ponds was alkaline and the temperature similar the taxa composition was different. Only two out of 30 taxa were observed in both types of pond: *Euglena viridis* fo. *viridis*, was abundant in the trout ponds and a single specimen was found in one carp pond, while *Lepocinclis ovum* var. *ovum* was found in one trout and two carp ponds.

The greatest taxonomic diversity was observed in a trout pond in Pieskowa Skała (site 61) in which 5 representatives of *Euglena,* 3 *Trachelomonas,* 2 *Phacus* and 1 *Lepocinclis* were noted (Wołowski 1992a).

The most abundant was *Euglena texta* var. *texta*, which developed in the Dziadówki carp pond (site 93). A slightly larger number of euglenophytes was found in richer trout ponds. The trout ponds were probably full of organic matter from ground cattle spleen served as trout food.

Several taxa which were not present in other types of the investigated bodies were found here: *Trachelomonas ampuliphormis, T. bacillifera* var. *minima, T. hispida var. coronata, Phacus anomalus,* and *Ph. monilatus* var. *suecicus.*

Flowing waters

Springs

9 springs were investigated, 5 were typical limnocrenic (sites 11, 17, 32, 48 & 67), 3 helocrenic (sites 39, 71 & 86), and one rheocrenic (site 43). The springs carried cold water.

Euglenophytes were only found in the small, shallow, helocrenic spring "Elżbieta" (site 86) – the smaller of the two springs giving rise to the Wiercica stream. The water flowed out of it slowly, being almost stagnant, partly held back by concrete steening with fallen decaying leaves enriching the water in organic substances and thus enabling euglenophyte development. 38 taxa occurred in the spring (Table 9). It was the only place in the investigated area where colourless euglenophytes (not widely studied so far in Poland) occurred in abundance. They were represented most plentifully by the genera *Astasia* (12 taxa), *Menoidium* (3), *Distigma* (2), *Anisonema* (2), with single specimens of *Hyalophacus* and *Pseudoperanema. Phacus alatus* var. *maximus* and *Ph. similis* also occurred abundantly.

The same floristic composition of the communities was maintained during the period of investigation in 1988 and in April 1989, but in May 1989 only two species, *Anisonema ovale* and *Pseudoperanema macromastix,* were found. In 1990 only single taxa of *Distigma*, Euglena, *Astasia,* and 6 taxa of *Phacus* were found in the samples. More data are given in a separate paper (Wołowski 1991a). Attempts to reconstruct the communities in laboratory cultures came to nothing up to 1995.

Bełchatów Brown Coal Opencast Mine probably caused the visible spring drawdown and extinction of the colourless euglenophytes occurring here. This problem was exacer-

Table 9. Occurrence of euglenophyte taxa in flowing waters. For key see Table 1.

Site no.	4	24a	69c	86			
Date	90.1–17	93.11.93	93.10.27	88.09.08	89.04.13	89.05.17	90.02.21
Water pH	.	8.0	8.9	7.0	6.8	7.0	6.8
Water temperature ^{o}C	.	5.5	19.0	9.8	11.0	11.5	5.5
Distigma curvatum	.	.	.	.	+	.	.
– *proteus*	.	.	.	.	2	.	1
Euglena agilis	.	.	2	.	.	.	1
– *deses* fo. *deses*	.	.	3	.	.	.	.
– *geniculata* var. *geniculata*	.	.	3	.	.	.	.
– *gracilis* fo. *gracilis*	.	.	.	1	2	.	.
– *hemichromata*	.	.	3	.	.	.	.
– *proxima*	.	.	.	1	.	.	.
– *viridis* fo. *viridis*	.	.	1	2	.	.	1
Astasia breviciliata	.	.	.	.	1	.	.
– *clavata*	.	.	.	+	.	.	.
– *curvata*	.	.	.	+	1	.	.
– *cylindrica*	.	.	.	2	2	.	.
– *fustis*	.	.	.	.	2	.	.
– *harrisii*	.	.	.	.	.	.	1
– *klebsii*	.	.	.	2	2	.	2
– *longa*	.	.	.	.	2	.	.
– *ovalis*	.	.	.	.	.	2	.
– *praecompleta*	.	.	.	1	+	.	.
– *pusilla*	.	.	.	+	.	.	.
– *recta*	.	.	.	.	1	.	.
Trachelomonas hispida var. *hispida*	1	1	.	.	.	.	.
– *intermedia* fo. *crenulatocollis*	+	.	.	.	.	.	.
– *planctonica* fo. *planctonica*	.	1	.	.	.	.	.
– *scabra* var. *scabra*	.	+	.	.	.	.	.
– *volvocina* var. *volvocina*	.	2	.	.	.	.	.
– *volvocinopsis* fo. *volvocinopsis*	+	+	.	1	.	.	.
Phacus acuminatus var. *acuminatus*	.	.	.	.	+	.	.
– – var. *indica*	.	.	.	.	+	.	.
– *alatus* var. *alatus*	.	.	.	.	.	.	1
– – var. *maximus*	.	.	.	1	3	.	.
– *ankylonoton*	.	.	.	1	2	.	.
– *caudatus* var. *caudatus*	.	.	.	1	.	.	.
– – var. *tenuis*	.	.	.	.	2	.	.
– *curvicauda* var. *robusta*	.	.	.	+	.	.	.

(cont.)

Table 9. Continued.

Site no.	4	24a	69c	86			
Date	90.1–17	93.11.93	93.10.27	88.09.08	89.04.13	89.05.17	90.02.21
Phacus formosus	.	.	.	.	+	.	.
– *indicus*	.	.	.	1	.	.	.
– *obolus*	.	.	.	.	1	.	.
– *raciborskii*	+	.	.	.	.	.	2
– *similis*	.	.	.	3	2	.	2
Hyalophacus ocellatus	.	.	.	+	+	.	2
Menoidium pellucidum var. *pellucidum*	.	.	.	1	2	.	.
– – var. *steinii*	.	.	.	3	.	.	2
– *tortuosum* var. *tortuosum*	.	.	.	2	+	.	1
Anisonema acinus	.	.	.	.	+	.	.
– *ovale*	.	.	.	.	+	.	.
Pseudoperanema macromastix	.	.	.	.	+	+	.

bated by the natural tendency of the investigated spring to drain away underground as frequently happens in the karstic area. Tourists leaving litter and lighting fires increased the site degradation which led to the extinction of the observed taxa of euglenophytes.

Several of these taxa: *Distigma curvatum*, all species of *Astasia, Trachelomonas intermedia* fo. *crenulatocollis, Phacus acuminatus* var. *indica, Ph. similis*, *Phacus curvicauda* var. *robusta*, *Menoidium pellucidum* var. *steinii*, and *Anisonema ovale* did not appear in other types of water body.

Streams and rivers

Streams and rivers in the investigated area – like the springs – are cold and mostly rather rapid-flowing. Samples from 14 streams and 2 rivers, the Vistula (site 4) and Pilica (site 71), were examined.

Euglenophytes were found only in two streams: Pokrzywianka (site 69c) and Kobylanka (site 24a) (Table 9).

The Pokrzywianka stream flowing across the city park in Wolbrom, collected strong organic pollution, which was indicated by the rich growth of bacteria *Beggiatoa alba* (Vauch.) Trevisan and *Sphaerotilus natans* Kützing on its bed. These conditions were favourable for abundant populations of *Euglena geniculata* var. *geniculata*, *E. deses* fo. *deses*, *E. hemichromata*, and in smaller numbers, *E. agilis* and *E. viridis* fo. *viridis*.

Samples taken from the lateral channel in the Kobylanka stream flowing through the village Zielona Mała contained *Trachelomonas hispida* var. *hispida*, *T. planctonica* fo. *planctonica*, T. *scabra* var. *scabra*, and *T. volvocinopsis* fo. *volvocinopsis* in small numbers and large numbers of *T. volvocina* var. *volvocina*. All the taxa found occurred in the brownish-red diatom coating on the mud surface.

The River Vistula sample taken from the river bed and plankton contained single specimens of *Trachelomonas volvocinopsis* fo. *volvocinopsis*, *T. hispida* var. *hispida*, *T. intermedia* fo. *crenulatocollis*, and *Phacus raciborskii.*

No euglenophytes were found in the sample taken from the bed of the River Pilica.

Peat bog

The studied peat bog is located in Budzyń (site 94) a village north-west of Kraków, and covers an area of about 0.5 ha. There are typical peat bog vascular plants: *Drosera rotundifolia* L., *Lycopodium innundatum* L., *Oxycoccus quadripetalus* Gilib., and *Sphagnum* sp. (Kozik 1996).

The samples were taken from plankton in a small water body and from mud under ice 30 cm thick during winter 1998; pH of the water was 4.5 and the temperature about 0.5°C. Only single specimens of *Euglena mutabilis*, *E. viridis* fo. *viridis*, *E. agilis*, *E. hemichromata*, and *Trachelomonas rugulosa* vere found. Together with the euglenophytes occurred *Synura uvella* Ehrenberg, *Closterium kützingii* Bréb., *Closterium tumidum* Johnson, *Cryptomonas* sp., and several taxa of diatoms.

Ephemeral water bodies

Puddles, impressions such as footprints of birds and cattle overflow-arms from streams, damp soil, sewage and drainage ditches belong to this category of water bodies. They all dried out periodically.

Puddles

In a puddle formed in a hollow of a concrete pavement (site 1) in Bronowice only two taxa were found: *Euglena deses* fo. *intermedia* (often) and *E. geniculata* var. *geniculata* (sparse).

A puddle formed at the bank of the Racławka stream (site 38) with a muddy bottom and water constantly stirred and fertilized by feeding ducks, was of a different character. Six taxa: *Euglena deses* fo. *deses, E. geniculata* var. *geniculata* (most abundant), *E. agilis*, *E. polymorpha*, *E. spirogyra* var. *spirogyra*, and *E. viridis* fo. *viridis*, were found (Table 10).

In cattle hoofprints (site 30) *Euglena obtusa* was abundant and accompanied by *E. mutabilis* and *E. proxima.*

Wet soils

A new taxon, *Euglena siemińskiana* (Wołowski 1992b) accompanied by other taxa of *Euglena* was found in soil polluted with urine (site 87) near a wooded part of the main Wiercica stream source. When the site was checked on a later occassion *E. siemińskiana* was not present.

Only *Trachelomonas hispida* var. *hispida* occurred in an investigated flood water arm of a river (site 83).

Table 10. Occurrence of euglenophyte taxa in puddles and on wet soil. For key see Table 1.

Site no.	1	30	38	83	87	
Date	85.08.15	86.09.03	88.04.19	88.09.15	88.09.08	89.05.15
Water pH	7.3	7.0	7.0	6.9	7.0	7.0
Water temperature °C	22.0	12.0	14.0	10.5	11.5	11.1
Euglena agilis	.	.	+	.	.	.
– *deses* fo. *deses*	.	.	+	.	3	.
– – fo. *intermedia*	2	.	.	.	.	2
– – fo. *klebsii*	.	.	.	.	.	1
– *geniculata* var. *geniculata*	1	2	2	.	.	.
– *mutabilis*	.	.	.	.	.	1
– *obtusa*	.	4	.	.	.	.
– *polymorpha*	.	.	+	.	.	.
– *proxima*	.	1	.	.	.	.
– *siemińskiana*	.	.	.	.	4	3
– *slavjanskinsis*	.	.	.	.	.	1
– *spirogyra* var. *spirogyra*	.	.	+	.	.	.
– *viridis* fo. *viridis*	.	.	1	.	.	.
Trachelomonas hispida var. *hispida*	.	.	.	1	.	.

In these small and quickly drying out water bodies, 13 taxa of *Euglena* were the most frequently observed (see Table 10).

Sewage and drainage ditches

The investigated roadside ditches usually drained sewage from village farms mixed either with rainwater or water flowing down from higher fields. Only 3 ditches of this type (sites 16, 25a & 29) had a similar taxonomic composition to the sites discussed previously. They were almost entirely occupied by the representatives of *Euglena*. *E. deses* fo. *deses* (Table 11) alone developed abundantly in the sewage ditches in Szklary (site 20).

Different taxa were noted in drainage ditches from village and fishponds. Smaller numbers of *Euglena* were found: *E. gracilis* fo. *gracilis*, *E. limnophila* var. *svirenkoi*, *E. minima*, *E. oxyuris* fo. *oxyuris*, *E. agilis, E. spirogyra* var. *fusca*. *Trachelomonas hispida* var. *hispida* and var. *spinulosa, Phacus alatus* var. *maximus*, *Ph. ankylonoton,* and *Ph. pleuronectes* var. *pleuronectes* were also observed.

In both investigated types of ditch the water was distinctly alkaline with a temperature of 6.8–12°C. The 3 sewage ditches and 2 drainage ditches from the fishponds contained mainly the representatives of genus *Euglena* (12) but the taxonomic composition was different. No mutual taxa in the two types of ditch were observed. Probably the large amount of organic substances in the sewage ditches allowed the development of large

Table 11. Occurrence of euglenophyte taxa in ditches. For key see Table 1.

Water body type	Sewage ditches			Drainage ditches			
Site no.	16	25a	29	10			20
Date	89.03.21	89.01.14	86.09.03	86.09.09	88.04.12	89.01.14	88.04.12
Water pH	8.6	8.4	7.0	7.2	7.2	7.5	8.0
Water temperature °C	12.0	9.5	12.0	7.8	7.8	6.8	9.1
Euglena agilis	.	.	.	.	1	.	.
– *chlamydophora*	.	.	3	.	.	.	.
– *deses* fo. *deses*	.	.	4	.	.	.	.
– – fo. *intermedia*	1	2	.	.	.	.	.
– – fo. *klebsii*	2	.	.	.	.	.	.
– *geniculata* var. *geniculata*	2	.	1	.	.	.	.
– *gracilis* fo. *gracilis*	.	.	.	.	.	.	1
– *limnophila* var. *svirenkoi*	.	.	.	1	.	.	.
– *lucens*	+	.	.	.	.	.	.
– *minima*	.	.	.	.	1	.	.
– *oxyuris* var. *oxyuris*	.	.	.	.	1	.	.
– *spirogyra* var. *fusca*	.	.	.	.	.	1	.
Trachelomonas hispida var. *hispida*	.	.	.	.	.	2	.
– – var. *spinulosa*	.	.	.	.	.	1	.
– *ovoides*	.	.	1	.	.	.	.
Phacus alatus var. *maximus*	.	.	.	.	1	.	.
– *ankylonoton*	.	.	.	.	+	.	.
– *pleuronectes* var. *pleuronectes*	.	.	.	.	.	1	1

numbers of just a few taxa of *Euglena*. The slightly faster running and less polluted water in the drainage ditches from the fishponds permitted the development of *Trachelomonas* and *Phacus* besides *Euglena*.

Other water bodies

This group comprises artificial water bodies: garden ponds, a plastic container, and a slow filter from the drinking water purification plant (Table 12).

In the garden ponds in Przegorzały 6 taxa were observed but in the first pond (site 6) *Trachelomonas volvocina* var. *volvocina* and *T. planctonica* fo. *planctonica* were abundant, whereas *Phacus obolus*, a rare taxon new for Poland, occurred here singly. In the second pond (site 6a), situated close to the first one, only 3 taxa were found. It is difficult to say why the taxon content differed totally although the water pH (8.0–8.4), temperature (16.0–16.2 °C), and the time of taking samples were nearly the same.

Table 12. Occurrence of euglenophyte taxa in other water bodies. For key see Table 1.

Site no.	2	7	3	6	6a	69	69b
Date	85.06.12	89.05.15	85.06.12	89.05.15	89.05.15	88.09.15	93.04.27
Water pH	6.7	8.0	6.6	8.4	8.0	7.0	7.5
Water temperature ^{o}C	17.0	17.0	16.0	16.0	16.2	13.2	14.0
Euglena acus var. *acus*	.	.	.	.	1	.	.
– *agilis*	.	1	.	.	1	.	1
– *deses* fo. *intermedia*	.	.	1	.	.	.	.
– *geniculata* var. *geniculata*	.	.	.	.	.	.	2
– *hemichromata*	+	.	.	.	.	.	+
– *oxyuris* fo. *skvortzovii*	2	.	.	.	.	.	.
– *proxima*	.	.	.	.	.	.	+
– *splendens*	.	.	.	.	2	.	.
– *viridis* fo. *viridis*	.	1	.	.	.	.	2
Trachelomonas intermedia fo. *intermedia*	.	+	2	.	.	.	.
– *planctonica* fo. *planctonica*	.	.	2	1	.	.	.
– *pusilla*	.	.	2	.	.	.	.
– *rugulosa*	2	.	.	.	.	.	.
– *sarmatica*	.	.	2	.	.	.	.
– *subverrucosa*	.	.	2	.	.	.	.
– *volvocina* var. *volvocina*	.	.	2	2	.	.	.
Lepocinclis ovum var. *ovum*	.	.	.	+	.	.	.
Phacus alatus var. *maximus*	.	.	1	.	.	.	.
– *obolus*	.	.	.	+	.	.	.
– *pleuronectes* var. *pleuronectes*	.	.	.	+	.	.	+
– *pyrum* var. *pyrum*	.	.	.	.	.	1	.

In the pond in the Botanical Garden (site 2) the water pH (6.7) was lower than in the pond in Przegorzały and a single specimen of *Euglena hemichromata,* abundant *E. oxyuris* fo. *skvortzovii* and *Trachelomoas rugulosa* were found there.

In the pond, (surrounded by a dam, site 7) which is the slow sand filter used for the drinking water purification plant in Bielany, the water had a similar pH (8.0) and temperature (17^{o}C) to the ponds in Przegorzały, but only 3 taxa of *Euglena* were observed.

In a reservoir in Wolbrom (site 69) *Phacus pyrum* var. *pyrum* was found in small numbers only. In another reservoir filled with water drained from the dried-up peat bog near Wolbrom (site 69b) *Euglena hemichromata, E. proxima*, and *Phacus pleuronectes* var. *pleuronectes* occurred singly, while *E. agilis* and *E. geniculata* var. *geniculata* were more frequent.

The most interesting community of euglenophytes was found in the Botanical Garden

in a plastic container ready for water plant culture (site 3), prepared with rich soil covered with water. The 8 taxa of *Trachelomonas*, among them the rare *T. sarmatica,* were found in the container. *T. sarmatica* had previously only been reported from Dobrostany fishponds in Ukraina (Dreżepolski 1925).

Taxa not observed in other types of water body were also found in these sites: *Euglena oxyuris* fo. *skvortzovii*, *Trachelomonas intermedia* fo. *intermedia*, *T. pusilla*, and *T. subverucosa*.

Comparison of composition of euglenophyte communities in various types of water body

The majority of the taxa observed in various types of water body (Table 13) occurred in the village karstic ponds. Such ponds are most plentiful in the Upland and therefore were investigated more frequently.

In the karstic field ponds 8 species which did not appear in other water bodies were found: *Euglena matvienkoii, Trachelomonas caudata* fo. *caudata, T. dubia* fo. *dubia*, *T. globularis* fo. *globularis*, *T. recticollis, Menoidium minimum*, *Anisonema acinus,* and *Heteronema globuliferum*.

Trachelomonas ampuliformis, *T. bacillifera* var. *minima*, *T. hispida* var. *coronata, Phacus anomalus*, *Ph. monilatus*, var. *suecicus* were found only in the fishponds.

Only one out of all the investigated springs contained euglenophytes among which 19 taxa appeared exclusively: *Distigma curvatum*, all 12 taxa of genus *Astasia*, *Phacus acuminatus* var. *indica*, *Ph. skujae*, *Ph. indicus*, *Ph. similis*, *Menoidium pellucidum* var. *steinii*, *Anisionema ovale.*

Euglena slavjanskiensis, *E. siemińskiana,* and *Trachelomonas ovoides* were present only in the ephemeral water bodies. *Euglena oxyuris* var. *skvortzovii*, *Trachelomonas intermedia* fo. *intermedia*, *T. pusilla*, and *Phacus obolus* were found in other types of investigated water bodies.

Euglena viridis fo. *viridis,* which never formed water blooms, was found in all types of water body.

Euglena deses fo. *intermedia*, *E. gracilis* fo. *gracilis, E. agilis*, *E. acus* var. *acus*, *E. hemichromata*, *E. spirogyra* var. *spirogyra*, *Trachelomonas volvocina* var. *volvocina, T. volvocinopsis* fo. *volvocinopsis*, *Phacus alatus* var. *maximus*, and *Ph. pleuronectes* var. *pleuronectes* were often found in various types of water body.

Euglena agilis, E. geniculata var. *geniculata, E. deses* fo. *deses*, *E. caudata* var. *caudata, E. siemińskiana, E. obtusa*, *Trachelomonas caudata* fo. *caudata, Phacus alatus* var. *maximus*, and *Ph. pyrum* were the only species which occurred in masses in different types of water body.

Euglena acus var. *acus*, *E. spirogyra* var. *spirogyra*, *E. limnophila* var. *svirenkoi*, *E. agilis*, *E. deses* fo. *deses*, *E. mutabilis*, *E. anabaena* var. *anabaena*, *E. geniculata* var. *geniculata*, *E. hemichromata*, *E. viridis* fo. viridis, *E. stellata* fo. *stellata*, *E. sanguinea*, and *E. texta* var. *texta* as well as *Trachelomonas volvocina* var. *volvocina*, *T. volvocinopsis*

Table 13. Comparison of euglenophyte taxa occurring (+) in all investigates types of water body.

Types of water body	Village ponds	Field ponds	Fish ponds	Flowing water	Peat bog	Ephemeric water bodies	Other water bodies
Distigma curvatum	.	.	.	+	.	.	.
– *proteus*	+	.	.	+	.	.	.
Euglena acus var. *acus*	+	+	+	.	.	.	+
– *adhaerens*	+	+	+	.	.	.	.
– *agilis*	+	+	.	+	+	+	+
– *anabaena* var. *anabaena*	+	.	.	.	.	.	.
– *archaeoplastidiata*	+	.	.	.	.	.	.
– *caudata* var. *caudata*	+	+	+	.	.	.	.
– *chadefaudii*	+	.	.	.	.	.	.
– *chlamydophora*	+	.	+	.	.	+	.
– *clara*	+	.	+	.	.	.	.
– *clavata*	+	+	.	.	.	.	.
– *deses* fo. *deses*	+	.	+	+	.	+	.
– – fo. *intermedia*	+	+	+	.	.	+	+
– – fo. *klebsii*	+	+	.	.	.	+	.
– *ehrenbergii*	+	+	.	.	.	.	.
– *ettlii*	+	.	.	.	.	.	.
– *gasterosteus*	+	.	.	.	.	.	.
– *geniculata* var. *geniculata*	+	.	.	+	.	+	.
– – var. *terricola*	+	.	.	.	.	.	.
– *gracilis* fo. *gracilis*	+	+	+	+	.	+	.
– – fo. *hiemalis*	+	.	.	.	.	.	.
– *granulata*	+	+	.	.	.	.	.
– *hemichromata*	+	+	.	+	+	.	+
– *hirudo*	+	.	.	.	.	.	.
– *limnophila* var. *limnophila*	+	.	.	.	.	.	.
– – var. *swirenkoi*	+	.	.	.	.	+	.
– *lucens*	+	.	.	.	.	+	.
– *matvienkoi*	.	+	.	.	.	.	.
– *minima*	+	.	.	.	.	+	.
– *multiformis*	+	.	.	.	.	.	.
– *mutabilis*	+	+	+	.	+	+	.
– *oblonga*	+	.	.	.	.	.	.
– *obtusa*	+	.	+	.	.	+	.
– *oxyuris* fo. *oxyuris*	+	.	.	.	.	+	.
– – fo. *maior*	+	.	.	.	.	.	.
– – fo. *skvortzovii*	.	.	.	.	.	.	+

Table 13. Continued.

Types of water body	Village ponds	Field ponds	Fish ponds	Flowing water	Peat bog	Ephemeric water bodies	Other water bodies
– *pavlovskoënsis*	+	.	.	.	.	.	.
– *polymorpha*	+	.	+	.	.	+	.
– *proxima*	+	.	.	+	.	+	.
– *rustica* var. *rustica*	+	.	.	.	.	.	.
– *sanguinea*	+	.	.	.	.	.	.
– *siemińskiana*	.	.	.	.	.	+	.
– *sima*	+	.	.	.	.	.	.
– *slavjanskiensis*	.	.	.	.	.	+	.
– *spathirhyncha*	+	.	.	.	.	.	.
– *spirogyra* var. *spirogyra*	+	+	+	.	.	+	.
– – var. *fusca*	+	+	.	.	.	+	.
– – var. *lacticlavius*	.	+	+	.	.	.	.
– *splendens*	+	.	.	.	.	.	+
– *stellata* fo. *stellata*	+	.	.	.	.	.	.
– *texta* var. *texta*	+	+	+	.	.	.	.
– *tripteris* var. *tripteris*	+	.	.	.	.	.	.
– *tripteris* var. *maior*	+	.	+	.	.	.	.
– *tristella*	+	.	.	.	.	.	.
– *truncata*	+	.	.	.	.	.	.
– *viridis* fo. *viridis*	+	+	+	+	+	+	+
Khawkinea quartana	+	.	.	+	.	.	.
Astasia breviciliata	.	.	.	+	.	.	.
– *clavata*	.	.	.	+	.	.	.
– *curvata*	.	.	.	+	.	.	.
– *cylindrica*	.	.	.	+	.	.	.
– *fustis*	.	.	.	+	.	.	.
– *harrisii*	.	.	.	+	.	.	.
– *klebsii*	.	.	.	+	.	.	.
– *longa*	.	.	.	+	.	.	.
– *ovalis*	.	.	.	+	.	.	.
– *praecompleta*	.	.	.	+	.	.	.
– *pusilla*	.	.	.	+	.	.	.
– *recta*	.	.	.	+	.	.	.
Strombomonas acuminata	+	+	.	.	.	.	.
– *planctonica*	+	.	.	.	.	.	.
Trachelomonas abrupta var. *abrupta*	+	.	.	.	.	.	.
– *acanthostoma*	+	.	.	.	.	.	.

(cont.)

Table 13. Continued.

Types of water body	Village ponds	Field ponds	Fish ponds	Flowing water	Peat bog	Ephemeric water bodies	Other water bodies
Trachelomonas allia	+	.	.	.	.	.	.
– *ampuliphormis*	.	.	+	.	.	.	.
– *bacillifera* var. *minima*	+	.	+	.	.	.	.
– *botanica* var. *borealis*	+	.	.	.	.	.	.
– *caudata* fo. *caudata*	.	+	.	.	.	.	.
– *compacta*	+	.	.	.	.	.	.
– *curta* fo. *curta*	+	.	.	.	.	.	.
– *decorata*	.	.	.	.	.	.	.
– *drežepolskiana*	+	.	.	.	.	.	.
– *dubia* fo. *dubia*	.	+	.	.	.	.	.
– *eurystoma* var. *producta*	+	.	.	.	.	.	.
– *globularis* fo. *globularis*	.	+	.	.	.	.	.
– – fo. *crenulatocollis*	+	.	.	.	.	.	.
– *granulosa* var. *subglobosa*	+	.	.	.	.	.	.
– *gregussii* var. *danubialis*	+	.	.	.	.	.	.
– *guttata*	+	.	.	.	.	.	.
– *hirta* var. *duplex*	+	.	.	.	.	.	.
– *hispida* var. *hispida*	+	.	.	+	.	+	.
– – var. *coronata*	.	.	+	.	.	.	.
– – var. *crenulatocollis*	+	.	.	.	.	.	.
– – var. *granulata*	+	.	.	.	.	.	.
– – var. *spinulosa*	+	.	.	.	.	+	.
– *intermedia* fo. *intermedia*	.	.	.	.	.	.	+
– – fo. *crenulatocollis*	+	.	.	+	.	.	.
– *janczewskii* var. *janczewskii*	+	.	.	.	.	.	.
– *lacustris* var. *klebsii*	+	.	.	.	.	.	.
– *lomnickii*	+	.	.	.	.	.	.
– *manginii* var. *subpunctata*	+	.	.	.	.	.	.
– *mirabilis* var. *minor*	+	.	.	.	.	.	.
– *nexilis*	+	.	.	.	.	.	.
– *oblonga* var. *oblonga*	+	+	.	.	.	.	.
– – var. *punctata*	+	.	.	.	.	.	.
– – *var. pulcherrima*	.	.	.	.	.	.	.
– *ovoides*	.	.	.	.	.	+	.
– *pavlovskoënsis* fo. *pavlovskoënsis*	+	+	.	.	.	.	.
– – fo. *ellipsoidea*	+	.	.	.	.	.	.
– *planctonica* fo. *planctonica*	+	+	.	.	.	.	+

Table 13. Continued.

Types of water body	Village ponds	Field ponds	Fish ponds	Flowing water	Peat bog	Ephemeric water bodies	Other water bodies
– – fo. *oblonga*	+	.	.	.	.	.	.
– – fo. *ornata*	+	.	.	.	.	.	.
– *polonica*	+	.	.	.	.	.	.
– *poltavica*	+	.	.	.	.	.	.
– *pusilla*	.	.	.	.	.	.	+
– *raciborskii* var. *incerta*	+	.	.	.	.	.	.
– *recticollis*	.	+	.	.	.	.	.
– *reinhardii*	+	.	.	.	.	.	.
– *robusta*	+	.	.	.	.	.	.
– *rugulosa*	+	.	.	.	+	.	+
– *sarmatica*	+	.	.	.	.	.	+
– *scabra* var. *scabra*	+	.	.	.	.	.	.
– *similis* fo. *similis*	+	.	.	.	.	.	.
– – var. *spinosa*	+	.	.	.	.	.	.
– *stokesiana* fo. *torquata*	+	.	.	.	.	.	.
– *subverrucosa*	+	.	.	.	.	.	.
– *superba*	+	.	.	.	.	.	.
– *verrucosa* fo. *irregularis*	+	.	.	.	.	.	.
– *volvocina* var. *volvocina*	+	+	+	.	.	.	+
– – var. *compressa*	+	.	.	.	.	.	.
– – var. *coronata*	+	+	.	.	.	.	.
– – var. *derephora*	+	.	.	.	.	.	.
– – var. *subglobosa*	+	.	.	.	.	.	.
– *volvocinopsis* fo. *volvocinopsis*	+	+	.	+	.	.	.
– *woycickii*	+	+	.	.	.	.	.
Ascoglena viridis	+	.	.	.	.	.	.
Colacium vesiculosum fo. *cyclopicola*	+	.	.	.	.	.	.
Lepocinclis acicularis	+	.	.	.	.	.	.
– *nayalii*	+	.	.	.	.	.	.
– *ovum* var. *ovum*	+	+	+	.	.	.	+
– – var. *palatina*	+	.	.	.	.	.	.
– – var. *striata*	+	.	.	.	.	.	.
– *playfairiana*	+	.	.	.	.	.	.
– *steinii*	+	.	.	.	.	.	.
Phacus acuminatus var. *acuminatus*	+	.	.	+	.	.	.
– – var. *indica*	.	.	.	+	.	.	.
– *agilis*	+	.	.	.	.	.	.

(cont.)

Table 13. Continued.

Types of water body	Village ponds	Field ponds	Fish ponds	Flowing water	Peat bog	Ephemeric water bodies	Other water bodies
Phacus alatus var. *alatus*	+	+	.	+	.	.	.
– – var. *maximus*	+	.	.	+	.	+	+
– *ankylonoton*	+	.	.	+	.	+	.
– *anomalus*	.	.	+	.	.	.	.
– *brachykentron*	+	.	.	.	.	.	.
– *carinatus*	+	.	.	.	.	.	.
– *caudatus* var. *caudatus*	+	.	.	+	.	.	.
– – var. *tenuis*	+	.	.	+	.	.	.
– *circulatus*	+	.	.	.	.	.	.
– *circumflexus*	+	.	.	.	.	.	.
– *contortus*	+	.	.	.	.	.	.
– *corculum*	+	.	.	.	.	.	.
– *costatus*	+	.	.	.	.	.	.
– *curvicauda* var. *curvicauda*	+	.	.	.	.	.	.
– – var. *robusta*	.	.	.	+	.	.	.
– *dangeardii*	+	.	.	.	.	.	.
– *formosus*	+	.	.	+	.	.	.
– *hamatus*	+	.	.	.	.	.	.
– *hamelii*	+	.	.	.	.	.	.
– *helicoides*	+	.	.	.	.	.	.
– *indicus*	.	.	.	+	.	.	.
– *inflexus*	+	.	.	.	.	.	.
– *longicauda* var. *longicauda*	+	+	+	.	.	.	.
– *megalopsis*	+	.	.	.	.	.	.
– *mirabilis*	+	+	.	.	.	.	.
– *monilatus* var. *suecicus*	.	.	+	.	.	.	.
– *obolus*	.	.	.	+	.	.	+
– *orbicularis* fo. *orbicularis*	+	.	.	.	.	.	.
– – fo. *cingeri*	+	.	.	.	.	.	.
– – fo. *communis*	+	.	+	.	.	.	.
– *oscillans*	+	.	.	.	.	.	.
– *parvulus*	+	.	.	.	.	.	.
– *pleuronectes* var. *pleuronectes*	+	.	+	.	.	+	+
– *pseudonordstedtii*	+	.	.	.	.	.	.
– *pulcherrimus*	+	.	.	.	.	.	.
– *pusillus*	+	.	.	.	.	.	.
– *pyrum* var. *pyrum*	+	.	+	+	.	.	.

Table 13. Continued.

Types of water body	Village ponds	Field ponds	Fish ponds	Flowing water	Peat bog	Ephemeric water bodies	Other water bodies
– *raciborskii*	+	.	.	+	.	.	.
– *skujae*	+	.	.	.	.	.	.
– *similis*	.	.	.	+	.	.	.
– *splendens*	+	.	.	.	.	.	.
– *stokesii*	+	.	.	.	.	.	.
– *striatus*	+	.	.	.	.	.	.
– *strongylus*	+	.	.	.	.	.	.
– *triqueter*	+	.	.	.	.	.	.
– *trypanon*	+	.	.	.	.	.	.
– *undulatus* var. *undulatus*	+	.	.	.	.	.	.
– *unguis*	+	.	.	.	.	.	.
– *vigueri*	+	.	.	.	.	.	.
Hyalophacus ocellatus	+	.	.	+	.	.	.
Menoidium minimum	.	+	.	.	.	.	.
– *pellucidum* var. *pellucidum*	+	+	.	+	.	.	.
– – var. *steinii*	.	.	.	+	.	.	.
– *tortuosum* var. *tortuosum*	+	.	.	+	.	.	.
Anisonema acinus	.	+	.	+	.	.	.
– *ovale*	.	.	.	+	.	.	.
Heteronema globuliferum	.	+	.	.	.	.	.
Pseudoperanema macromastix	+	.	.	+	.	.	.

fo. *volvocinopsis*, *T. scabra* var. *scabra*, *Lepocinclis ovum* var. *ovum*, *Phacus inflexus*, P*h. caudatus* var. *tenuis*, *Ph. similis* and *Menoidium pellucidum* var. *steinii* appeared at times in large quantities. All these species are cosmopolitan but they were usually noted here only in a few sites.

Changes in numbers of taxa encountered in a water body were irregular. This was confirmed by monthly observations during 1990. It seems that the appearance of the rarely represented taxa was accidental possibly due to active translocation of the observed organisms, including vertical migration (Happey-Wood 1988), which occasionally exposed some of them. Summer rainfall at the time when the investigation was carried out and constant stirring up of the water by ducks and geese also appeared to affect community content.

Water blooms, and the abundant appearance of euglenophyte taxa, were observed at pH 7.5–10.1. The mass appearance of the other algal taxa such as *Microcystis viridis, Oscillatoria limosa, Asterionella formosa, Chlamydomonas ehrenbergii*., *Cryptomonas*

ovata, *Chlorogonium minimum*., and *Pediastrum boryanum* var. *perforatum*, seemed generally not to affect the development of euglenophyte communities nor their quantity.

Conclusions

In the investigated material 206 taxa of euglenophytes, among them 149 species, 37 varieties and 20 forms, were identified. Only 45 taxa of euglenophytes had been known before in the Kraków-Częstochowa Upland thus 161 taxa are new for this area. Among them 69 taxa are new for Poland, and 5 out of 69 are new for Europe.

Taxa new for science: *Euglena siemińskiana* (Wołowski 1992b) and *E. ettlii* (Wołowski 1993) were described on the basis of the investigated material.

At present 651 euglenophytes taxa are known in Poland, among them 431 species, 198 varieties, 22 forms; 31% of these were found in the Upland. In relation to the general quantity of the known taxa in Europe it is an impressive figure since when writing the world flora of green and colourless euglenophytes Huber-Pestalozzi (1955) set down descriptions for 1286 taxa, among them 842 species, 359 varieties and 85 forms. Later Starmach (1983) assambled 1353 descriptions of euglenophyte taxa known in the world, and among them 916 species, 317 varieties, and 122 forms.

In partly compilative euglenophyte floras Popova (1966), and Popova and Safonova (1976) gave for the former Soviet Union (mostly western Siberia) information on 638 taxa (429 species, 118 varieties, and 91 forms) Asaul (1975) reported for Ukraine 727 taxa (502 species, 142 varieties, 83 forms), and Tell and Conforti (1986) recorded 447 taxa for Argentina (among them 296 species, 132 varieties, and 19 forms).

The investigated flora turned out to be diversified in comparison with that offered in the known regional monographs. In Uppland (Sweden) Skuja (1948) found 130 taxa (among them 119 species and 11 varieties); from waters of different regions he (Skuja 1956) found 161 taxa (among them 145 species and 16 forms) and in Lappland he found (Skuja 1964) 69 taxa (60 species, 8 varieties, and 1 form). Thérezién (1989), gave information about 67 taxa, among them 26 species, 31 varieties, and 10 forms for the Amazonian system in Brazil.

In none of the above mentioned works are there physico-chemical parameters concerning the waters in which the separate taxa occurred.

The most numerous in the water bodies of the Kraków-Częstochowa Upland were the following genera: *Trachelomonas* (64 taxa), *Euglena* (55), *Phacus* (52), *Astasia* (12), and *Lepocinclis* (7 taxa). Representatives of rare genera such as: *Menoidium* (4 taxa), *Distigma* (2), *Strombomonas* (2), and *Anisonema* (2), and single taxa of *Kawkinea*, *Ascoglena*, *Colacium*, *Hyalophacus*, *Heteronema,* and *Pseudoperanema* were also found.

Five taxa are new for the European flora: *Euglena truncata* previously known only from North America, twice was observed here in one site (see Table 3); *Trachelomonas botanica* var. *borealis*, known only from Australia, occurred as a single specimen in the plankton of one pond; *T. decorata* known only from Manchuria was also noted in the plankton of one pond; *T. hirta* var. *duplex* described from Madagascar, was found here as a single

specimen; *Phacus acuminatus* var. *indica,* known from India, was found in an Upland spring and *Ph. carinatus*, known from Australia, was found here in a village pond.

Very rare taxa occurring as either single or scarce specimens known only in Europe and no other continent were also found in the Upland: *Euglena slavjanskiensis* before known only from Russia, *E. hirudo* described by Drežepolski (1925) and known only from Ukraine, *Trachelomonas ovoides* found before in Belgium alone, *T. guttata* known only in the Netherlands, and the two taxa *T. sarmatica* and *T. lomnickii* described by Drežepolski (1925) from Lithuania and Ukraine, and *Trachelomonas gregussii* var. *danubialis* described by Hortobágyi (1979) from Hungary.

Undoubtedly the most interesting group among euglenophytes found in the Upland are the colourless euglenophytes: quite a few specimens of various genera were found in one site, spring "Elżbieta" (Table 9). It was the first site in Poland where colourless euglenophytes were found abundantly. Bełchatów Opencast Coal Mine most probably caused the visible drawdown of "Elżbieta" spring as well as other springs in this region and consequently the extinction of the colourless euglenophytes occurring here.

The euglenophytes in the Upland developed mainly in closed water bodies, from puddles to the village karstic ponds most commonly appearing here. They gathered at the edge of stagnant water on the slightly rippling surface where they easily warmed up, just above the muddy bed, and sometimes in plankton.

Not a single euglenophyte was found in 9 out of 33 investigated karstic village ponds. Swimming and feeding ducks and geese may have prevented or limited the development of euglenophytes here. It was found that the euglenophytes did not occur in ponds rich in *Lemna minor* where the water surface was covered with a dense layer which excluded most of the light.

No euglenophytes were found in cold vancluses or other springs except a small one with almost stagnant water. In the streams they were found neither in the mud, in stagnant water, nor among *Vaucheria* thalli, although algae from other systematic groups, especially blue-green algae and diatoms, developed. There was only one exception: this was in a typical stream (site 24a) where a few specimens of *Trachelomonas* were found among diatoms in the mud of stagnant water away from the main water flow. This may be due to fast water currents and the mobility of euglenophyte cells.

Little relationship between taxa and low water temperature could be found in stagnant water bodies as they sometimes occurred under the ice surface in shallow areas of the ponds although some euglenophytes occurred in larger quantities at higher water temperatures.

During the investigation the euglenophyte composition in various water bodies in the same area, with similar physico-chemical parameters, always differed.

Euglenophytes were found in a comparatively small number of fishponds; out of 15 investigated carp ponds they appeared in 6, and out of 7 trout ponds they occurred in 3. It is difficult to explain this phenomenon.

Distinct developmental lines in individual species could not be found in the four karstic village ponds observed in an annual cycle. The occurrence of many taxa, both in plankton and mud, in other ponds and water bodies and on wet soils were strictly ac-

cidental, especially when the majority of taxa occur in inconsiderably small specimen numbers. Only occasionally was an abundant appearance of some species observed: *Euglena agilis, E. deses* fo. *deses, E. geniculata* var. *geniculata, E. stellata* fo. *stellata, E. obtusa, E. siemińskiana, E. texta* var. texta, *Trachelomonas caudata* fo. *caudata,* and *Phacus pyrum* var. *pyrum*. These occurred in masses at pH 7.0 to 7.6. Water temperature caused greater drifts in the number of individuals of certain taxa such as *E. stellata* fo. *stellata* and *T. caudata* fo. *caudata,* which occurred in masses at a water temperatures of 0.5–2.0°C.

The majority of the euglenophytes found in the Upland are very tolerant of organic pollution. Following the known lists of saprobic systems of Kolkwitz and Marsson (1908), Zelinka and Marvan (1961), Fjerdingstad (1964), Cyrus and Sladeček (1973), Sladeček and Perman (1977), and known reserchers of the group Lemmermann (1910), Swirenko (1939), Popova (1966), Asaul (1975), Popova and Safonova (1976), it can be stated that the majority of the representatives of genus *Euglena* found in this study occur in both clean and strongly polluted waters.

According to Fjerdingstad (1964) many of them are saprophilous (organisms which generally occur in polluted waters but which may also occur in others): *Euglena acus* var. *acus, E. spirogyra* var. *spirogyra, E. spirogyra* var. *fusca, E. oxyuris* fo. *oxyuris, E. deses* fo. *deses, E. deses* fo.. *intermedia, E. ehrnbergii, E. gracilis* fo. *gracilis, E. agilis, E. polymorpha, E. proxima, E. sanguinea,* and *E. mutabilis* were all found in the Kraków-Częstochowa Upland. According to him *E. spathirhyncha* which was rarely found in the Upland and *E. viridis* fo. *viridis* which occurred in various types of water body in the study area are both saprobionts (organisms which in fairly large numbers occur in polluted waters only). On the basis of my personal long-standing observations I consider that *E. hemichromata, E. geniculata* var. *geniculata, E. texta* var. *texta*, *Trachelomonas volvocina* var. *volvocina*, *T. volvocinopsis* fo. *volvocinopsis, T. hispida* var. *hispida*, *Phacus acuminatus* var. *acuminatus*, *Ph. pleuronectes* var. *pleuronectes* and *Ph. pyrum* var. *pyrum* should also be classified as saprobionts.

The noted representatives of genus *Trachelomonas* and *Phacus,* show less resistance to pollution and therefore are usually classified as appearing in catharobic and β-mesosaprobic waters. Recognized as indicators of clean water are *Trachelomonas acanthostoma, T. globularis* fo. *globularis, T. robusta, T. dubia* fo. *dubia* (Swirenko 1939) as well as *Phacus stokesii*, *Ph. dangeardii*, *Ph. oscillans*, and *Ph. monilatus* var. *suecicus* (Lemmermann 1910).

According to these lists, the colourless euglenophytes such as: *Astasia klebsii, Menoidium minimum*, *M. pellucidum* var. *pellucidum,* and *M. pellucidum* var. *steinii* are classified as appearing in strongly polluted polysaprobic waters. They were found in the Upland in relatively unpolluted water, in a spring (site 86) fairly rich in organic substances coming from decomposing leaves.

From my own observations and the data from literature, I may conclude that all the karstic village ponds were of polysaprobic, sometimes α-mesosaprobic character. Only springs and the initial parts of the streams were of β-mesosaprobic character.

Knowledge of the geographical distribution of euglenophyte taxa is still so incom-

plete that future intensive studies are needed. In some papers however, one can find attempts at defining ranges for selected species (Popova 1966; Safonova 1987; Vetrova 1986, 1993).

An analysis of euglenophyte flora of central Asia and its comparison with southern Kasakhstan (Hisoriev 1996a, b) has recently been carried out on the basis of literature; the analysis deals mechanically, however, with the diversity of the representatives of particular genera and families, disregarding species and their ecological requirements.

Studies of this systematic group, both in Poland and in the rest of the world, do not allow full qualification of the ecological character of all known species because many of them are encountered in sparse quantities and in a great variety of sites. Geographical ranges for many of them will probably not be established soon, either.

The ecological parameters for 36 taxa collected in this work will make possible their comparison with the spectrum given for the same taxa in work on the tropical euglenophyte population in the Pantanal of Mato Grosso in Brazil (Heckman *et al.* 1996; De-Lamonica-Freire & Heckman 1996); this will require a separate study.

This work certainly does not describe the entire species content of euglenophytes which occur in the Kraków-Częstochowa Upland. Long-term investigation on a greater number of sites may provide some further data.

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