Hoehnea 29(2): 79-91, 2 tab., 29 fig., 2002

Contribution to the knowledge of genus *Euglena* (Euglenophyceae) of the state of Rio Grande do Sul, southern Brazil

Sandra Maria Alves-da-Silva[1,3] e Carlos Eduardo de Mattos Bicudo[2]

Received: 14 May, 2001; accepted: 23 April, 2002

ABSTRACT - (Contribution to the knowledge of genus *Euglena* of the state of Rio Grande do Sul, southern Brazil). Taxonomic survey of representatives of genus *Euglena* (Euglenophyceae) of a reservoir in the municipality of Triunfo (30°02'15"S and 51°13'13"W), state of Rio Grande do Sul, southern Brazil. Samplings were made at two stations during 14 consecutive months, from February 1995 to March 1996. Thirteen species were identified. Among these *E. repulsans* was registered for the first time for the Brazilian territory. *E. hemichromata*, *E. splendens*, and *E. tripteris* var. *tripteris* were the best represented taxa, since they were present during several months and always by high relative densities. Environmental abiotic variables ranges for each taxon identified are mentioned.
Key words: pigmented Euglenophyceae, floristic survey

RESUMO - (Contribuição ao conhecimento do gênero *Euglena* do estado do Rio Grande do Sul, sul do Brasil). Inventário taxonômico dos representantes do gênero *Euglena* (Euglenophyceae) de um reservatório no município de Triunfo (30°02'15"S e 51°13'13"W), estado do Rio Grande do Sul, sul do Brasil. Material para estudo foi coletado em duas estações de amostragem durante 14 meses consecutivos, de fevereiro de 1995 a março de 1996. Treze espécies foram identificadas, dentre as quais *E. repulsans* foi documentada pela primeira vez para o território brasileiro. *E. hemichromata*, *E. splendens* e *E. tripteris* var. *tripteris* foram os táxons melhor representados, pois ocorreram em vários meses e sempre em altas densidades relativas. São fornecidas as amplitudes de algumas variáveis abióticas dos ambientes em que cada táxon ocorreu durante o estudo.
Palavras-chave: Euglenophyceae pigmentadas, inventário florístico

Introduction

Knowledge of the algae of present study area is restricted to two papers: Torgan et al. (1979), and Alves-da-Silva & Laitano (1994). The first one refers to representatives of the phytoplankton in general, including some Euglenophyceae; the second one to 46 specific and infraspecific taxa of pigmented Euglenaceae. Besides these two papers, some technical reports prepared by the Fundação faculty (Fundação Zoobotânica do Rio Grande do Sul 1978, 1981, 1988, 1992, 1994, 1996) include mention to euglenophytes in broader fauna and flora taxonomic surveys carried out for the area.

Present work is the taxonomic study of representatives of the genus *Euglena* in Contention Basin n. 7, and aimed at a broad knowledge on the taxonomy and the geographical distribution of representatives of the genus *Euglena*, as well as on supplying information about the environmental conditions in which material studied was collected in an attempt to subsidize ecological studies being carried out in the area.

Material and methods

The reservoir (30°02'15"S and 51°13'13"W), locally known as Contention Basin n. 7, was built for retention and accumulation of rain water. It is located in a biological reserve under jurisdiction of a petrochemical company (Pólo Petroquímico do Sul) and is a refuge site for the remaining biota after the 1978 installation of the petrochemical complex in the municipality of Triunfo, Rio Grande do Sul State, southern Brazil. Reservoir n. 7 has the surface of approximately 15 ha and the maximum depth of 2 m during the rainy season.

According to Köppen's international classification system, climate of the study area is of the Cfa type, i.e. subtropical humid.

1. Núcleo de Vegetais Inferiores, Museu de Ciências Naturais, Caixa Postal 1188, 90690-000 Porto Alegre, RS, Brasil.
2. Seção de Ficologia, Instituto de Botânica, Caixa Postal 4005, 01061-970 São Paulo, SP, Brasil.
3. Corresponding author: algas@fzb.org.br

Samples for the physical and chemical analyses of water as well as those for biological material study were gathered monthly, from February 1995 to March 1996, in two collecting stations. Station 1 was located in the central-most part of the basin. It had the maximum depth of 1 m during the entire study period, leaving many dead tree branches sticking out of the water, which serve as support for construction of nests by several bird species, mainly herons (*Egretta thula* Mol.) and hawks (*Rostrhamus sociabilis* Vieill.). Station 2 was located at the margin of basin n. 7. It had the maximum depth of 1.4 m during the whole sampling period and presented a considerable amount of submersed dead branches that were left during the filling up of the reservoir (figure 1). Samples were gathered from the subsurface (20-30 cm depth) of the water column of the reservoir by using a 25 μm mesh plankton net.

For specific and infra-specific identification of the taxa, basic works were used such as Conrad & Van Meel (1952), Gojdics (1953), Huber-Pestalozzi (1955), Németh (1980), Starmach (1983), Tell & Conforti (1986), and Zakrýs (1986), as well as several very recent floristic works on the genus.

All samples containing representatives of *Euglena* were deposited in the Herbarium Prof. Dr. Alarich R.H. Schultz (HAS) of the Museu de Ciências Naturais at the Fundação Zoobotânica do Rio Grande do Sul, Rio Grande do Sul State, southern Brazil.

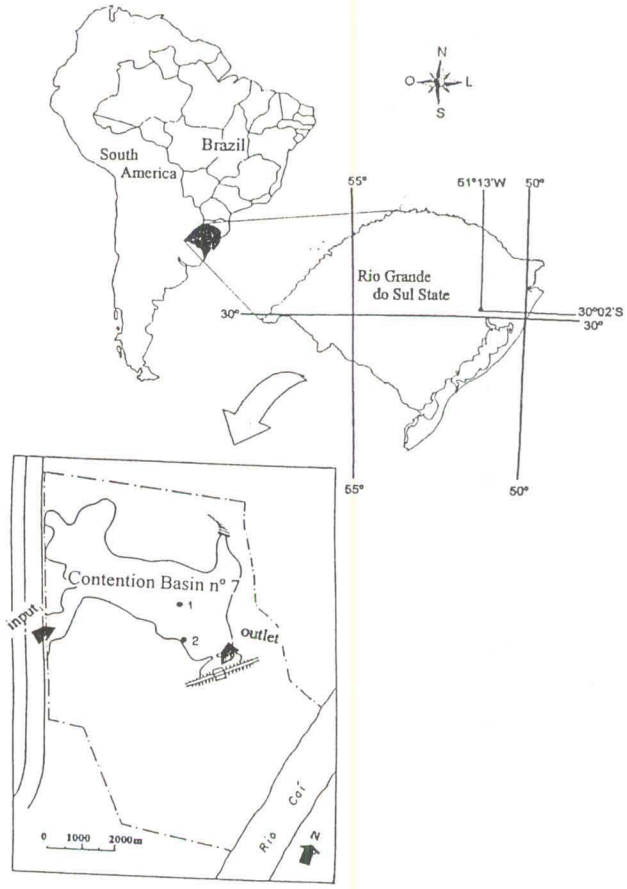


Figure 1. Location of sampling stations in the Contention Basin n. 7, municipality of Triunfo, state of Rio Grande do Sul, Brazil.

Results and Discussion

Key for identification of the species and varieties of *Euglena*

1. Pyrenoids present.
   2. Chloroplasts 2, shield like ..... *E. agilis* var. *agilis*
   2. Chloroplasts > 2 to numerous, disc-shaped.
      3. Chloroplasts axial, margins with deep incisions; double-pyrenoids present ..... *E. splendens*
      3. Chloroplasts parietal.
         4. Cells fusiform; chloroplasts with irregular margins;double-pyrenoids present ..... *E. polymorpha*
         4. Cells cylindrical; pyrenoids naked ..... *E. deses* var. *intermedia*
1. Pyrenoids absent.
   5. Chloroplasts small (≤ 3.7 μm); numerous, disc-shaped or rod-shaped.
      6. Cells fusiform.
         7. Paramylum granules numerous; cells 88.0-127.4 × 7.0-9.5 μm; Rl:b = 10.0-14.7 ..... *E. acus* var. *acus*
         7. Paramylum granules 2; cells 55.5-62.3 × 8.0-9.2 μm; Rl:b = 6.7-7.5 ..... *E. limnophila* var. *limnophila*
      6. Cells oblong, oblong-eliptic or cylindrical.
         8. Cells very little twisted.

9. Cells oblong or oblong-eliptic, 106.4-111.0 × 14.0-16.5 μm, Rl:b = 6.7-7.2; posterior pole twisted towards one side while in displacement ..... *E. allorgei* var. *allorgei*
9. Cells cylindrical, 55.5-62.0 × 9.2-10.7 μm, Rl:b = 5.8-6.0; posterior pole straight or bent while in displacement ..... *E. gaumei*

8. Cells conspicuously twisted.
10. Cell 3-radiate in transverse optical section ..... *E. tripteris* var. *tripteris*
10. Cell elliptical in transverse optical section ..... *E. oxyuris* var. *oxyuris*

5. Chloroplasts large, (> 3.7 μm), numerous, rod, ring or disc-shaped
11. Cells fusiforms, chloroplasts ring or disc-shaped, highly metabolic, with pulsing movements during displacement ..... *E. repulsans*
11. Cells fusiforms at cylindrical-fusiforms, chloroplasts rod or disc- shaped.
12. Paramylum granules disc-shaped, more concentrated in the anterior portion of cell; cells rounded while metabolic ..... *E. hemichromata*
12. Paramylum granules disc or ring-shaped, scattered throughout the cytoplasm; cells top-shaped while metabolic ..... *E. proxima*

Euglena acus Ehrenberg var. *acus*, Die Infusionsthierchen als volkommene Organismen. 112, pl. 7, fig. 15. 1838.
Figures 2-3

Cell fusiform, little metabolic, 88.0-127.4 × 7.0-9.5 μm, Rl:b = 10.0-14.7; posterior pole attenuated in a colorless, conical caudal process, 14-16 μm long; pellicle rigid to semi-rigid, striae longitudinal, sometimes absent or so delicate that are of difficult observation; chloroplasts numerous, disc-shaped, parietal, 1.8-2.8 μm diam.; pyrenoids absent, paramylum granules 5 to numerous, rod-shaped, 11-14 × 3.5-4.6 μm; nucleus central, oblong, 6.0-8.3 μm long; stigma elliptic; flagellum ca. 0.5 times the cell length; displacement fast, reduced metaboly, can assume an S and J shapes.

Geographical distribution: widespread.

Comments: morphologically, *E. acus* is very similar to *E. limnophila* Lemm., from which differs in the cell dimensions, number of paramylum granules, and metaboly. *E. limnophila* has only two rod-shaped paramylum granules, one of which is anterior and the other one posterior to the nucleus, as well as smaller cell dimensions and cell length:cell breadth ratio, whereas *E. acus* has a greater number of usually rod-shaped sometimes narrowly fusiform paramylum granules, greater cell dimensions and cell length:cell breadth ratio, and is slightly metabolic.

Specimens measured 88.0-127.4 × 7.0-9.5 μm and could, based on measurements only, be identified either with those of the type-variety of the species or those of var. *rigida* and var. *major* of *E. acus*. It was also observed that pellicle striae density varied from very dense to not perceptible or even absent; and that paramylum granules varied from a few (ca. 5) in the small-sized individuals to 17 in the largest ones. Specimens seen also showed, as it was already noticed by Menezes (1994), that in the large-sized individuals flagellum was comparatively smaller than that of the small-sized ones.

Results above just reinforce the enormous phenotypical plasticity commonly displayed by *E. acus*, as it was already pointed out by Zakrýs (1986). Consequently, we presently preferred to identify all individuals presently seen with the type-variety of the species, *E. acus* var. *acus*.

Species can stand a broad temperature variation range. Cecy (1990) collected specimens living at temperatures from 16 to 23°C. Present individuals were collected at temperatures varying from 17 to 30°C. It was also possible to collect *E. acus* individuals in slightly acid to slightly alkaline waters (6.6-7.3).

Specimens identified were gathered in 1995, March, April, and July, and in 1996, January and February, i.e. during the summer, fall, and winter. Species presented low relative density in all sample units in which it was detected.

Euglena agilis H.J. Carter var. *agilis*, Annals and Magazine of Natural History, 18(105): 240, pl. 6, fig. 62. 1856.
Figures 4-5

Cell usually fusiform, strongly metabolic, 19.6-23.1 × 7.3-9.2 μm, Rl:b = 2.1-2.7; anterior pole suddenly

narrowed; posterior pole gradually attenuated in a colorless, conical caudal process, ca. 2 μm long; pellicle flexible, colorless, striae delicate, helicoidal; chloroplasts 2, shield-like, parietal, almost reaching the whole cell length, double-pyrenoids present; paramylum granules small, elongate; nucleus posterior, elliptic; stigma elongate, flagellum 1.5-2 times the cell length; active moving, displacement fast, in several directions, with anterior bending of cell.

Geographical distribution: widespread.

Comments: all observed specimens showed a marked metaboly, with a pronounced bulging of the anterior region of the cell and fast displacement, that made somewhat difficult identification of the species. However, presence of two shield-like, parietal chloroplasts, that takes the whole length of the cell, each with a double-pyrenoid allowed taxonomical identification with a high certainty degree.

According to Pringsheim (1948), *E. agilis* and *E. pisciformis* Klebs are identical to each other and their names must, consequently, be considered taxonomic (heterotypic) synonyms. Such a conclusion derives from the analysis of the original illustration of *E. agilis* in Carter (1856), pl. 1, fig. 5c. In fact, the original proposition of *E. agilis* was not accompanied by a Latin diagnosis and/or description. Twenty-seven years later, in 1883, identical specimens were described by Klebs under the name *E. pisciformis*. Since Latin description or diagnosis for a new taxon of non-fossil algae is mandatory from 1st. January 1958 on (art. 36.2 of the International Code of Botanical Nomenclature) (Greuter et al. 2000), the combination *E. agilis* must prevail over *E. pisciformis* on the basis of the priority principle.

E. agilis is morphologically similar to *E. minima* Francé, *E. nana* Johns., *E. minuta* Presc., *E. archaeoplastidiata* Chad., and *E. vivida* Playf., since in all of the latter species cell displacement is fast and cell dimensions relatively smaller. However, individual cells of *E. minima* measure 27 × 8-9 μm and have but a single chloroplast with rarely one, usually two pyrenoids; *E. nana* has cell dimensions of 13-17 × 6-9 μm, two concave-convex, elongate chloroplasts that measure 9-12 μm long and lie against the cell pellicle; *E. minuta* measures 12.0-13.5 × 5-6 μm and has but a single chloroplast with a single pyrenoid; *E. archaeoplastidiata* has cell dimensions of ca. 20 × 18 μm and two pyrenoids per cell, which are enclosed in a paramylum sheath; and *E. vivida* has cell dimensions of 22-31 × 7-9 μm and just one chloroplast with two parietal pyrenoids.

E. agilis was presently documented in all four climatic seasons of the year.

Euglena allorgei Deflandre var. *allorgei*, Bulletin de la Société botanique de France, 24: 116, fig. 1-2. 1924b. Figures 6-7

Cell oblong to oblong- elliptic, more or less metabolic, 106.4-111.0 × 14.0-16.5 μm, Rl:b = 6.7-7.2; posterior pole gradually attenuated, suddenly ending in a colorless, conical, bent to one side caudal process during cell displacement, 12.0-16.5 μm long; pellicle slightly granulate, granules almost imperceptible, rigid to semirigid, striae longitudinal, sometimes absent or so delicate that are of difficult observation; chloroplasts numerous, disc-shaped, parietal, 3.5-3.7 μm long; pyrenoid absent, paramylum granules 2, rod-shaped, 23.5-25.4 μm long, one anterior, the other one posterior to the nucleus; nucleus central or excentric, ca. 6 μm diam.; stigma elliptic, flagellum not observed; displacement through slow movements.

Geographical distribution: widespread.

Comments: *E. allorgei* can, if cell shape is considered, be mistaken by *E. oxyuris* Schmarda and *E. gaumei* Allorge & Lef., from which differs in having pellicle slightly granulate, longitudinal striae, and cell posterior pole ending in a caudal process bent to one side during cell displacement. *E. oxyuris* has helicoidal striae and cell posterior pole suddenly attenuated into a straight, conical, colorless caudal process; and *E. gaumei* has smaller cell dimensions, striae longitudinal, caudal process straight, conical, colorless, and a distinct cell displacement pattern.

For Németh (1980), *E. allorgei* includes one variety besides the typical, var. *granulifera* Ném. Cell dimensions of both varieties in Németh (1980) are practically coincident: *E. allorgei* var. *allorgei* = 105-114 × 13-14 μm and *E. allorgei* var. *granulifera* Ném. = 105.0-106.5 × 11.0-13.5 μm. Consequently, pellicle granules would constitute the only reliable diagnostic feature for separation of both varieties above. The few specimens we presently studied should be identified to those of var. *granulifera* because of their granulate pellicle despite, however, of the granules being not as evident as the ones in Németh (1980). Consequenly, we preferred for the time being to identify the specimens studied with those of the type-variety of the species until a greater

number of specimens be available for study and interpretation in culture condition, at population level, of the presence of granules.

Uherkovich (1981) registered the occurrence of the species in the Paracuni river and in the Calado Lake, both localities in the state of Amazonas with acid pH (4.7-6.2) and relatively high water temperature (29.2-30.0°C), whereas in present study occurred in pH between 6.6 and 8.0 and water temperature between 13°C and 30°C, what demonstrates that the species is highly tolerant to these two abiotic factors.

E. allorgei was present during all four climatic seasons of the year.

Euglena deses Ehrenberg var. *intermedia* Klebs, Untersuchungen der Botanisches Institüt Tübingen, 1(2): 303. 1883.
Figures 8-9

Cell cylindrical to oblong, 92.5-101.7 × 9.2-10.2 μm, Rl:b = 9.9-11.0; anterior pole rounded, flagellar pore subapical; posterior pole suddenly ending in a colorless, obtuse caudal process; pellicle semi-rigid, striae delicate, helicoidal, difficult to observe; chloroplasts, numerous, more than 20, disc-shaped, 4-8 μm long, parietal; naked pyrenoids; paramylum granules dimorphic, numerous, some rod-shaped or slightly elliptic, nucleus elliptic, central, ca. 9 μm long; stigma granulate, eliptic, flagellum 0.1-0.2 times the cell length. Movement reptant.

Geographical distribution: widespread.

Comments: Pringsheim (1956) considered *E. deses* a collective species because of its many descriptions and different denominations. Explanation for that many descriptions would be the high degree of morphological variability that *E. deses* may exhibit and the difficulty in defining what organism Ehrenberg (1838) really described.

According to Zackrýs (1986), differences between *E. deses* var. *deses* and *E. deses* var. *intermedia* are the kind of paramylum granule and the presence or absence of pyrenoid. In the *E. deses* var. *deses* representatives, pyrenoids are present and paramylum granules are small and rod-shaped, whereas in the *E. deses* var. *intermedia* there is no pyrenoid and paramylum granules are dimorphic. Zakrýs et al. (2001) studied the ultrastructure of the chloroplasts of the two varieties above and realized that both have pyrenoids and that the plastid organization is exactly the same.

E. deses var. *intermedia* and *E. mutabilis* look very much each other in being highly metabolic, what makes difficult immediate differentiation of the two species.

E. mutabilis is broadly fusiform, with slightly attenuate posterior pole that ends in a rather obtuse caudal process, few large chloroplasts with curved margins, and naked pyrenoids, whereas *E. deses* var. *intermedia* has numerous parietal, disc-shaped chloroplasts and dimorphic paramylum granules, some being numerous, rod-shaped or slightly elliptic, and a few ones large, rod-shaped.

E. deses var. *intermedia* was collected just during the spring and summer, and always in low numbers of cells.

Euglena gaumei Allorge & Lefèvre, Bulletin de la Société botanique de France, 24: 122-150. 1925.
Figures 10-11

Cell cylindrical, 55.5-62.0 × 9.2-10.7 μm, Rl:b = 5.8-6.0; posterior pole ending in a colorless, conical caudal process, 9.2-10.7 μm long; pellicle semi-rigid, striae longitudinal, very delicate, difficult to observe; chloroplasts numerous, disc-shaped, parietal, ca. 2.8 μm diam.; pyrenoid absent; paramylum granules 2, rod-shaped, 1 anterior, the other one posterior to the nucleus, nucleus not clearly observed; stigma irregular, flagellum 0.2-0.3 times the cell length; rotation movement intense, cell fastens itself by the caudal process and begins rotation from one side to the other, from left to right and vice-versa.

Geographical distribution: Europe, North America, and South America.

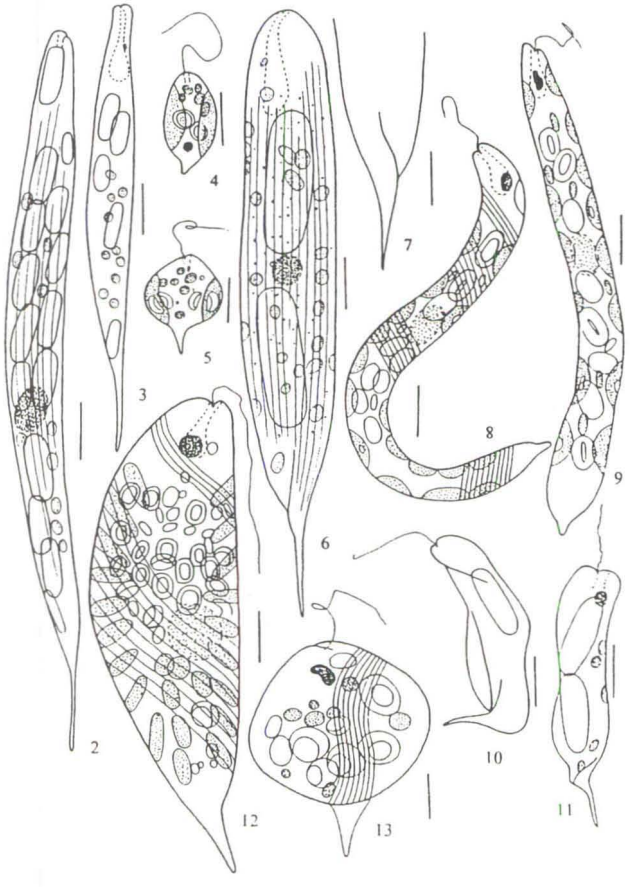
Comments: striae were not observed in the great majority of specimens seen. Furthermore, chloroplasts were disc-shaped and not elliptic as it was originally described for *E. gaumei* All. & Lef. All other characteristics, however, perfectly agreed with those of the species original description.

E. gaumei is morphologically very similar to *E. limnophila* Lemm., from which differs in having more metabolic cells and a distinct pattern of cell displacement. *E. gaumei* gives the impression of showing two torsions during its slow displacement, for what reason can be confused with *E. tripteris* (Duj.) Klebs. *E. tripteris* shows, however, a different pattern of cell displacement, rotating rather rapidly around its longitudinal axis. The latter species also has two or three very distinct longitudinal keels.

The species occurred during the fall, winter, and summer.

Euglena hemichromata Skuja, Symbolae botanicae upsalienses, 9(3): 185, pl. 21, fig. 10-13. 1948.
Figures 12-13

Cell fusiform to cylindric-fusiform, strongly metabolic, 95.3-106.2 × 18.5-23.1 µm, Rl:b = 4.3-5.7; anterior pole rounded, posterior pole gradually attenuated, suddenly ending in a colorless, obtuse caudal process, 8.3-9.2 µm long; pellicle flexible, striae very delicate, helicoidal, chloroplasts numerous, rod or disc-shaped (> 4.5 µm) , margins irregular, parietal, tendency towards a radial arrangement, filling most of the cell, sometimes replaced anteriorly by the paramylum granules that gives a colorless appearance to the anterior portion of cell and a greenish one to the posterior portion; paramylum granules numerous, globose to rod-shaped, sometimes perforate, 5-6 µm diam., nucleus elliptic, central, ca. 9 µm long, stigma elongate, granulate; flagellum 0.3-0.5 times the cell length.



Figures 2-3. *Euglena acus* var. *acus*. Figures 4-5. *Euglena agilis* var. *agilis*. 5. Detail of cell metaboly. Figures 6-7. *Euglena allorgei* var. *allorgei*. 7. Detail of caudal process. Figures 8-9. *Euglena deses* var. *intermedia*. Figures 10-11. *Euglena gaumei*. 11. Detail of cell metaboly. Figures 12-13. *Euglena hemicronata*. 13. Detail of cell metaboly. (Bar = 10 µm).

Geographical distribution: widespread.

Comments: cells very metabolic that swim very fast rotating along their longitudinal axis, changing continuously their shape through contractions of the anterior cell pole and of the median region, thus giving the cell a somewhat club shape. Meanwhile, the posterior cell pole remains projected and ends in a round or truncate caudal process.

E. hemichromata can, in what respects its overall morphology, be confused with *E. schmitzii* Gojd. (= *E. geniculata* Duj.) and *E. viridis* Ehr. *E. schmitzii* resembles *E. hemichromata* in the cell shape and length of flagellum, but not in the chloroplasts arrangement relatively far apart from each other. It also differs from *E. viridis* Ehr. in the smaller size of the individual cells and the chloroplasts touching each other in a central point of the cell. However, neither in *E. schmitzii* nor in *E. viridis* paramylum granules are so large and abundant.

E. hemichromata was collected all year round and in high relative densities in some of the months.

Euglena limnophila Lemmermann var. *limnophila*, Beihefte zum Botanischen Zentralblatt, 76(44-45): 152. 1898.
Figures 14-15

Cell fusiform, very little metabolic, 55.5-62.3 × 8.0-9.2 µm, Rl:b = 6.7-7.5; posterior pole ending in a colorless, conical caudal process, ca. 10.5 µm long; pellicle rigid, striae delicate, difficult to observe, chloroplasts numerous, disc-shaped, parietal, ca. 1.8 µm diam.; pyrenoid absent; paramylum granules 2, rod-shaped, 1 anterior, the other one posterior to the nucleus, 11.1-13.9 µm long; nucleus not clearly observed; stigma evident, flagellum not observed.

Geographical distribution: widespread.

Comments: *E. limnophila* has several taxonomic varieties that were proposed mainly on the basis of cell dimensions. Thus, for instance, Starmach (1983) accepted two varieties besides the typical one based on the following: *E. limnophila* measures 40-90 × 75-12(-13.6) µm, var. *lemmermanii* Drez. 52-98 × 10-12 µm, and var. *swirenkoi* (Arn.) Pop., that according to Starmach (1983) is a synonym of var. *minor* Drez., measures 24-40 × 7.5-12.0 µm. Németh

(1980) accepted two varieties that would differ according to the following: cells of the type-variety 60-90 × 8-12 μm, whereas those of var. *minor* 38-50 × 6-12 μm. Tell & Conforti (1986) considered metrical limits of 80-82 × 10 μm for *E. limnophila* var. *limnophila* and of 38-50 × 6-12 μm for var. *minor*. Finally, Zakrýs (1986) did not consider infraspecific categories in *E. limnophila* and reduced the species to its type-variety.

Specimens presented cell dimensions of 55.5-62.3 × 8.0-9.2 μm and Rl:b = 6.7-7.5, thus allowing their identification with either the species type-variety or its var. *minor*. In the present study, however, we preferred to adopt the suggestion of Zakrýs (1986), i.e. to consider just the type-variety of the species and consequently identify all specimens in the population with *E. limnophila* var. *limnophila*.

E. limnophila is morphologically very similar to *E. acus* and *E. megalithus* Skuja. Representatives of *E. limnophila* are different from those of *E. acus* in the cell length that vary in the latter from 47 to 311 μm. Furthermore, *E. acus* has from five to 17 rod-shaped paramylum granules per cell, whereas *E. limnophila* has consistently two. *E. megalithus* may, besides having greater cell dimensions (82-90 × 14-16 μm), also have one or two large paramylum granules, which measure ca. 28 × 7 μm.

Presence of *E. limnophila* var. *limnophila* in the reservoir was documented during the summer, fall, and winter.

Euglena oxyuris Schmarda var. *oxyuris*, Kleine Beiträge zur Naturgeschichte der Infusorien. 17, pl. 1, fig. 17. 1846.
Figure 16

Cell cylindrical, sometimes with a half median twisting, 160-231 × 25.4-27.7 μm, Rl:b = 9-12; posterior pole ending in a colorless, conical caudal process, 20-42 μm long; pellicle rigid to semi-rigid, striae helicoidal, following the cell body twisting; chloroplasts numerous, disc-shaped, parietal, 1.8-2.8 μm diam.; pyrenoid absent; paramylum granules 2, rod-shaped, 1 anterior, the other one posterior to the nucleus, ca. 15.0 × 4.6 μm; nucleus elliptic, central, ca. 27.7 μm diam.; stigma elongated, flagellum 0.2-0.3 times the cell length; movement reduced, displacement helicoidal, slow, changes in cell shape restricted to small bends of the cell body.

Geographical distribution: widespread.

Comments: there is much controversy regarding the cell dimensions of *E. oxyuris*. Among others, Schmarda (1846), Lemmerman (1910), Swirenko (1915), Playfair (1921), Drezepolski (1925), Johnson (1944), Chu (1946), Gojdics (1953), Huber-Pestalozzi (1955), and Zakrýs & Walne (1994) defined 95-490 μm and 16-48 μm, respectively, as the minimum and maximum metrical limits for the cell length and cell breadth of this species. Such limits practically include those of all infraspecific categories mentioned in Bourrelly (1949).

Previous papers based on material gathered from Rio Grande do Sul showed that *E. oxyuris* var. *oxyuris* may occur in systems ranging from acid (pH = 5.7-6.9) to alkaline (pH = ca. 10.2) and a rather broad temperature variation spectrum (12-33°C). Cecy (1990) mentioned that *E. oxyuris* is a commonly found species in waters with moderate amounts of organic matter. Populations presently studied were gathered from places with low organic matter content (1-19 mg L^{-1}) when compared with values registered by the latter author.

E. oxyuris var. *oxyuris* was collected during the spring and summer.

Euglena polymorpha Dangeard, Botaniste, 8: 175, fig. 12. 1901.
Figures 17-18

Cell fusiform, strongly metabolic, 79.0-84.2 × 20.0-24.1 μm, Rl:b = 3.4-3.6; anterior pole rounded; posterior pole suddenly attenuated in a colorless, conical caudal process, ca. 4.5 μm long; pellicle flexible, striae delicate, helicoidal; chloroplasts numerous, disc-shaped, margin irregular; double-pyrenoids present; paramylum granules numerous, rod-shaped, ca. 2.7 μm diam.; nucleus elliptic, central to posterior; stigma granulate; flagellum not observed; highly metabolic, assuming varying shapes during displacement.

Geographical distribution: Asia, Europe, North America, and South America.

Comments: specimens studied were highly metabolic, with strong contortions of the anterior cell pole that would make it broadly enlarged whereas the posterior one would remain attenuate (conical). Consequently, cell would assume an obovoid to top shape, with a strong tendency towards formation of spheres; however, caudal process remained always rigid.

According to Pringsheim (1948), Dangeard has for a long time mistaken *E. polymorpha* for *E. velata* Klebs, although both species have very different chloroplasts. Pringsheim (1948) stated that despite having a very elaborate description, *E. polymorpha* is not yet a well circumscribed species. It can be distinguished from *E. granulata* (Klebs) Lemm. in the lack of granules and spiral muciferous bodies; and from *E. sociabilis* Dang. in the more rounded shape of the cell, more evident and numerous pellicle striation, more numerous chloroplasts, much longer flagellum, and lack of fusiform muciferous bodies.

E. polymorpha was gathered during the summer, winter, and spring.

Euglena proxima Dangeard, Botaniste, 8: 154, fig. 6. 1901.
Figures 19-21

Cell fusiform, strongly metabolic, 52-54 × 13.8-17.1 μm, Rl:b = 3.1-3.7; posterior pole gradually attenuated in a short, colorless, obtuse caudal process, ca. 5 μm long; pellicle flexible, colorless, striae helicoidal; chloroplasts disc-shaped, parietal, numerous (> 20), 3.8-4.6 μm long; pyrenoid absent; paramylum granules numerous, disc or ring-shaped; nucleus not observed; stigma conspicuous, granulate, ca. 4 μm diam.; flagellum ca. 0.3 of cell length, movement slow, rotational; metaboly intense, contortions irregular, more pronounced at the anterior part of cell.

Geographical distribution: widespread.

Comments: Pringsheim (1956) referred to considerable cell length variation in *E. proxima* within one same population, but mainly among cells from different populations. Average for those measurements is, however, between 50 and 65 μm. The same author also commented on the difficulty of taking the cell length with precision due to the intense metaboly of the representatives of this species (Pringsheim, 1956). Finally, the same author compared *E. proxima* with *E. variabilis* Klebs stating that they differ in their cell dimensions, cell shape, degree of metaboly, and in having some small granules located near by the nucleus (Pringsheim 1956).

According to Zakrýs (1986), *E. proxima* is distinct from *E. spathirhyncha* Skuja in the shape of its caudal process. In *E. proxima* caudal process is short and obtuse, whereas in *E. spathirhyncha* it is acuminate and colorless. It should, however, be added that *E. spathirhyncha* has comparatively more pronounced pellicle striation.

Present specimens showed strong metaboly at the cell midregion, similar to that described for *E. spathirhyncha.* Such specimens differ, however, from those of *E. spathirhyncha* in their obtuse caudal process. Nucleus was never observed in the present specimens, despite of being very conspicuous in the illustrations of Pringsheim (1956). However, cell measurements of the present specimens agree very much with those in Pringsheim (1956), 50-65 μm long and Németh (1980), 52-80 × 13-25 μm.

Species was collected during spring, summer, and winter.

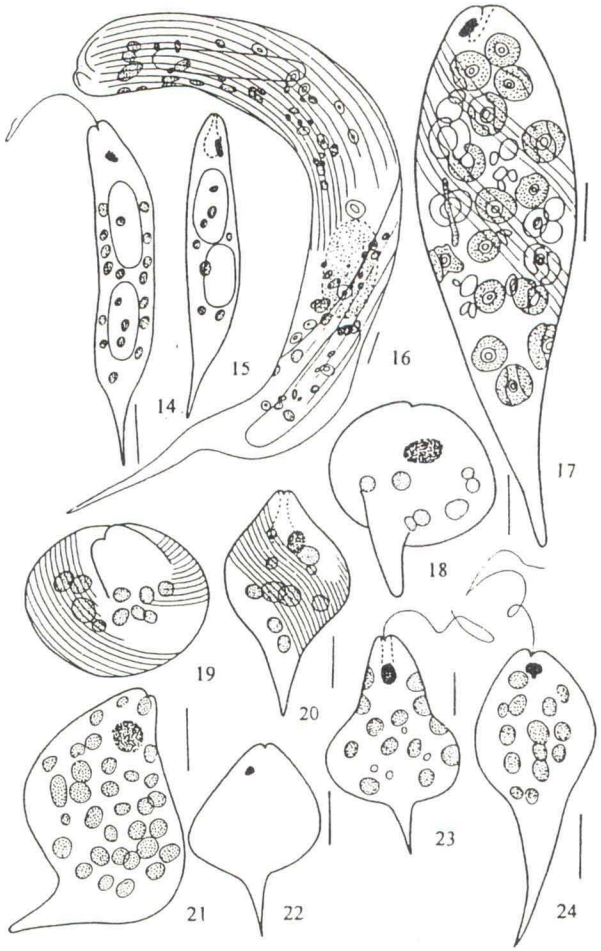
Euglena repulsans Schiller ex Huber-Pestalozzi, Das phytoplankton des Susswässers, 16(4): 115. 1955.
Figures 22-24

Cell fusiform, strongly metabolic, 51.0-53.3 × ca. 18.5 μm, Rl:b = 2.7-2.9; anterior pole suddenly attenuated; posterior pole gradually attenuated in a colorless, conical caudal process, ca. 7.5 μm long; pellicle flexible, colorless, striae not observed; chloroplasts more than 12, disc-shaped, parietal, 3.8-4.6 μm long; pyrenoid absent; paramylum granules numerous, disc-shaped, small; nucleus not observed; stigma conspicuous, granulate, ca. 3.3 μm diam., flagellum about as long as the cell length; displacement very fast, pulsating movements during displacement, contortions irregular, more intense in the cell midregion.

Geographical distribution: Australia and North America. First reference to the occurrence of the species in Brazil.

Comments: specimens examined were highly metabolic and swam very fast, with pulsing movements during displacement. Pulsation included the entire cytoplasm, from the anterior portion of the cell to the posterior one and vice-versa, including chloroplasts and paramylum granules, thus making extremely difficult exact description of the cell shape. Cell displacement made that the anterior portion of the cell would suddenly narrow up whereas the posterior one would remain conical, ending in a rather long caudal process. During cell contraction movements, caudal process varied in size from short to long, but the cell always kept its rounded shape.

All specimens presently identified were slightly smaller than the metrical limits in Huber-Pestalozzi (1955) of 60-63 × 20-22 μm). However, the strong



Figures 14-15. *Euglena limnophila* var. *limnophila*. Figure 16. *Euglena oxyuris* var. *oxyuris*. Figures 17-18. *Euglena polymorpha*. 18. Detail of a top shaped cell. Figures 19-21. *Euglena proxima*. 21. Optical transverse section. Figures 22-24. *Euglena repulsans*. 22-23. Detail of cell metaboly. (Bar = 10 μm).

contraction movement described for the species confirmed identification of present specimens with *E. repulsans*, despite of our difficulty in illustrating all changes in cell shape.

E. repulsans was collected during all four climatic seasons of the year.

Euglena splendens Dangeard, Botaniste, 8: 69, fig. 9. 1901.
Figures 25-28

Cell fusiform, strongly metabolic, 64.7-85.5 × 18.5-23.1 μm, Rl:b = 3.3-3.7; anterior pole rounded; posterior pole gradually attenuating in a colorless, conical caudal process, ca. 6 μm long; pellicle flexible, striae helicoidal; chloroplasts ca. 12, axial, disc-shaped, longitudinal incisions deep, projections irradiating towards the cell periphery like narrow, anastomosing bands, disposed in a helix; double-pyrenoids present; paramylum granules numerous, rounded, mainly concentrated in the midregion of cell, ca. 2 μm diam.; mucocysts fusiform, ca. 0.9 μm diam.; nucleus central, elliptic; stigma elongate; flagellum 0.5-1 times the cell length; movement active; displacement fast, around its longitudinal axis, rounding up very easily.

Geographical distribution: widespread.

Comments: it was difficult to identify *E. splendens* for three reasons. First, because it belongs to a group in which species are morphologically very much similar to each other. Second, because it has a very complex chloroplast-pyrenoid system. Finally, because it shows a strong tendency towards forming spheres, a fact that made observation and representation of specimens a very difficult task.

Menezes (1989, 1994) and Xavier (1988) discussed in details the taxonomic distinction between representatives of *E. splendens* and those of *E. sanguinea* Ehr. and *E. oblonga* Schmitz that very closely resemble the first one.

The main diagnostic characteristic of *E. splendens* is the constant presence of mucocysts, which vary from some much deeper and fusiform to some others superficial and globose, which are always organized in irregular helicoidal series in between the pellicle striae.

Gojdics (1953) stated that since *E. oblonga* and *E. splendens* were originally described, much controversy about their mantainance as separate species has been accumulated due to their very close morphological resemblance to each other, to the point that Skuja (1948) considered the two just one species. Gojdics (1953), however, kept them separate differing the two species by just the shape of their muciferous bodies that are globose in *E. oblonga* and fusiform in *E. splendens*.

E. splendens was collected during the entire study period. Palmelloid stages with one, two and even three cells were observed.

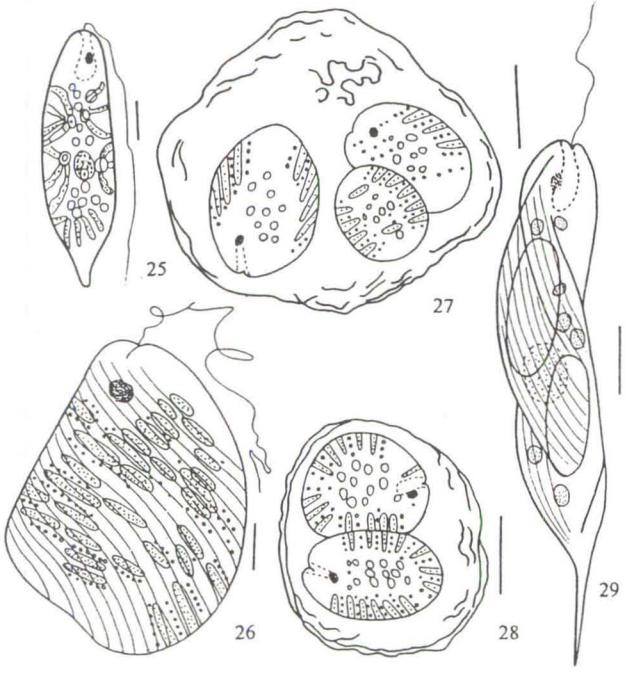
Euglena tripteris (Dujardin) Klebs var. *tripteris*, Untersuchungen der Botanisches Institüt Tübingen, 1: 306. 1883.
Figure 29

Cell fusiform, twisted, 3-radiate in transverse optical section, 67.5-106.4 × 11.1-15.7 μm, Rl:b = 5.0-7.6; anterior pole rounded; posterior pole gradually attenuated in a colorless, conical caudal process, ca.

14 µm long; pellicle flexible, striae longitudinal, delicate, following the cell torsion; chloroplasts numerous, disc-shaped, parietal, 2.8-3.7 µm diam.; paramylum granules 2, rod-shaped, larger one 24.9-26.8 µm long, smaller one 14.8-17.5 µm long, located 1 anterior, the other one posterior to the nucleus; nucleus somewhat central, oblong, ca. 9 µm long; stigma granulate, 3.7-4.6 × ca. 1.8 µm; flagellum 0.3-0.5 times the cell length; displacement fast, rotation movement helicoidal.

Geographical distribution: widespread.

Comments: During the present study two well distinct populations of *E. tripteris* were identified, which could be separated by the size of their component specimens. One of them, composed by the small-sized individuals presented cell length from 67.5 to 85.1 µm, cell breadth from 12.0 to 15.7 µm, and Rl:b = 5.0-5.4; the other one, composed by the large-sized individuals presented cell length from 86.0 to 106.4 µm, cell breadth from 14.0 to 15.7 µm, and Rl:b = 6.4-7.6. In the small-sized individuals population, it was also observed a comparatively greater torsion of the cell, which was apparently used for the cell displacement since their movement was much faster, with spiral rotations around the longitudinal axis of the cell.



Figures 25-28. *Euglena splendens*. 26. Detail of cell metaboly and presence of globular mucocysts. 28. Palmelloid stage of *E. splendens* with two and threee individual cells. Figure 29. *Euglena tripteris* var. *tripteris*. (Bar = 10 µm).

Literature shows considerable variation of cell dimensions in *E. tripteris*. Thus, for example Chu (1946) mentioned 70-190 × 11-23 µm, Gojdics (1953) 62-74 × 12-15 µm, Huber-Pestalozzi (1955) 70-80 × 8-14 µm, Pringsheim (1956) 65-203 × 8-22 µm, Starmach (1983) (54-)150-210 × (8-)10-24 µm, and Zakrýs & Walne (1994) 95-135 × 12.0-17.6 µm.

Metrical limits (table 1) of *E. tripteris* summed up are 53-128 × 11.5-19.6 µm, whereas those of the two populations from the Contention Basin n. 7 are 67.5-106.4 × 11.1-15.7 µm, with Rl:b = 5-7.6, i.e. well inside the limits defined for the species in the Brazilian literature.

Table 1. Metrical limits and cell lenght / cell breadth ratio of *Euglena tripteris* registered in the literature from the study of Brazilian material.

Author	Lenght (µm)	Breadth (µm)	Rl:b
Cardoso (1979)	102.8	12.9-18.0	5.6-7.9
Menezes (1989)	70-90	11.5-18.0	5.0-6.1
Cecy (1990)	53	12-18	3.5-4.4
Franceschini (1992)	71-128	13	5.4-9.8
Xavier (1994)	63-73	12-16	4.5-5.4
Alves da Silva & Torres (1994)	85.5-115.5	13.9-19.6	5.5-7.6
Jati & Train (1994)	115.2	19.2	6

E. tripteris morphologically resembles very much *E. oxyuris*, *E. fronsundulata* L.P. Johns., *E. pseudospiroides* L.P. Johns., and *E. trisulcata* L.P. Johns. It differs from *E. oxyuris* in the greater cell torsion and in the transverse optical section of cell which is 3-radiate in *E. tripteris* and elliptical in *E. oxyuris*; from *E. fronsundulata* in the greater cell dimensions and in the Y-shaped transverse optical section of cell; from *E. pseudospiroides* in the faint striation of pellicle which follows the cell torsion; and from *E. trisulcata* in the smaller cell dimensions (62-210 × 8-24 µm), more pronounced twisted cell, much greater (2.8-3.7 µm diam.) disc-shaped chloroplasts, and much longer flagellum.

Alves-da-Silva & Torres (1994) reported *E. tripteris* from shallow ponds at the Parque Zoológico do Rio Grande do Sul, whose pH varied between 6.2 and 8.5 and water temperature between 13 and 28.5°C. Greatest occurrence of specimens was at acid to neutral pH (6.2-7.0) and temperature above 24°C. Cecy (1990) mentioned that the species is frequent in organic matter rich waters and in estabilization ponds. The latter author found *E. tripteris* in localities with pH 6.3, water temperature 21°C, and high amounts of organic matter (Cecy 1990).

Table 2. Presence of representatives of *Euglena* at Contention Basin n. 7, sampling stations 1 and 2, during 1995, February to 1996, March.

	1995																						1996					
Sampling month	February		March		April		May		June		July		August		September		October		November		December		January		February		March	
Sampling station	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S2		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
E. acus var. *acus*			X		X						X												X		X	X		
E. agilis var. *agilis*	X		X	X	X	X		X		X								X	X	X		X			X			
E. allorgei var. *allorgei*						X					X			X							X	X						
E. deses var. *intermedia*																						X		X		X		
E. gaumei							X	X						X								X			X			
E. hemichromata		X	X				X				X				X		X			X						X	X	X
E. limnophila var. *limnophila*			X		X									X										X	X		X	
E. oxyuris var. *oxyuris*			X												X		X											
E. polymorpha		X	X	X					X									X				X			X	X		
E. proxima			X	X							X	X								X		X						
E. repulsans					X		X	X			X		X							X		X	X					
E. splendens			X		X		X		X		X	X	X	X			X	X	X									X
E. tripteris var. *tripteris*			X			X	X				X			X			X		X		X	X	X	X	X	X	X	X

Xavier (1994) mentioned that *E. tripteris* can be either a planktonic or a benthic species in ponds at the Parque Zoológico de São Paulo. At present, only plankton was studied.

E. tripteris was collected all four climatic seasons in comparatively high numbers, and occurred in about 58% of the sample units studied.

Conclusions

Best represented taxa during the study period because were either collected all year round, occurred in a significant number of sample units or showed high relative densities were: *E. hemichromata*, *E. splendens*, and *E. tripteris* var. *tripteris*.

E. repulsans is presently cited for the first time for the Brazilian territory.

Cell dimensions and presence of striae in the pellicle were not considered for distinction of infraspecific categories of *E. acus*, since such characteristics displayed continuous variation spectra within each population examined as well as in all of them.

Cultivation of *E. allorgei* in laboratory should be conducted to know wheather granules are formed in the pellicle under controlled conditions.

Metrical limits of cell length and cell breadth of most *Euglena* specimens presently observed fall within the world wide accepted variation range of their respective taxa. In several other taxa, however, such limits are much greater than those in the literature. Notwithstanding, a close resemblance in the cell length: cell breadth ratio was always noticed. This strongly suggests that the cell length: cell breadth ration is far more important for taxonomical purposes than the raw measurements themselves.

E. deses var. *intermedia*, and *E. limnophila* var. *limnophila* were considered rare, since they occurred during at most two of the 14 sampling months. Only *E. gaumei*, *E. polymorpha* and *E. repulsans* out of the 13 species currently identified presented somewhat restrict geographical distribution. All other ones were cosmopolitan.

E. agilis var. *agilis*, *E. allorgei* var. *allorgei*, *E. hemichromata*, *E. repulsans*, *E. splendens*, and *E. tripteris* occurred in all four climatic seasons. All other ones were present in just one, two or three climatic seasons (table 2).

All species, varieties, and taxonomic formae of *Euglena* studies here were not selective to pH, since they were collected in environments that varied from acid to alkaline.

E. polymorpha was the only species that occurred in ranges of temperature below 10 °C; all other species showed high ranges of tolerance to temperature.

Acknowledgments

Senior author acknowledges Coordenação de Aperfeiçoamento de Pessoal do Ensino Superior (CAPES), for partial financial support; to artist Rejane Rosa, for the final inking of the original drawings, and Laboratório de Geoprocessamento, Museu de Ciências Naturais, Fundação Zoobotânica do Rio Grande do Sul.

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