

Composition, Occurrences and Checklist of Periphyton Algae of Some Water Bodies Around Benin City, Edo State, Nigeria

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Abstract

This paper presents an investigation of the periphyton algae of five rivers around Benin City. The rivers studied were River Okhuaihe (station I), River Ikpoba (station II), River Ossiomo, Ologbo station (station III), River Siluko (station IV) and River Ogba (station V). Samples were collected monthly for periphyton and physico-chemical analysis. Periphyton samples were collected by scraping the roots, leaves and stems of aquatic macrophytes, dead and felled logs submerged on the banks of the rivers as well as from rocks embedded in the substratum while water samples for physical and chemical parameters were collected directly into clear plastic containers. The rivers were acidic with a pH range of 5.10-6.31 and very low in nutrients. A total of 87 taxa of periphyton algae were identified and categorized into 4 divisions, 11 orders, 9 families and 44 genera. The distribution among the division was Chlorophyta 64.37%, Bacillariophyta 22.99%, Cyanophyta 5.75% and Euglenophyta 6.89%. The majority of the green periphyton algae were desmids.

Key words: Periphyton, rivers, physico-chemical, taxa.

Introduction

All water bodies in the tropics have submerged substrates (stones, plants and logs) covered at least in part by a community of periphyton. The factors controlling the species composition, distribution and biomass of periphyton species are physico-chemical, biological and hydrological cycle (Chindah, 2004). Periphyton is a complex mixture of algae, cyanobacteria, heterotrophic microbes and detritus that attached to submerged surfaces in most aquatic ecosystem. It serves as an important food source for invertebrates, tadpoles and some fish. It is exposed to contaminants in the water column and can absorb them into their body tissues. The periphyton is also an important indicator of water quality (Azim *et al*, 2006).

Attached algae are primitive plants that get their nutrients from water passing over them. Almost every part of an algal cell takes up nutrients. Terrestrial plants take nourishment primarily from only specialized cells in their roots. Algae utilize carbon dioxide during photosynthesis to produce food which the other rung in the aquatic food chain depend directly or indirectly on as food source. Periphyton is capable of nutrient pollution removal down to very low pristine ranges. Reports on algal periphyton community includes those of Chindah (2004), Chindah *et al* (2006).

There is a dearth of information on periphyton algae in these rivers. This paper aims to investigate the composition and occurrence of the periphyton algae in the different rivers as well as provide a background information on the physical, chemical and trophic status of the rivers.

Study Area

In this study, rivers (Okhuaihe, Ikpoba, Ossiomo, Siluko and Ogba) were investigated. The rivers are situated at extreme ends of Benin City and are affected by two main climates; the dry season which commences in November till April. It is often accompanied by dry, dusty harmattan winds from December to January, and the rainy season starts in May and continues till October or November. The river waters are fresh in both seasons as there is no influence of sea water. Human activities on the rivers include fishing, washing or clothes and commercial activities.

Methodology

Samples for the study were collected on monthly basis for eight months from December 2001 to July 2002, for both physical and chemical factors and periphyton algae. Standard methods as described in APHA (1985) were followed for the determination of water quality parameters studied at the Benin Owena River Basin Laboratory in the University of Benin. At each station, water temperature was measured using mercury in glass thermometer. pH values of the water samples were determined by using a Jenway digital pH meter model 3305. Means of mostly readings were calculated for all variables. Analysis of variance (ANOVA) was also performed to detect significant difference between stations. Periphyton samples were scraped from roots, leaves and stems of aquatic macrophytes, dead and felled logs submerged on the banks of the rivers as well as from rocks embedded in the substratum. The periphyton samples were preserved in a solution of 4% formaldehyde in a 500ml plastic container.

Examination was done at the phycology laboratory in the University of Benin in Benin City using Leitz Orthoplan Universal Wide-Field micro scope equipped with tracing and measuring devices while identification and classification of periphyton algae were carried out with the aid of the works and publications of Kadiri (1987) and Opute (1991, 2000 and 2003).

Results

Physico-Chemical Parameters

The minimum pH of 5.10 in April was recorded in station 1 while the highest of 6.67 was recorded in station 2 in January. The recorded temperature ranged between 27.87°C and 30.50°C for air and 25.56°C - 27.18°C for water. Total dissolved solids ranged between 22.13mg/l in station 4 to 32.12 mg/l in station 1. Dissolved oxygen values ranged between 6.25mg/l 0.03 in station 2 to 7.00mg/l. Lowest sulphate value was 0.03 in station 1 and highest was 0.11mg/l in station 4. The minimum value of nitrate was recorded in stations 1 and 5 (0.04mg/l respectively) and the highest, 0.09mg/l in station 4. Highest phosphate concentration was 0.36mg/l in station 4 and lowest concentration was 0.30mg/l in stations 2, 3 and 5 (see Table 1).

Periphyton Composition

A total of 87 taxa of periphyton belonging to four divisions-Chlorophyta (56), Bacillariophyta (20), Cyanophyta (5) and Euglenophyta (6) were identified (see Table 2).

The Chlorophyta were represented by 6 orders and 9 families. The orders were Zygnematales, Chlorococcales, Oedogoniales, Ulotricales, Siphonocladales and Volvocales. The families on the other hand were Desmidiaceae, Gonatozygonaceae, Mesotaeniaceae, Zygnemataceae, cenedesmaceae, Oedogoniaceae, Ulotrichaceae, Cladophoraceae, Volvocaceae. The order Zygnematales constituted the bulk of Chlorophyta with a record of over half of the taxa found. They were mainly members of Desmidiaceae.

The Bacillariophyta were represented by 2 orders, the Centrales (families Coscinodiscaceae, Melosiraceae and Thalassiosiraceae) and Pennales (families Naviculaceae, Eunotiaceae, Diatomaceae and Surirellaceae). Of all these families, Naviculaceae (6 taxa) and Diatomaceae (7 taxa) were better represented than others. Cyanophyta was represented by Chroococcales (family

Chroococaceae) and Nostocales (family Oscillatoriaceae) with 2 and 3 taxa each. Euglenophyta were entirely Euglenales (family Euglenaceae) being represented by species of *Euglena* (2), *Leopocinclis* (1), *Phacus* (1) and *Trachelomonas* (2).

Generally, the division Chlorophyta constitute about 64.37% of the entire periphyton algal population. About 41.3% of this was made of desmids. Bacillariophyta accounted for 22.99% of the total periphyton algae of which the pennate forms dominated by 19.4%. A contribution of 5.75% and 6.89% was made by members of the Cyanophyta and Euglenophyta divisions respectively as shown in Figure 1.

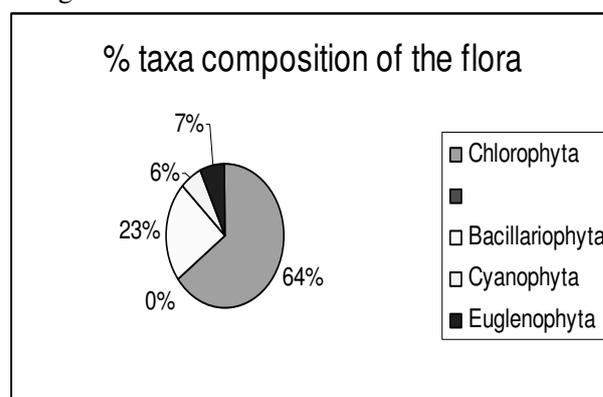


Fig 1: Percentage composition of periphyton algae in studied water bodies area

Distribution

Majority of the diatoms (Bacillariophyta) were found in stations 1, 3 and 4. The Chlorophyta members were mostly seen in stations 1 and 3 while some Cyanophyta and Euglenophyta members were mostly found in station 4 (see Table 3).

Specifically, taxa which occurred in 3 stations and above include, *Frustulia rhomboides*, *Naviculla* sp, *Eunotia flexuosa* and *Fragillaria* sp. (for diatoms) and *Closterium libellula*, *Cl. pseudolunula*, *Cosmarium contractum*, *C. sp.*, *Hyalotheca dissiliens*, *Spirogyra dudia* and *S. sp.* (for Chlorophyta). Other species occurred in 1 or 2 stations only.

Discussion

The acidic pH observed in the rivers is expected and has been reported in similar river systems where litter falls underlying the river bed impacts on the water through the process of decay thereby introducing humic substances that induce acidic conditions (Chindah *et al.*, 2006). The acidic nature of the pH values is also attributable to geological and biochemical

factors within the river catchment, which may be poor in lime or silica (Akpan *et al*, 2003).

Relatively higher values of air and water temperatures were recorded in the dry months (December to March) than in the wet months (April to July). This could be attributed to increased cloud cover and consequent reduction in solar radiation (Onyema, 2007).

Values for total dissolved solids were low throughout the study, an indication that the rivers were not under intense pressure from pollution such as untreated sewage, sawdust, petrochemical materials, detergent and industrial effluents (Onyema, 2007).

Mean dissolved oxygen concentration ranged from 6.25 ± 0.56 mg/l to 7.35 ± 0.52 mg/l and shows that the running waters were well aerated irrespective of stations. This is expected as it is a running water where dissolved oxygen is usually a limiting factor due to direct diffusion at the surface and surface water agitation like turbulence (Imoobe and Oboh, 2003 and Kadiri, 2000).

Nutrients (sulphate, nitrate and phosphate) values were low throughout the study, an indication of their low concentration in the surrounding watershed. The water bodies in stations 1,2 and 5 were poor in nutrient which may have resulted in the non-occurrence of these divisions. Saliu and Ekpo (2006), supported this by stating that increase in nutrient elements, PO_4^- and NO_3^- suggested organic pollution and nutrient enrichment.

In eutrophic and hypereutrophic waters where high nutrients are being supplied continuously, the high level of nutrient would also support the coexistence of many phytoplankton species and high productivity, resulting in high diversity (Ichimura and Ogawa, 1984). But from this study, low level of nutrients was observed. On the other hand, the scouring effect of floodwaters could have dislodged attached forms, leading to a reduction of occurrence of members of these divisions (Onyema, 2007). A total of 87 taxa of periphyton algal flora were identified. The periphyton algal community observed in this study is taxonomically dominated by Chlorophyta 64.37% followed by Bacillariophyta 22.99%, Euglenophyta and Cyanophyta with 6.89% and 5.75% respectively. The order of dominance of the major algal groups in this study is however at variance with the report of Chindah *et al*

(2006), who stated that the general trend of the community structure pattern of Bacillariophyceae, > Chlorophyceae, > Euglenophyceae, > Chlorophyceae had been the trend reported for most freshwater systems with limited disturbance. However, the difference in algal assemblages between stations in this study and the above trend, may be explained in part by the microhabitat differences in water quality habitat variability and perturbation which corresponds to the occurrence of some species particularly members of the Chlorophyta group (Chindah, 2004).

There were variations in the periphyton species assemblages amongst the stations studied. In station 1, the division Chlorophyta occurred most with a wide assortment of desmids occurring freely (41.3%). Particularly impressive among the desmids were the genera *Cosmarium* and *Closterium*. Members of the Volvocales (*Eudorina*, *Pandorina*, *Pleodorina* and *Volvox*) and Zygnematales (different species of *Spirogyra* and *Mougeotia*) also occurred. The high percentage of desmids in this study could be that they are typically freshwater and characteristic of acidic and nutrient poor aquatic ecosystems (Kadiri, 2002). The occurrence of abundance of desmids is an indication that the water body is largely unpolluted (Kadiri and Omozusi, 2002). The diatoms species found in the different stations included the genera, *Melosira*, *Synedra*, *Eunotia* and *Frustulia*. Diatoms encountered in this study occurred in all the stations with slight variations but more occurring in station 1 and the lowest species occurring in station 5. The pennate forms dominated with 19.4%. The dominant pennate genera were *Frustulia* and *Fragillaria*. 43 diatoms species belonging to 19 genera and dominated by pennate forms were recorded in the investigations of bottom dwelling diatoms of a West African Lagoon sewage disposal site (Nwankwo, 1994). Members of the Cyanophyta and Euglenophyta divisions did not occur in stations 1, 2 and 5. This could be attributed to the lack of activities such as auto mechanic workshops and other domestic discharges in the stations which would have enhanced the occurrence of the blue-green algae (Chindah *et al*, 2006). This was also corroborated by the report of Kadiri (1999), who reported that euglenoids and blue-greens could be qualitatively less numerous as they are characteristic of eutrophic or nutrient

rich water bodies. Substrate preference may have been responsible for the higher occurrence of some divisions over others as observed in this study. It is necessary to suggest that the

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substrate type and some environmental attributes are critical to the development of periphyton (Chindah, 2004).

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Table 1: Physico-Chemical parameters

Parameters	ST.1 Okhuaihe		ST.2 Ikpoba		ST.3 Ossiomo-Ologbo		ST.4 Siluko		ST.5 (Ogba)	
	pH	5.10- 6.12	5.56 ±0.11	5.44- 6.67	5.93 ±0.17	5.21- 6.40	5.79 ±0.12	5.57- 7.20	6.31 ±0.17	5.33- 6.25
Air Temperature °C	27.50- 30.20	28.27 ±0.37	27.50- 36.80	30.03 ±1.2	29.00- 35.00	30.50 ±0.75	27.00- 32.50	28.87 ±0.60	27.00- 32.50	28.87 ±0.60
Water Temperature °C	24.00- 26.50	25.50 ±0.33	24.50- 27.00	25.87 ±0.27	25.00± 28.00	26.87 ±0.36	26.00- 29.50	27.18± 0.45	25.00- 27.00	26.25 ±0.23
Total dissolved solids (TDS)(Mg/l)	25.10- 35.50	32.12± 1.50	19.40- 41.00	28.66 ±2.94	18.40± 45.00	29.22 ±3.09	15.50- 34.00	22.13± 5.59	21.50- 42.50	31.21 ±2.69
Dissolved oxygen (Mg/l)	4.80- 10.00	7.00±0. 59	3.20- 9.60	6.25 ±0.75	5.60- 9.60	7.35 ±0.52	5.60- 8.80	6.70±0. 40	4.80- 9.60	6.25 ±0.56
Nitrate (NO ₃) (Mg/l)	0.03- 0.07	0.04±0. 004	0.05- 0.10	0.07 ±0.007	0.04- 0.01	0.07 ±0.008	0.05- 0.14	0.09±0. 009	0.02- 0.07	0.04 ±0.005
Sulphate (SO ₄) (Mg/l)	0.02- 0.05	0.03±0. 004	0.08- 0.14	0.10 ±0.007	0.05- 0.12	0.08 ±0.008	0.07- 0.16	0.11±0. 01	0.03- 0.17	0.09 ±0.01
Phosphate (PO ₄)(Mg/l)	0.21- 0.46	0.31±0. 03	0.19- 0.44	0.30 ±0.02	0.13- 0.42	0.30 ±0.03	0.14- 0.52	0.36±0. 04	0.17- 0.41	0.03 ±0.03

Table 2: Periphyton algal composition of some water bodies around Benin City

Division	Classes	Orders	Families	Genera	Total taxa	% taxa composition of the flora
Chlorophyta	Chlorophyceae	6	9	26	56	64.37
Bacillariophyta	Bacillariophyceae	2	7	11	20	22.99
Cyanophyta	Cyanophyceae	2	2	3	5	5.75
Euglenophyta	Euglenophyceae	1	1	4	6	6.89
Total	4	11	19	44	87	100.00

Table 3: Periphyton checklist and occurrence in The Studied water bodies around Benin City.

DIVISION: BACILLARIOPHYTA	ST. Okhuaihe	ST2 Ikpoba	ST3 Ossiomo -Ologbo)	ST4 Siluko	ST5 Ogba
CLASS: Bacillariophyceae ORDER: Centrales Family: Conscinodiscaceae Genus: <i>Conscinodiscus</i> Ehrenberg <i>Conscinodiscus centralis</i> Ehrenberg	+				
Family: Melosiraceae Genus: <i>Melosira</i> Agardh <i>Melosira nyassensis</i> Muller var. <i>victoriae</i> Muller	+		+		
Family: Thalassiosiraceae Genus: <i>Aulacoseira</i> Thwaites <i>Aulacoseira granulata</i> var. <i>angustissima</i> (Muller) Simonsen	+		+		
ORDER: Pennales					
Family: Naviculaceae Genus: <i>Cymbella</i> Agardh <i>Cymbella</i> sp. Genus: <i>Frustulia</i> Rabenh <i>Frustulia rhomboides</i> (Ehr.) DeToni	+	+	+	+	

Table 3 contd.

Genus: <i>Navicula</i> Rabenh <i>Navicula</i> sp. Genus: <i>Pinnularia</i> Ehrenberg <i>Pinnularia cardinaliculus</i> Cleve	ST 1	ST. 2	ST. 3	ST. 4	ST. 5
	+	+	+		
					+
<i>P. subcapita</i> Greg. <i>P. viridis</i> (Nitzsch) Ehr. Family: Eunottiaceae Genus: <i>Eunotia</i> Ehrenberg <i>Eunotia flexuosa</i> Breb and Kutz	+		+	+	
<i>E. monodon</i> (Ehr). var. <i>tropica</i> Hust. <i>E. garussica</i> Chohn.				+	+
Family: Diatomaceae Genus: <i>Fragillaria</i> Lyngb. <i>Fragillaria javanica</i> Hustedt	+		+		
<i>F.</i> sp. Genus: <i>Synedra</i> Ehrenberg <i>Synedra acus</i> Kutz.	+	+	+	+	
<i>S. superba</i> Kutz <i>S. ulna</i> (Nitzsch) Her Genus: <i>Tabellaria</i> Ehrenberg <i>Tabellaria</i> sp	+			+	
	+		+		
<i>T. flocculosa</i> (Rothe) Kutz.					+
Family: Surirellaceae Genus: <i>Surirella</i> Turp. <i>Surirella elegans</i> Ehr.			+	+	
<i>C. sabbulteum</i> Schmidle var. <i>maius</i> Thom <i>C. subariculatum</i> West var. <i>bogoriense</i> (Bern)	+				
	+				
<i>C.</i> sp. Genus: <i>Desmidium</i> (Agardh) Ralfs <i>Desmidium quadratum</i> Nordst Genus: <i>Euastrum</i> (Ehrenberg) Ralfs. <i>Euastrum ansatum</i> Ehr.	+		+	+	+
	+			+	
<i>horikawae</i> Ehr. Genus: <i>Hyalotheca</i> (Ehrenberg) Ralfs. <i>Hyalotheca dissiliens</i> (Smith) Breb. Genus: <i>Micrasteria</i> (Agardh) Ralfs <i>Micrasterias jeneri</i> var. <i>simplex</i> West and West Genus: <i>Pleurotaenium</i> Nageli <i>Pleurotaenium ovatum</i> Nordst.	+		+		+
	+				
<i>Pl. coronatum</i> (Turn.) W. and G.S West var <i>africanum</i> Schmid	+				+
<i>Pl. coronatum</i> (Breb) Rabenh Genus: <i>Sphaeroszma</i> Corda <i>Sphaeroszma granulatum</i> Roy and Biss.					+
					+

Table 3 contd.

DIVISION: CHLOROPHYTA	ST 1	ST.2	ST. 3	ST. 4	ST. 5
CLASS: Chlorophyceae					
ORDER: Zygnematales					
FAMILY: Desmidiaceae					
Genus: Actinotaenium Teiling <i>Actinotaenium globosum</i> (Buln) Forster					+
<i>mooreanum</i> (Arch) Teil. var. <i>mooreanum</i>	+				
Genus: <i>Bambusina</i> (Kutz.) Ralfs <i>Bambusina brebissoni</i> Kutz. var. <i>maius</i> (Racib) Croasd.	+		+		
Genus: Closterium (Nitzsch) Ralf <i>Closterium acerosum</i> (Schr.) Ehr. var. <i>elongatum</i> Breb.				+	
<i>Cl. diana</i> Ehr.	+				
<i>Cl. calasporum</i> Wittr.	+				
<i>Cl. leiblenii</i> Kutz.		+			
<i>Cl. libebulla</i> Focke var. <i>interruptum</i> (West and West) Donat	+			+	+
<i>Cl. lunula</i> (Mull) Nitzsch ex Ralfs	+				
<i>Cl. pseudolunula</i> Borge var. <i>concaum</i> Forest and Eckert	+	+	+		
<i>Cl. setaceum</i> (Ehr) Ralfs			+		
<i>Cl. turgidum</i> (Her) var. <i>borgei</i> (Borge) Defl.	+			+	
Genus: <i>Cosmarium</i> Corda					
<i>Cosmarium askenasyi</i> Schmidle f. <i>latum</i> Scot and Presc.	+			+	
<i>C. contractum</i> Kich f. <i>jacobsenin</i> (Roy) West and West	+	+			+
<i>C. decoratum</i> West and West			+		
<i>C. hammeri</i> Reinsch var. <i>africanum</i> Fritsch and Rich			+		
<i>C. pectinatum</i> Breb. var. <i>inevolutum</i> West and West				+	
<i>C. Pseudoconnatum</i> Nordst	+				
<i>C. quadrum</i> Lund	+				
<i>C. spinuliferum</i> West and West					+
<i>S. sp.</i>				+	
Genus: <i>Staurastrum</i> Meyen <i>Stauroidesmus glabus</i> (Ehr) Teil f. Subglabrus (Groubl. Teil)	+				
Family: Gonatozygonaceae					
Genus: <i>Gonatozygon</i> DeBary <i>Gonatozygon aculeatum</i> Hastings					+
Family: Mesotaeniaceae					
Genus: <i>Cylindrocystis</i> (Menegh) Ralfs <i>Cylindrocystis brebessoni</i> Menegh					
Genus: <i>Netrium</i> (Nageli) Itzigs and Rothe <i>Netrium digitus</i> (Ehr) Itzigs and Rothe var. <i>lamellosum</i> (Breb) Gronbl.				+	+
Family: Zygnemataceae					
Genus: <i>Mougeotia</i> Agardh <i>Mougeotia sphaerocarpa</i> Wolle	+		+		
<i>M. sp</i>	+		+		
Genus: <i>Spirogyra</i> Link <i>Spirogyra communis</i> (Hass.) Kutz	+		+		
<i>S. dubia</i> Kutz	+	+	+		
<i>S. variance</i> (Hass) Kutz.		+			

Table 3 contd.

	ST. 1	ST2	ST3	ST4	ST5
<i>S. sp</i> ORDER: Chlorococcales Family: Scenedesmaceae Genus: <i>Scenedesmus</i> Meyen <i>Scenedesmus ecornis</i> (Ehr.) Chod. var. <i>polymorphus</i> Chod.		+	+	+	+
ORDER: Oedogoniales Family: Oedogoniaceae Genus: <i>Bulbochaete</i> Agardh <i>Bulbochaete nigeria</i> Gantheir-Lieure Genus: <i>Oedogonium</i> Link <i>Oedogonium grande</i> Kutz.			+		
<i>O. suecicum</i> Wittr ORDER: Ulotricales	+		+		
Family: Ulotrichaceae Genus: <i>Ulothrix</i> Kutz. <i>Ulothrix tenuissima</i> Kutz.			+		
ORDER: Volvocales Family: Volvocaceae Genus: <i>Eudorina</i> Ehrenberg					
<i>Eudorina elegans</i> Ehr. Genus: <i>Pandorina</i> Bory <i>Pandorina morum</i> (Mull) Bory				+	+
<i>P. sp</i>				+	
Genus: <i>Pleodorina</i> Shaw <i>Pleodorina illinoisensis</i> (Kofoid) Genus: <i>Volvox</i> Linnaeus				+	
<i>Volvox Africana</i>			+		
DIVISION: CYANOPHYTA CLASS: Cyanophyceae ORDER: Chroococcales					
Family: Chroococcaceae Genus: <i>Coelophaerium</i> Nageli <i>Coelosphaerium</i> sp. Genus: <i>Merismepodia</i> Meyen <i>Merismepodia elegans</i> Braun var. <i>major</i> G.M. Smith			+	+	
ORDER: Nostocales Family: Oscillatoriaceae Genus: <i>Oscillatoria</i> Vaucher					

Table 3 contd.

	ST1	ST2	ST3	ST4	ST5
Oscillatoria bornettia (Kuzal) Forti			+		
O. ornata Kutz				+	
O. proboscidea Gomont				+	
DIVISION: EUGLENOPHYTA					
CLASS: Euglenophyceae					
ORDER: Euglenales					
Family: Euglenaceae					
Genus: Euglena Ehrenberg					
Euglena helecooides (Bern) Lemm.					+
E. sp			+		
Genus: Phacus Dujardin					
Phacus curvicauda Swir.			+		
Genus: Lepocinclis Perty					+
Lepocinclis ovum (Ehr) Lemm. var. australis Playfair.					
Genus: Trachelomonas Ehrenberg					+
Trachelomonas eurytoma var. nuda Szab.					
T. hispida (Perty) Stein					+