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Ficological Flora Of Rio Aguapeú, Mongaguá, SP.

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ABSTRACT

This work aims to present the biodiversity of the phycological flora of continental waters of the Aguapeú River, located in the municipality of Mongaguá and extending to the municipality of Itanhaém, south coast of the State of São Paulo, belonging to the Metropolitan Region of Baixada Santista, with geographical coordinates of 24º05'364 ”S and 46º39'368” W. It is born in the Serra do Mar, formed by the Bichoró river, joins the Mineiro river and empties into the Branco river in Itanhaém. The meaning of the word Aguapeú comes from the term tupi agûapé’y which means “aguapes river”. Classified as a black water river with lentic characteristics, enabling the development of large banks of macrophytes. Together with the rivers Branco, Preto, Itanhaém and Mambu form the hydrographic basin of Itanhaém with 1440 km of extension and 950 km^2 of area, being considered the largest coastal basin of the State of São Paulo and nicknamed “Amazonas Paulista”. The Indians use the river to fish for traíra, catfish, yam, cascudo, lambari, tajaba, mandi and mussum. The region suffers from the actions of palm growers, hunters and illegal fishermen. Knowing that the Aguapeú river is part of the daily life of the local indigenous population and the current quality of its waters is unknown, since the Indians use the river for food, bathing, entertainment, an attempt was made to inventory the ficological flora, many algae are bioindicators of pollution. Real estate speculation, suppression of terrestrial ecosystems, predatory exploitation are concerns, leading us to carry out this project. To date, 27 genera and 34 species have been identified.
Keywords: freshwater algae, Mongaguá River, taxonomy.

1. Introduction

The term alga has no taxonomic value, its stem is not differentiated in leaves and stems, in addition to gathering characteristics of other organisms, such as plants containing chlorophyll and bacteria containing cell wall. Its size ranges from macro to microscopic.

This work aims to carry out a taxonomic survey of the ficological flora of the Aguapeú River, located in the municipality of Mongaguá and extending to the municipality of Itanhaém, south coast of the State of São Paulo, Metropolitan Region of Baixada Santista. The municipality of Mongaguá has a population of 54.257 people in an area of 143,205 km^2, according to data from IBGE - Brazilian Institute of Geography and Statistics (2017).

The Aguapeú River rises in the Serra do Mar, formed by the Bichoró River, joins the Mineiro River and flows into the Branco River in Itanhaém. The meaning of the word Aguapeú comes from the term tupi agûapé’y which means “aguapes river”. Classified as a black water river with lentic characteristics, enabling the development of large banks of macrophytes. The anthropic change occurs in some areas of banana plantation. Together with the rivers Branco, Preto, Itanhaém and Mambu form the hydrographic basin of Itanhaém with 1440 km of extension and 950 km^2 of area, being considered the largest coastal basin of the State of São Paulo and nicknamed “Amazonas Paulista”. The surrounding population uses the river as a source of resources and leisure. The region's climate is humid subtropical (Cfa) with an annual average between 18-25^{0}C. The river has served as protection and security to

the local indigenous lands, as well as a source of food for the indigenous population of the Aldeia Aguapeú of Guarani Mbyá ethnicity (Alves, 2012-2013). According to an ISA census (2010), the village has 66 people, corresponding to 0.7% of the population of Mongaguá, which has 34.54% of its territorial extension as indigenous areas. In the village, corn, beans, manioc, sweet potatoes, peanuts, watermelons and squash are cultivated for subsistence of the tribe, even so, malnutrition was detected in the local indigenous population (site-antigo.socioambiental.org). The banks of the river are vegetation of virgin forest (primary) and capoeira (secondary). The Indians also use the river for fishing for traíra, catfish, yams, cascudo, lambari, tajaba, mandi and mussum. Otters, capybaras, alligators and turtles are also found swimming in the Aguapeú river. Close to the river, you can see peccaries, peccary, agouti, coati, armadillo, tapir, deer, jaguar, monkeys, jacu, jacutinga, macuco, toucan, parrots, saracura and hummingbirds. Among the local flora, there are cedar, box, brejaúva, guajuvira, taquara, jerivá, palmito-juçara, guaricanga, indaiá, pacuri and vines. The extraction of sand by a mining company has compromised the quality of the river, so much so that in some sections it is already polluted. The region suffers from the actions of palm growers, hunters and illegal fishermen. The Aguapeú River is located within the Aguapeú Indigenous Land, in the Atlantic Forest region, approved on 9/8/1998 and declared on 4/13/2000. Knowing that the Aguapeú river is part of the daily life of the local indigenous population and the current quality of its waters is unknown, since the Indians use the river for food, bathing, entertainment, an attempt was made to inventory the ficological flora, many algae are bioindicators of pollution. Real estate speculation, suppression of terrestrial ecosystems, predatory exploitation are concerns, leading us to carry out this project. Three collections were carried out on the following days: 08/26/2017, 10/28/2017 and 12/3/2017, capsizing the vial laterally in the water column when in shallow environments and the use of plankton net was used in order to to obtain a more concentrated sampling of microalgae, in deeper environments.

2. Matherials and methods

2.1 Study area

The área covered by this study is the Aguapeú River, located in the municipalities of Mongaguá and Itanhaém, SP. Classified as a river of black waters, its
lentic characteristic allows the development of large banks of macrophytes (Ferreira, 2007). With an average depth between 2-4 m, located in the metropolitan region of Baixada Santista, State of São Paulo and composed of 9 (nine) municipalities. According to Ross (2003), the region has a tropical climate. An attempt was made to cover the geographical area of the river in its maximum extension and in the most uniform way possible, covering materials both in plankton and in the periphyton.

2.2 Material studied

Periphyton and phytoplankton materials were sampled in the most uniform coverage possible and the materials had an equivalent representation with respect to planktonic and peripheral habitats in lentic, semi-lentic and lotic environments.

2.3 Material collection

Four (4) random collections were carried out on the following days: 08/26/2017, 10/28/2017, 12/03/2017 and 03/31/2018, capsizing the flask sideways in the water column at the desired depth, careful way so that there is no loss of material with the entry of air or dragging the plankton net with 20 μm diameter mesh made of nylon fabric, with the help of a rope, an integral part of the plankton net, in the horizontal directions in the superficial layer of the water column, about 30 cm deep and vertical along the water column, in order to sample the phytoplankton at the most varied levels. This collection method basically consists of passing the net successively at different levels of the water column in order to allow water to flow through the tissue and fill the bottle attached to the net. The collections took place in bright and poorly lit areas close to wooded regions, preferably close to the margin, where floating aquatic plants (totally or partially submerged), leaves and other debris dispersed in the water commonly occur. Environments with these characteristics are considered phytoplankton and periphyton concentrators. All samples, without exception, were stored in suitable flasks and then stored in the refrigerator until the material was analyzed in the microscopy laboratory at UNIP - Universidade Paulista. The information on the geographic provision of the material (as complete as possible), including the date of collection and the name of the collector, was recorded. For fixing the material, 4-5% formalin was used in polypropylene flasks, with identification of the place, date of collection and collector. 10 (ten) slides were analyzed per sample, until the presence of the material under study was exhausted.

2.4 Fixing, preserving and preparing the material for observation

Fixation and preservation of the materials were provided immediately after collection, still in the field, with 3-5% aqueous formalin solution (40% commercial formaldehyde), in glass or plastic bottles. Immediate fixation prevents the rate of cell division from being accelerated due to adverse conditions (sample concentration), which can promote the appearance of anomalous phenotypes. The preparation of the slides for observation under the optical microscope followed the following routine: (1) one or two drops of the material from the homogenized sample were placed on a common microscope slide; (2) a drop of alcoholic lugol solution was added to that of the material to evidence the starch (pyrenoid); and (3) a coverslip was placed over the set of drops, taking care not to form a bubble. In some cases, a drop of methylene blue was also added to evidence mucilage and another, of pure glycerin, to densify the medium and, consequently, facilitate the specimens' rotation on themselves and observe them from other angles.

2.5 Observation of material under a microscope

For qualitative analysis, at least 10 slides prepared from the concentrated material of each sample unit were examined. The aim was to observe the largest possible number of specimens of each type and exhaust each sample unit taxonomically. The observation of the specimens was performed using an Olympus CX31 binocular optical microscope, with 10 magnifying eyepieces and 4, 10, 40 and 100 magnifying lenses. For each characteristic, as many measures were taken as necessary (and / or possible) with the sole purpose of accurately describing each species, variety or taxonomic form identified. Obviously, the minimum number of specimens observed depended on the size of the populations available in the preparations. Analysis of three preparations without a representative of any species, variety or taxonomic form not yet identified in that sample unit was accepted as taxonomic

depletion. In the present study, however, for the greatest certainty of taxonomic depletion, 10 preparations from the same sample unit were examined without new species, varieties or taxonomic forms of algae appearing. Individuals found only once during the study were only identified when they presented their unmistakable diagnostic characters or when they did not show any morphological variation or it was too small and considered negligible.

2.6 Description of the material

The description of each species, variety or taxonomic form identified included all the diacritical or meristic morphological characteristics of the vegetative and reproductive phases of its life-history that could be observed in the examined materials. When varieties and / or taxonomic forms other than the typical species were identified, their descriptions address only the distinctive characters in relation to the respective typical. When existing, it was related to homotypic (nomenclatural) synonymy and, in particular, the basionym component. The heterotypic (taxonomic) synonyms were also considered, however, only those that could be evaluated. The identifications in the literature, whose lack of information (description, measurements, illustration and / or material deposited in a herbarium) did not allow their reidentification, were not currently considered.

2.7 Taxonomic identification

Taxonomic identifications were based on the analysis of the largest possible number of individuals, based on the analysis of populations. Isolated individuals were only identified when they presented their unambiguous diagnostic characteristics. Photographs were taken and with the aid of bibliographic reviews, it is possible to identify some taxa. All material in the specialized literature of the State of São Paulo was evaluated. Taxonomic identifications of materials that presented description and / or illustrations were reviewed, as well as the materials deposited in herbariums and document collections of aquatic ecology laboratories. As a basic literature for the classification of genres in families, Bourrelly (1972) was used because it is the only compendium that classifies all the genres proposed so far. The identifications of the genera, species, varieties and taxonomic forms were based on classic and recent works in the specialized literature. We sought to observe the largest possible number of individuals and, whenever possible, through the analysis of populations, thus increasing the validity of interpretations. For each taxon inventoried, the following data will be presented: (1) species name, variety or taxonomic form; (2) name (s) of the author (s) responsible for the specific binomial, varietal trinomial or formatic quadrinomial; (3) complete bibliographic reference of the work “princeps”, that is, of the work that contains the original description of the species, variety or taxonomic form; (4) basionym when existing; (5) synonyms (especially homotypic ones) from Brazilian material; (6) detailed description of all diacritical morphological characteristics, including meristic and metric ones, with an emphasis on the spectrum of their variation in the population scope. The descriptions were accompanied by an illustration for their taxonomic identification, list of the material (s) studied and taxonomic and nomenclatural comments.

3. Results and discussion

27 genera and 34 species were identified, as follows:

***Actinoptychus splendens* (Shadbolt) Ralfs**

Figure 32

Discoid format; smooth center; with granular irradiations that go to the margin; alternation of higher and lower areas.

***Actinotaenium wollei* (West & G.S. West) Teiling**

Figure 1

Cylindrical shape; slightly elongated; wide ends giving a wide profile; smooth cell wall; solitary cell.

***Aulacoseira brasiliensis* Tremarin, Torgan & Ludwig**

Figure 31

Circular and cylindrical shape; it has "pores" in most of the body, having some bands of smooth cell wall.

***Brachysira brebissonii* Ross**

Figure 29

Fusiform, elongated shape, thin ends, streaks radiate from the center in a non-continuous way.

***Chlorella vulgaris* Beyerinck**

Figure 2

Spherical shape; it has a nucleus, a colonial cell.

***Chlorococcum acidum* Archibald & Bold**

Isolated individuals; oblong cells, 8.5-16 □m length; c
located laterally; pyrenoid 1, with starch sheath; relatively thick cell wall.

***Coelastrum reticulatum* (Dangeard) Senn**

Figure 18

Circular shape, small, colony cells, form colonies in a prismatic shape, not so close to each other, joined by tubes.

***Cosmarium amoenum* Brébisson *ex* Ralfs**

Deep median constriction; linear, closed median sine, semicircular semicells; apical rounded angles; truncated apical margin; ornate or grainy cell wall; chloroplasty with 2 pyrenides.

***Cosmarium dichondrum* var. *tumidum* Borge**

Figure 10

Cylindrical shape; joined cells, slightly elongated, have a median cell wall.

Cosmarium margaritatum* var. *margaritatum* West & G.S. West f. *margaritatum

Figure 16

Circular shape, two parts joined, each with semicircular shape.

Cosmarium punctulatum* var. *punctulatum* Brébisson f. *punctulatum

Figure 17

Circular shape, two parts joined, each with semicircular shape.

Cosmarium quadrifarium* Lundell var. *quadrifarium* f. *quadrifarium

Ornate cell wall; granules irregularly arranged; sine slightly open; semicircular semicell; convex apex; 2 pyramids.

***Craticula cuspidata* (Kützing) Mann**

Figure 3

Fusiform shape, narrow and rounded ends; wider central area; it has parallel grooves, perpendicularly in the central part there is a structure that goes from one end to the other.

***Cyclotella meneghiniana* Kützing**

Figure 19

Wide circular shape, with well-defined grooves close to the margin that do not go to the center, the center is smooth.

***Cylindrocelis cylindrica* (Hindák) Hindák**

Figure 4

Cylindrical shape, wide and rounded ends, smooth cell wall.

***Desmidium aptogonum* var. *aptogonum* Brébisson ex Kützing**
Figure 23
Stem formed by elongated filament of cells in the shape of a semi-rectangular disc; apical view has a triangular shape; it looks like a smooth cell, has no spiny projections; slightly twisted filament.
***Diploneis bombus* (Ehrenberg) Ehrenberg**
Figure 33
Oval to panduriform shape; the center is quite thin, with streaks all around.
***Encyonema silesiacum* (Bleisch) Mann**
Figure 5
Asymmetrical fusiform shape, elongated, arched dorsal margin, straight ventral margin.
***Encyonopsis aequalis* (Smith) Krammer**
Figure 8
Fusiform shape, with ridges facing the center, has dilated ends.
***Encyonopsis* cf. *schubartii* (Hustedt) Krammer**
Figure 30
Fusiform format; it has stretch marks that go from one margin to another; thin and rounded ends.
***Frustulia crassinervia* (Brébisson *ex* W. Smith) Lange-Bertalot & Krammer**
Rhombic valves with wavy margins; apexes moderately prolonged; longitudinal ribs tightened a little in the center; 35-48 µm length .; 9-10 µm wide .; central raphe with 33-35 µm length.
***Frustulia saxonica* Rabenhorst**
Figure 6
Fusiform shape, narrow and rounded ends; wider central area; it has parallel grooves with slight curvature, perpendicularly in the central part there is a structure that goes from one end to the other.
***Gomphonema gracile* Ehrenberg**
Figure 7
Fusiform shape, with asymmetrical shape, has one of the narrowest ends, has streaks facing the center of the cell.
***Microcystis aeruginosa* (Kützing) Kützing**
Figure 11
Spherical shape, colonial cell, extremely small size.
***Navicula cryptotenella* Lange-Bertalot**
Figure 12
Fusiform shape, wide streaks radiating from the center, wide center, thin and rounded ends.
***Navicula radiosa* Kützing**
Figure 24
Fusiform, elongated shape, rounded tips, streaks radiate from the center, the center is slightly wider than the extremities.
***Nitzschia fruticosa* Hustedt**
Figure 21
Spiky, elongated and thin shape.
***Nitzschia palea* (Kützing) Smith**
Figure 28
Fusiform format; thin ends, have streaks that go from one margin to another.
***Onychonema laeve* var. *laeve* Nordstedt**
Figure 26
Filamentous shape, thin and wide cells, the cells have small spines around them.

***Oscillatoria curviceps* C. Agardh ex Gomont**
Figure 25
Filamentous, elongated shape, with curved end cells, wide cells, with a disc shape.
***Pleurotaenium simplicissimum* Grönblad**
Figure 15
Cylindrical shape, extremely elongated, straight ends, smooth cell wall.
***Possonia sestonica* Hindák**
Figure 9
Semi-spherical shape, two cells joined, slightly elongated.
***Psammodictyon panduriforme* (Gregory) Mann**
Figure 34
Panduriform format; with a slightly thin center, with pointed ends.
***Pseudodidymocystis fina* (Komárek) Hegewald & Deason**
Figure 22
Circular, elongated shape, divided into two parts in a semicircle.
***Staurosirella leptostauron* var. *dubia* (Grunow) Edlund**
Fusiform shape, elongated, looks like smooth cell.
***Ulnaria ulna* (Nitzsch) Compère**
Linear-lance stalk; without median constriction; parallel streaks along the entire length of the stalk.
***Ulothrix zonata* (Weber & Mohr) Kützing**
Figure 14
Filamentous shape, formed by several cells joined each with their own organelles, each cell has a rectangular shape.

4. Conclusions

In view of that this is the first bibliographic reference regarding the algae taxonomy of the Aguapeú River, it is possible to observe the richness of the local biodiversity, indicating that the environment is not yet degraded, despite being used by vessels and agricultural practices throughout of the course of the river, also being noticed, an initial process of urbanization. The locality of the Aguapeú River contributes to the facility of collection in the coastal region of the same, there was sampling in the limnetic region of the river in low depth regions, since there is no availability of a vessel for sampling in the deeper regions. However, despite some difficulties, it appears that the number of species identified is considerable so far, with the possibility of this number increasing, until the end of the study.

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ATTACHMENTS

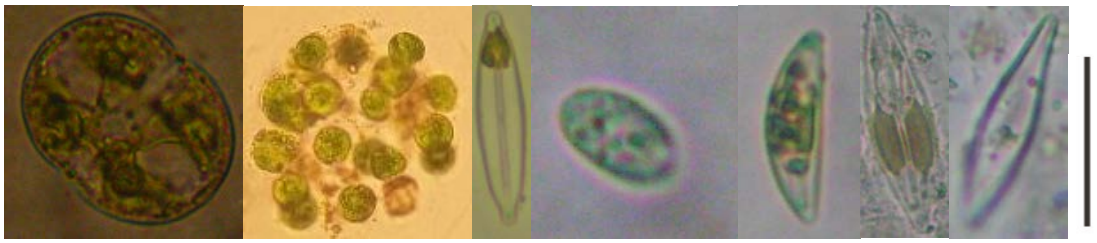

Fig. 1-7. 1.*Actinotaenium wollei*. 2.*Chlorella vulgaris*. 3.*Craticula cuspidata*. 4.*Cylindrocelis cylindrica*. 5.*Encyonema silesiacum*. 6.*Frustulia saxonica*. 7.*Gomphonema gracile*.

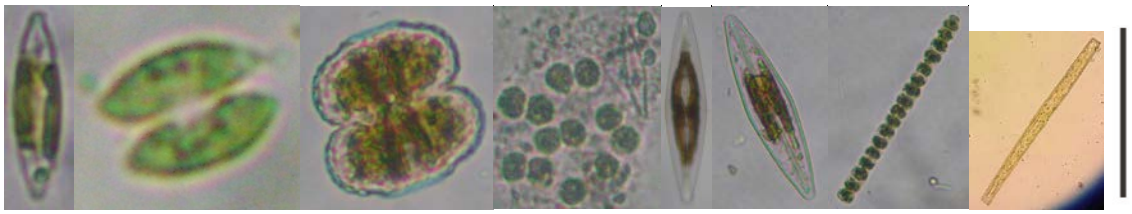

Fig. 8-15. 8.*Encyonopsis aequalis*. 9.*Possonia sestonica*. 10.*Cosmarium dichondrum* var. *tumidum*. 11.*Microcystis aeruginosa*. 12.*Navicula cryptotenella*. 13.*Staurosirella lepostaurum* var. *dubia*. 14.*Ulothrix zonata*. 15.*Pleurotaenium simplicissimum*.

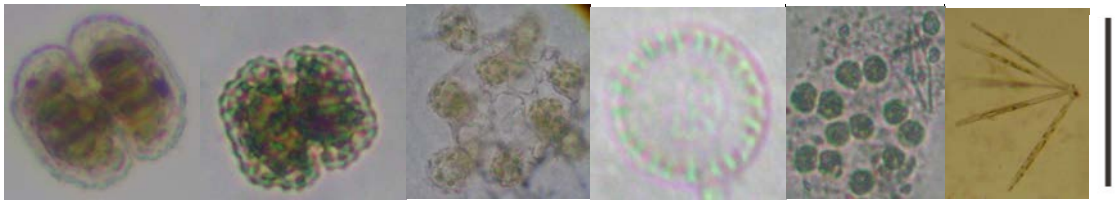

Fig. 16-21. 16.*Cosmarium margaritatum* var. *margaritatum* f. *margaritatum*. 17.*C. punctulatum* var. *punctulatum* f. *punctulatum*. 18.*Coelastrum reticulatum*. 19.*Cyclotella meneghiniana*. 20.*Microcystis aeruginosa*. 21.*Nitzschia fruticosa*.

Fig. 22-28. 22.*Pseudodidymocystis fina*. 23.*Desmidium aptogonum* var. *aptogonum*. 24.*Navicula radiosa*. 25.*Oscillatoria curviceps*. 26.*Onychonema laeve* var. *laeve*. 27.*Desmidium aptogonum* var. *aptogonum*. 28.*Nitzschia palea*.

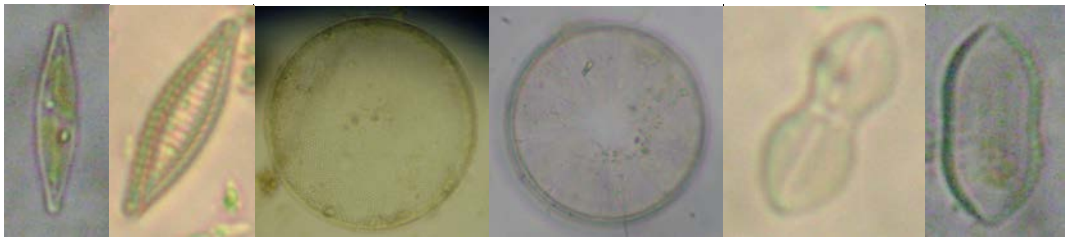

Fig. 29-34. 29.*Brachysira brebissonii*. 30.*Encyonopsis* cf. *schubartii*. 31.*Aulacoseira brasiliensis*. 32.*Actinoptychus splendens*. 33.*Diploneis bombus*. 34.*Psammodictyon panduriforme*.

Barra = 10 μm