

Biodiversity of Freshwater Protozoa in Thailand

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ABSTRACT

Freshwater protozoa in Thailand have been investigated in different provinces of northern, eastern, northeastern and southern parts of Thailand from 1982 till 1999. The total of 166 genera and 259 species found were identified as 36 genera and 72 species of Phytomastigophora, 9 genera and 11 species of Zoomastigophora, 23 genera and 38 species of Sarcodina, 2 genera and 2 species of Labyrinthomorpha and 95 genera and 134 species of Ciliophora.

The diversity of protozoa in each part of Thailand had no difference from those found in the central part. These species of protozoa in the central part that had been studied for years were used as a database for those investigated in the other parts of Thailand.

Two new species of protozoa were first recorded in this part of the world, *Neobursaridium gigas* was found around the roots of water hyacinth (*Eichhornia crassipes*) and *Loxodes rex* around the roots of duckweed (*Spirodela polyrhiza*) and common duckweed (*Lemna perpusilla*).

Key words: freshwater, protozoa

INTRODUCTION

Protozoa are single-cell organisms within the Kingdom Protista which grow well in the humid. The important factor that affects the survival as well as species number of protozoa is food. Most of the protozoa feed on bacteria while some are capable of photosynthesis and other can absorb dissolved organic substances caused by bacterial decomposition. Aside from food, almost all protozoa need oxygen for their living. Hence, dissolved oxygen is an important factor effecting the growth of protozoa. The abundant areas for the survival and growth of protozoa are freshwater resources available with moderate amount of bacteria and dissolved organic substances as well as proper

oxygen. While in the water with defined factors, only specific type of protozoa would be found, for example, the existence of *Metopus*, *Brachonella*, *Caenomorpha* and *Saprodinium* indicated the hydrogen sulfide condition of water. Therefore, some species of protozoa are used as preliminary indicators identifying character and quality of water resources.

Since protozoa are generally observed microorganisms, the investigation of freshwater protozoa in Thailand would provide biological database on protozoa diversity.

MATERIALS AND METHODS

Water samplings were collected from

different provinces representing 5 regions of Thailand; central, northern, southern, eastern and northern namely:

Central : Bangkok, Ayudhaya, PathumThani, Nakornnayok, Nakornpathom, Samutprakarn and Lopburi

Northern : Chiangmai, Chaingrai, Lampoon, Lampang

Eastern : Chonburi, Rayong, Chantaburi

Northeastern : Sakolnakorn, Udonrthani

Southern : Trang, Krabi

Water samples were collected from ditches, pond, paddies, canal, reservoirs in Thailand, and were examined under microscope. Living specimens were identified and photographed in laboratory at the Department of Zoology, Faculty of Science, Kasetsart University, using techniques described by Brusca and Brusca (1990), Corliss (1979), Edmondson (1959), Farmer (1980), Grell (1973), Kozloff (1990), Kudo (1966), Wongrat (1998), Wongrat (1999), Lee *et al.* (1985), Margulis *et al.* (1990), Ogden and Hedley (1980), Patterson and Hedley (1992), Ruppert and Barnes (1990), Shirota (1966).

RESULTS AND DISCUSSION

The results of the investigation on freshwater protozoa in Thailand could be summarized as follows:-

1. The total of 166 genera and 259 species found were identified as 36 genera and 62 species of Phytomastigophora, 9 genera and 11 species of Zoomastigophora, 23 genera and 38 species of Sarcodina, 2 genera and 2 species of Labyrinthomorpha and 96 genera and 136 species of Ciliophora.

2. The classification of main groups of protozoa was based on their structural features, feedings, movement and reproduction. Group identification of protozoa was considered, though

there would be some differences in one or more biological features, for instance, some flagellates were heterotroph consuming organic substances while some had chloroplast for photosynthesis.

Protozoa classification following Lee, *et al.* (1985) and Kozloff (1990) 's standard are shown in Table 1 - 4.

3. First-found protozoa in the region

3.1 *Neobursaridium gigas* (Figure 1A) : *Neobursaridium gigas* were ciliated having the size of about 500 micrometer long. We found them on hyacinth roots area. They were first found in Argentina (Balech, 1941) and thereafter in Africa (Nilsson, 1962, Dragesco and Dragesco-Kerneis, 1986).

3.2 *Loxodes rex* (Figure 1B,D): Five species were found in this investigation namely; *Loxodes vorex*, *Loxodes striata*, *Loxodes rostrum* which were 200-300 micrometer in size while *Loxodes magnus* (Figure 1C-D) and *Loxodes rex* were about 600 and 1,200 micrometer, respectively.

Loxodes magnus (Figure 1D) were not more than 600 micrometer in length having about 8-19 Muller's vesicles depending on their sizes and associated with *Loxodes rex* around the root of duckweed (*Spirodela polyrhiza*) and common duckweed (*Lemna perpusilla*).

Loxodes rex were 500-1,200 micrometer long with 37-60 Muller's vesicles. Dragesco and Dragesco-Kerneis (1986) reported that *Loxodes rex* were endemic species living in the tropical zone of Africa (Uganda, Cameroon and Benin). So, *Loxodes rex* were first found in Thailand and Asia of which further study should be monitored.

4. Two species of unknown protozoa

4.1 One species of *Phytomastigophora* (Figure 1E-F) with the size of about 100 micrometer and with chromatophore at the posterior part of cell was recorded. They were quite abundant with rapid motility.

Table 1 Biodiversity of protozoa in the phylum Sarcomastigophora, Subphylum Mastigophora.

Class Phytomastigophora	<i>Phacus helikoides</i>	Order Chrysomonadida
Order Cryptomonadida	<i>Phacus quinquemarginatus</i>	Family Chromulinidae
Family Cryptomonadidae	<i>Phacus anomalus</i>	<i>Oikomonas termo</i>
<i>Cryptomonas ovata</i>	<i>Phacus trimarginata</i>	<i>Oikomonas socialis</i>
<i>Chilomonas paramecium</i>	<i>Phacus raciborskii</i>	Family Syncryptidae
<i>Cyathomonas truncata</i>	<i>Trachelomonas hispida</i>	<i>Synura uvella</i>
<i>Rhodomonas sp.</i>	<i>Trachelomonas horrida</i>	Family Ochromonadidae
Order Dinoflagellida	<i>Trachelomonas volvocida</i>	<i>Monas socialis</i>
Family Gymnodiniidae	<i>Trachelomonas piscatoris</i>	<i>Dinobryon sertularia</i>
<i>Gyrodinium sp.</i>	<i>Trachelomonas armata</i>	<i>Dendromonas cryptostylis</i>
Family Peridiniidae	<i>Trachelomonas urceolata</i>	<i>Cephalothamnium cyclosum</i>
<i>Glenodinium sp.</i>	<i>Strombomonas giradians</i>	<i>Anthophysis vegetans</i>
Order Euglenida	<i>Strombomonas gibberosa</i>	Class Zoomastigophora
Family Euglenidae	<i>Lepocinclis ovum</i>	Order Rhizomastigida
<i>Euglena rostrifera</i>	<i>Cryptoglana pigra</i>	Family Mastigamoebidae
<i>Euglena acus</i>	Family Astasidae	<i>Mastigamoeba</i>
<i>Euglena spirogyra</i>	<i>Astasia klebsi</i>	Order Chaonoflagellida
<i>Euglena spiroides</i>	<i>Menoidium falcatum</i>	Family Codosigidae
<i>Euglena oxyuris</i>	Family Peranemidae	<i>Codosiga utriculus</i>
<i>Euglena gracilis</i>	<i>Peranema trichophorum</i>	<i>Monosiga ovata</i>
<i>Euglena deses</i>	<i>Heteronema acus</i>	<i>Monosiga robusta</i>
<i>Euglena deses var. tenuis</i>	<i>Entosiphon sulcatum</i>	<i>Salpingoeca fusiformis</i>
<i>Euglena tripteris</i>	<i>Anisonema truncatum</i>	<i>Salpingoeca vaginicola</i>
<i>Euglena rubra</i>	Order Volvocida	<i>Poteroiodendron petiolatum</i>
<i>Euglena polymorpha</i>	Family Chlamydomonadidae	Order Kinetoplastida
<i>Euglena ehrenbergii</i>	<i>Chlamydomonas angulosa</i>	Family Bodonidae
<i>Euglena proxima</i>	<i>Coccomonas orbicularis</i>	<i>Bodo saltans</i>
<i>Euglena geniculata</i>	<i>Chlorogonium euchlorum</i>	<i>Rhynchomonas nasuta</i>
<i>Euglena terricola</i>	Family Carteriidae	<i>Cercomonas crassicauda</i>
<i>Euglena pseudoviridis</i>	<i>Collodictyon triciliatum</i>	Order Diplomonadida
<i>Euglena anabaena</i>	Family Volvocidae	Family Hexamitidae
<i>Euglena caudata</i>	<i>Volvox sp.</i>	<i>Gyromonas ambulans</i>
<i>Euglena cyclopicola</i>	<i>Pyrobotrys stellata</i>	
<i>Phacus pleuronectes</i>	<i>Spondylomorom</i>	
<i>Phacus acuminata</i>	<i>quaternarium</i>	
<i>Phacus alata</i>	<i>Gonium pectorale</i>	
<i>Phacus curvicauda</i>	<i>Pandorina morum</i>	
<i>Phacus ranula</i>	<i>Pleodorina illinoisensis</i>	
<i>Phacus longicauda</i>	<i>Eudorina elegans</i>	
<i>Phacus torta</i>		

Table 2 Biodiversity of protozoa in the phylum Sarcomastigophora, Subphylum Sarcodina.

Superclass Rhizopodea	Order Schizopyrenida	Family Euglyphidae
Class Lobosea	Family Vahlkamfiidae	<i>Euglypha cristata</i>
Subclass Gymnamoebia	<i>Vahlkamphia limax</i>	<i>Euglypha filifera</i>
Order Amoebida	Order Pelobiontida	Cass Filosea
Family Amoebidae	Family Pelomyxidae	Order Gromiida
<i>Amoeba proteus</i>	<i>Pelomyxa palustris</i>	Family Gromiidae
<i>Amoeba vespertilio</i>	Subclass Testacealobosia	<i>Artodiscus saltans</i>
<i>Amoeba radiosa</i>	Order Arcellinida	Class Heliozoa
Family Chaosidae	Family Arcellinidae	Order Actinophryida
<i>Chaos carolinensis</i>	<i>Arcella vulgaris</i>	Family Actinophryidae
<i>Chaos illinoisensis</i>	<i>Arella bathystoma</i>	<i>Actinophrys sol</i>
<i>Metamoeba discoides</i>	<i>Arcella gibbosa</i>	<i>Echinospaerium eichhorni</i>
<i>Polychaos dubia</i>	<i>Arcella polyppora</i>	Order Desmothoracida
<i>Glaeseria mira</i>	Family Diffugiidae	Family Clatrellidae
Family Acanthamoebidae	<i>Diffugia urceolata</i>	<i>Clatrella foreli</i>
<i>Saccamoeba gorgonia</i>	<i>Diffugia lebes</i>	Family Clathrulinidae
<i>Striamoeba striata</i>	<i>Diffugia curvicaulis</i>	<i>Clathrulina elegans</i>
<i>Striamoeba munda</i>	<i>Diffugia acuminata</i>	Order Centrohelida
<i>Discamoeba guttula</i>	<i>Diffugia oblonga</i>	Family Acanthocystidae
Family Mayorellidae	<i>Diffugia viscidula</i>	<i>Acanthocystis turfacea</i>
<i>Mayorella bigemma</i>	<i>Lesquereusia modesta</i>	<i>Raphidiophrys pallida</i>
<i>Mayorella panardi</i>	<i>Centropyxis aculeata</i>	
	<i>Centropyxis hemisphaerica</i>	

Table 3 Biodiversity of protozoa in the phylum Labyrinthomorpha.

Phylum Labyrinthomorpha
Class Labyrinthulea
Order Labyrinthulida
Family Vampyrellidae
<i>Chlamydomyxa montana</i>
<i>Panardia metabolis</i>
<i>Biomyxa vagans</i>

Table 4 Biodiversity of protozoa in the phylum Ciliophora.

Class Kinetofragminophorea	Order Karyorelictida	Family Dendrosomatidae
Subclass Gymnostomatia	Family Loxodidae	<i>Anarma brevis</i>
Order Prostomatida	<i>Loxodes vorax</i>	<i>Hypophrya</i> sp.
Family Holophryidae	<i>Loxodes rostrum</i>	<i>Hallezia brachypoda</i>
<i>Holophrya simplex</i>	<i>Loxodes striata</i>	<i>Erastophrya chattoni</i>
Family Prorodontidae	<i>Loxodes magnus</i>	<i>Tokophrya quadripartita</i>
<i>Prorodon discolor</i>	<i>Loxodes rex</i>	<i>Tokophrya infusionum</i>
Family Colepidae	Subclass Vestibulifera	<i>Tokophrya lemnarum</i>
<i>Coleps hirtus</i>	Order Trichostomatida	<i>Tokophrya beetoni</i>
Order Haptorida	Family Plagiopylidae	<i>Multifasciculatum elegans</i>
Family Enchelyidae	<i>Plagiopyla nasuta</i>	Family Discophryidae
<i>Trachelophyllum clavatum</i>	Order Colpodida	<i>Periacineta buckei</i>
<i>Lacrymaria olor</i>	Family Colpodidae	Family Trichophryidae
<i>Lacrymaria coronata</i>	<i>Colpoda cucullus</i>	<i>Trichophrya epistylidis</i>
Family Spathidiidae	<i>Tillina magna</i>	Family Podophryidae
<i>Spathidium spathula</i>	Subclass Hypostomatia	<i>Podophrya fixa</i>
<i>Spathidioides sulcata</i>	Order Synhymeniida	<i>Podophrya collini</i>
<i>Homalazon vermiculare</i>	Family Scaphidiodontidae	<i>Sphaerophrya soliformis</i>
<i>Cranotheridium taeniatum</i>	<i>Chilodontopsis vorax</i>	Family Urnulidae
<i>Bryophyllum vorax</i>	<i>Scaphidiodon navicula</i>	<i>Metacineta mystacina</i>
Family Didiniidae	Order Cyrtophorida	Class Oligohymenophorea
<i>Didinium nasutum</i>	Family Cryptopharyngidae	Subclass Hymenostomatia
<i>Mesodinium acarus</i>	<i>Cryptopharynx setigerus</i>	Order Hymenostomida
Family Actinobolinidae	<i>Chilodonella cucullus</i>	Family Tetrahymenidae
<i>Actinobolina radians</i>	<i>Chilodonella uncinata</i>	<i>Tetrahymena pyriformis</i>
Family Tracheliidae	Family Furgasoniidae	Family Parameciidae
<i>Trachelius ovum</i>	(Cyclogrammidae)	<i>Paramecium caudatum</i>
<i>Dileptus anser</i>	<i>Cyclogramma trichocystis</i>	<i>Paramecium</i>
<i>Paradileptus elephantinus</i>	Order Nassulida	<i>multimicronucleatum</i>
<i>Paradileptus caducus</i>	Family Nassulidae	<i>Paramecium trichium</i>
Order Pleurostomatida	<i>Nassula aurea</i>	Family Frontoniidae
Family Amphileptidae	Family Microthoracidae	<i>Frontonia leucas</i>
<i>Acineria incurvata</i>	<i>Drepanomonas dentata</i>	<i>Frontoniella complanata</i>
<i>Amphileptus claparedei</i>	Subclass Suctoria	Family Urocentridae
<i>Litonotus fasciola</i>	Family Acinetidae	<i>Urocentrum turbo</i>
<i>Litonotus lamella</i>	<i>Acineta tuberosa</i>	Family Neobursaridiidae
<i>Loxophyllum helus</i>	Family Thecacinetidae	<i>Neobursaridium gigas</i>
<i>Loxophyllum</i> sp.	<i>Thecacineta calix</i>	

Table 4 (con.) Biodiversity of protozoa in the phylum Ciliophora.

Order Scuticociliatida	Family Trichodinidae	Family Strobilidiidae
Family Cohnilembidae	<i>Tricodina pediculus</i>	<i>Strobilidium</i> sp.
<i>Cohnilembus fusiformis</i>	Class Polyhymenophorea	Order Hypotrichida
Family Loxocephalidae	Subclass Spirotichia	Family Spirofilidae
<i>Loxocephalus plagius</i>	Order Heterotrichida	<i>Hypotrichidium conicum</i>
Family Cinetochilidae	Family Bursariidae	<i>Stichotricha secunda</i>
<i>Cinetochilum margaritaceum</i>	<i>Bursaria truncatella</i>	<i>Stichotricha intermedia</i>
<i>Balanonema biceps</i>	Family Metopidae	Family Oxytrichidae
Family Cyclidiidae	<i>Metopus es</i>	<i>Oxytricha fallax</i>
<i>Cyclidium glaucoma</i>	<i>Metopus fuscus</i>	<i>Stylonychia mytilus</i>
Order Astomatia	<i>Metopus striatus</i>	<i>Stylonychia pustulata</i>
Family Hopliophryidae	<i>Metopus</i> sp.	<i>Kahlia</i> sp.
<i>Radiophryoides komareki</i>	<i>Brachonella darwini</i>	<i>Urosoma acuminata</i>
Subclass Peritrichia	Family Caenomorphidae	<i>Urosoma caudata</i>
Order Peritrichida	<i>Caenomorpha medusula</i>	Family Holostichidae
Family Vorticellidae	<i>Caenomorpha sapropelica</i>	<i>Gonostomum strenuum</i>
<i>Vorticella convallaria</i>	Family Spirosomidae	<i>Uroleptus limnetes</i>
<i>Vorticella campanula</i>	<i>Spirostomum ambiguum</i>	<i>Uroleptus longicaudatus</i>
<i>Carchesium polypinum</i>	<i>Spirostomum intermedium</i>	<i>Uroleptus halseyi</i>
<i>Zoothamnium arbuscula</i>	<i>Spirostomum minus</i>	<i>Uroleptus</i> sp.
Family Epistylidae	<i>Spirostomum teres</i>	Family Psilotrichidae
<i>Epistylis cambari</i>	<i>Blepharisma japonicum</i>	<i>Psilotricha acuminata</i>
<i>Epistylis</i> sp.	<i>Pseudoblepharisma tenuis</i>	Family Urostylidae
<i>Campanella umbellaria</i>	Family Condyllostomatidae	<i>Paraholotricha herbicola</i>
Family Operculariidae	<i>Condyllostoma arenarium</i>	Family Euplotidae
<i>Opercularia</i> sp.	Family Stentoridae	<i>Euplotes patella</i>
<i>Pyxidium urceolatum</i>	<i>Stentor coeruleus</i>	<i>Euplotes eurystoma</i>
Family Scyphidiidae	<i>Stentor polymorpha</i>	<i>Euplotes aediculatus</i>
<i>Scyphidia</i> sp.	<i>Stentor roeseli</i>	<i>Euplotes aberrana</i>
Family Atylozoidae	<i>Stentor mulleri</i>	<i>Euplotes</i> sp.
<i>Hastatella aesculacantha</i>	<i>Stentor</i> sp.	Family Aspidiscidae
<i>Hastatella radians</i>	Family Climacostomidae	<i>Aspidisca costata</i>
Family Vaginicolidae	<i>Climacostomum viren</i>	<i>Aspidisca lynceus</i>
<i>Vaginicola leptosoma</i>	Order Odontostomatida	
<i>Thuricola folliculata</i>	Family Epalxellidae	
<i>Pyxicola affinis</i>	<i>Saprodinium dentatum</i>	
<i>Platycola longicollis</i>	Order Oligotrichida	
Family Lagenophryidae	Family Halteriidae	
<i>Lagenophrys nassa</i>	<i>Halteria grandinella</i>	

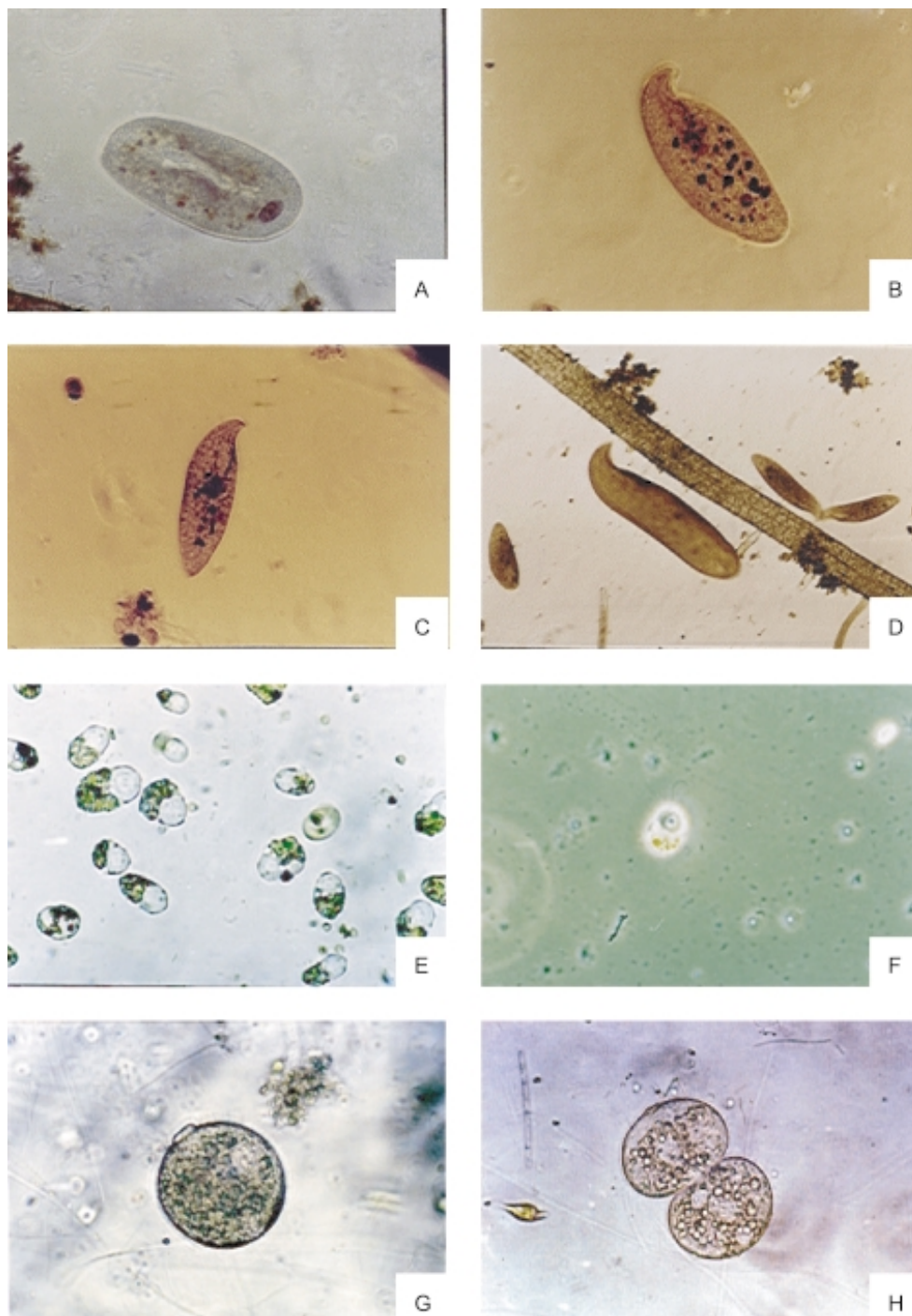


Figure 1 A-B. New records of Southeast Asia: A. *Neobursaridium gigas* B. *Loxodes rex* C. *Loxodes magnus* D. Different sizes of *Loxodes rex* and *Loxodes magnus*. E-F. Unknown I G-H. Unknown II.

4.2 One species of *Ciliophora* (figure 4G-H) with round cells, having cytostome in front of the cells and contractile vacuole at the posterior end was found. Their general feature was similar to *Prorodon*.

CONCLUSION

The protozoa under investigation have been collected from 1982 till 1999. The total of 166 genera and 259 species of freshwater protozoa in Thailand found were identified as 36 genera and 72 species of Phytomastigophora, 9 genera and 11 species of Zoomastigophora, 23 genera and 38 species of Sarcodina, 2 genera and 2 species of Labyrinthomopha and 96 genera and 136 species of Ciliophora. The first found ciliate in this region were *Neobursaridium gigas* and *Loxodes rex*. Both of them were reported as endemic species found in the tropical zone of Africa (Uganda, Cameroon and Benin). Moreover, 2 unknown species were also observed; one was Phytomastigophora and the other was Ciliophora.

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