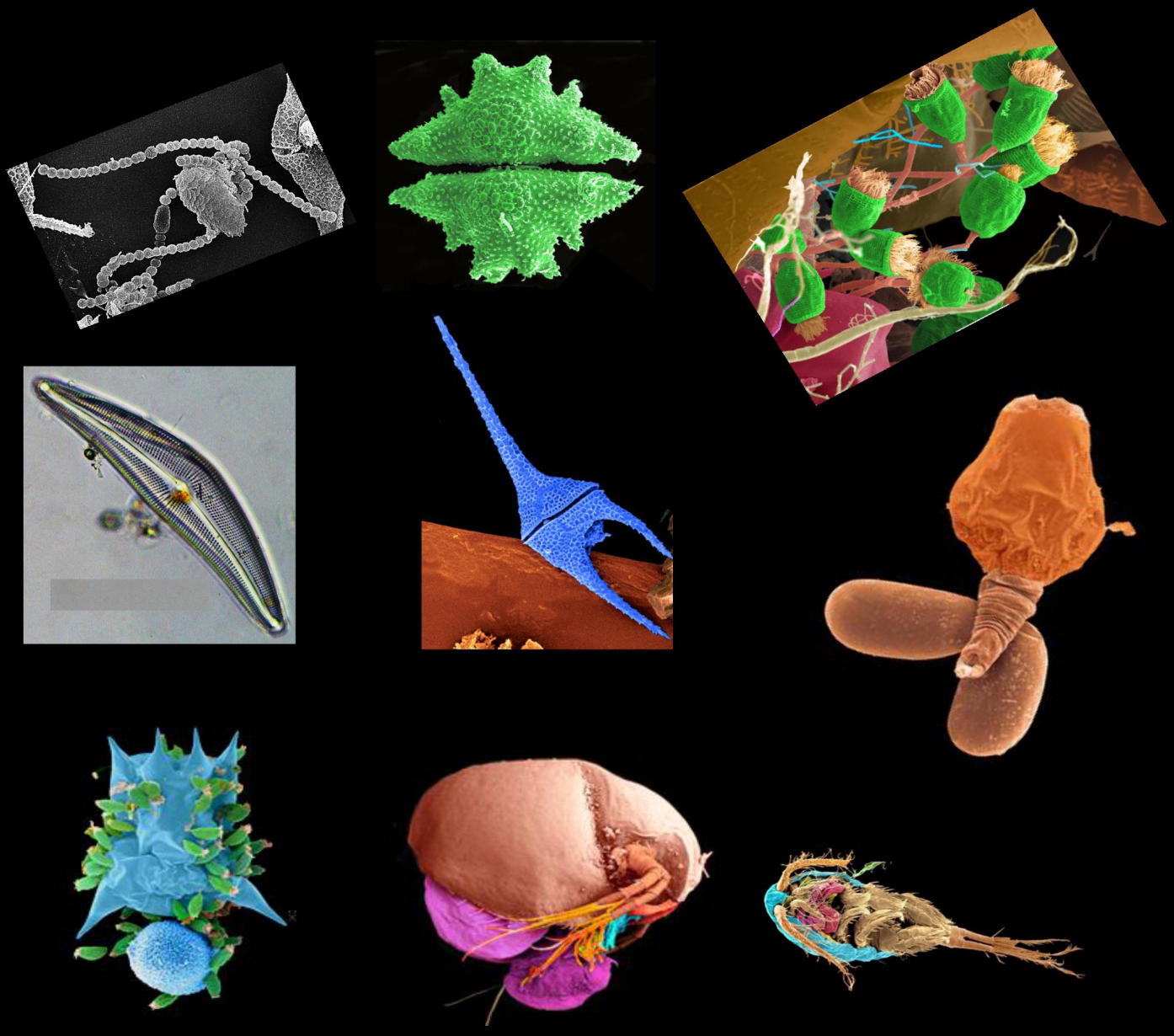
ISBN No: 978-1-946628-14-5

Some examples of Algae, Protists and Invertebrates from Aguascalientes State, México
Algunos ejemplos de Algas, Protistas e Invertebrados del estado de Aguascalientes. México

Marcelo Silva Briano, Araceli Adabache Ortiz & Vianney Beraud Macías, and collaborators.

Universidad Autónoma de Aguascalientes, MÉXICO.



International Journal of Environmental Sciences & Natural Resources.

Some Examples of Algae, Protists and Invertebrates from Aguascalientes State, México

Marcelo Silva Briano*, Araceli Adabache Ortiz and Vianney Beraud Macías

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Published By

Juniper publishers Inc.

United States

October 10, 2024

Abstract

In the state of Aguascalientes, water bodies host a freshwater diversity of algae, protists and invertebrates that are invisible to the human eye due to their small dimensions. Among the invertebrates, there are three main groups of zooplankton: Rotifera, Cladocera and Copepoda. Some species of these three groups have been reported as new to science and endemic.

Keywords: Algae; Protists; Rotifera; Cladocera; Copepoda

Introduction

In Aguascalientes state there is a microscopic Universe that is invisible to the human eye due to its dimensions, however, it is incredible, awesome to know the complexity and the beauty of the life forms of micro-biodiversity of water bodies that we explore through the microscope, then there is a chance to find and explore a beauty hidden organism worldwide. The living **beings** that are born, grow, live, reproduce and die in the water bodies of the state, go unnoticed by most people, but they move, interact, eat and are eaten in a microscopic jungle that is completely unknown. Since the beginning of the Biology career at the Universidad Autónoma de Aguascalientes, in the early 70's, there were few studies or nothing about life on the planet and especially about the flora and fauna of our state, some of us had concerns to know what species inhabited our environment of a little more than 5, 080Kms^2, which has an area of Aguascalientes.

Generally, people who live closer to nature, observe the flora as well as the fauna of the place, even our ancestors learned to know the properties of species both beneficial and harmful. They gave them names according to their characteristics and properties. However, the tiny species, could perceive them when they reproduced in a massive and abundant form, that is to say the microscopic or hidden ones, have never been appreciated.

In Aguascalientes State, the Algae and Protists have been studied very briefly, and there are not really records of these groups. However, three important groups of freshwater invertebrates (**ROTIFERA**, **CLADOCERA** and **COPEPODA**) have been recorded. As far as, these groups have been disappearing mainly due to the construction of houses, ranches, highways and roads, causing the destruction of these small ecosystems. Other causes are the construction of large industrial buildings and the silting of existing water bodies. However, new species have been reported and some of them are endemic for science into the central region of Mexico. These species belong to three zooplankton groups: Rotifera (***Brachionus araceliae***, ***B. josefinae*** and ***Keratella mexicana***); Cladocera (***Macrothrix mexicanus***, ***M. smirnovi***, ***M. sierrafriatensis***, ***Karualona penuelasi***, ***Alona aguascalientensis***, ***A. anamariae***), and recently a new species of ***Pseudochydorus*** has been described, initially recorded for the state of Aguascalientes as ***Pseudochydorus globosus***. Now when making the diagnosis of this cladocero, it has been named ***Pseudochydorus margaritalfonsorum***; and Copepoda (***Paracyclops hirsutus***, ***Acanthocyclops dodsoni***, ***A. marceloi***, and ***A. caesariatus***).

Previous work testifying to these species were published in their articles by: Bold & Wynne. 1985; Ciros-Pérez, Silva Briano & Elías Gutiérrez, 1996; Dodson & Silva-Briano, 1996; Dumont, & Silva-Briano, 2000; Dumont, Silva-Briano & Subhash Babu, 2002; Elías-Gutiérrez, Ciros-Pérez, Suárez-Morales Silva-Briano 1999; Elías-Gutierrez, Suárez-Morales, Gutiérrez-Aguirre, Silva-Briano, Granados-Ramirez, & Garfias-Espejo, 2008; Koste, W. 1978, Kutikova & Silva-Briano, 1995; Mercado Salas, Suárez-Morales, &. Silva-Briano, 2006; Mercado-Salas, Suárez-Morales, and Silva-Briano. 2009. Neretina, Garibian, Patterson, 1992; Prescott, G. W. 1962; Romero, Mondragón & Silva-Briano, 2019; Rico Martínez, R. & M. Silva-Briano, 1993; Rico-Martínez, Silva-Briano, Adabache-Ortiz & Domínguez-Contreras, 2004; Silva-Briano M. 2008; Silva-Briano. M. & A. Adabache-Ortíz. 1999; Silva Briano, & Segers, 1992; Silva-Briano & Suárez-Morales, 1998; Silva-Briano, Quang-Dieu & Dumont, 1999; Silva-Briano, Rico-Martínez y Adabache-Ortíz, 2003; Silva-Briano, Galván-De la Rosa, Pérez-Legaspi & Rico-Martínez, 2007; Sinev & Silva-Briano, 2012, 2021; Suárez-Morales, Elías-Gutierrez, Ciros-Pérez & M. Silva-Briano, 2000; UAA, 2019. Thorp J. Covich A. 2010, 2020 [1-26].

In general, rotifers have been reported with approximately 100 species, 55 of cladocerans and 36 of copepods. Aguascalientes has an area of slightly more than 5000 kms^2. However, Algal groups, Protozoa and other groups of aquatic invertebrates do not have a systematic record. As you can see the map of the localities with the species that were found, identified taxonomically and described in this work.

Background

Since 1987, a series of collections began in Aguascalientes State with the purpose of collecting the three groups of zooplankton already mentioned, however, in the samplings that have been taken during approximately 21 years, other groups such as algae, protists and different groups of freshwater invertebrates appeared in some of these samples. The problem is that there are scarce specialists in these groups. However, from the beginning, samples have been kept together with the three zooplankton groups that are stored in the Ecology Laboratory No. 1, and images of these groups have been taken both digitally and SEM in the hope of being able to identify them, which has been partially accomplished. These images of the three zooplankton groups are compiled in archives and have been under our custody in the fairly extensive photo library. In addition, digital photos have been taken in recent years of algae, protists and invertebrates whose collection is also found in different image archives, being approximately 3000 to 4000 images. In the last year two exhibitions of nature images were mounted entitled: **"Microflora and Microfauna of Mexico"** at the university campus of the Autonomous University of Aguascalientes from January to June 2019. **"The microscopic universe of Aguascalientes"** was exhibited at the municipal palace of Aguascalientes city, from November to December 2019. These exhibitions, showed up mostl of the scientific images of species new to science, were found in Aguascalientes State.

Objectives

The intention of this work is to present a small sample of this Universe that is not known, but is very important in the aquatic ecosystem, which affects all levels of life of living beings living on this planet. In addition, some images of the species taken with the scanning electron microscope JEOL LV 5900, have been given a special treatment with **PHOTOSHOP 6** to give them an artistic enhancement.

Materials and Methods

- Nikon optical microscope Digital Sight DS-Fi2 with software screen. DS-L3, camera Digital Sight DS-Fi2 and Nikon.
- Olympus optical microscope BX51, with software IMAGE PRO PLUS vs 3.5 and digital camera Media Cybernetics. Evolution LC color.
- Scanning Electron Microscope JEOL JSM-5900LV.

A large majority of Algae, Protists and Invertebrates were captured and taken from the live samples under the optical microscope by a software, in real time. These species were found on the different samplings. The photomicrographs (digital images) are obtained by the camera and software Image Pro Plus of the Oympus Optical Microscope and the camera DS-Fi2 of Nikon and software screen DS-L3 of Nikon optical Microscope Digital Sight DS-Fi2 DS-Fi2.

Microphotographs were taken with the Scanning Electron Microscope JEOL JSM-5900LV. The program used image editing and artistic treatment was Photoshop.

Results

The great biodiversity of scientific images of the species of Algae, Protists, Protozoa and invertebrates of the state were obtained. No special or current classification has been followed, only the species are shown in more pictorial way than following the taxonomic groups in the strict sense, only the microscopic world is made known in an informal way, so that the reader can marvel at this invisible world for all of us who do not know this hidden universe, but present in our environment. The following is a small pictorial sample of some of the groups that inhabit the state.

Collaborators

Ana Ekaterina Retes Pruneda, Jaime Antonio Escoto Moreno, Frida Sabine Álvarez Solís, Rocío Natalia Armas Chávez, Aleksandra Baquero Mariaca, Leslie Darlene Serrano, Porfirio Jassiel López Hernández, Ángel Alcalá Pavia, Martín Carlos González Alcalá, Vianney Beraud Macías, Fernanda Calderón, María Fernanda Cabrera Cabral, Alejandro Jesús Galicia Zacarías, Ana Valeria Árias Magaña, Mireya del Rocío Hernández Villalobos.

Acknowledgment

These are extended to all those who have supported us with their knowledge and skills in different aspects for the completion of this work. We would like to thank CONAHCYT for its technological and financial support, and the Universidad Autónoma de Aguascalientes for its support through internal projects PIB21-3 and PIB24-1.

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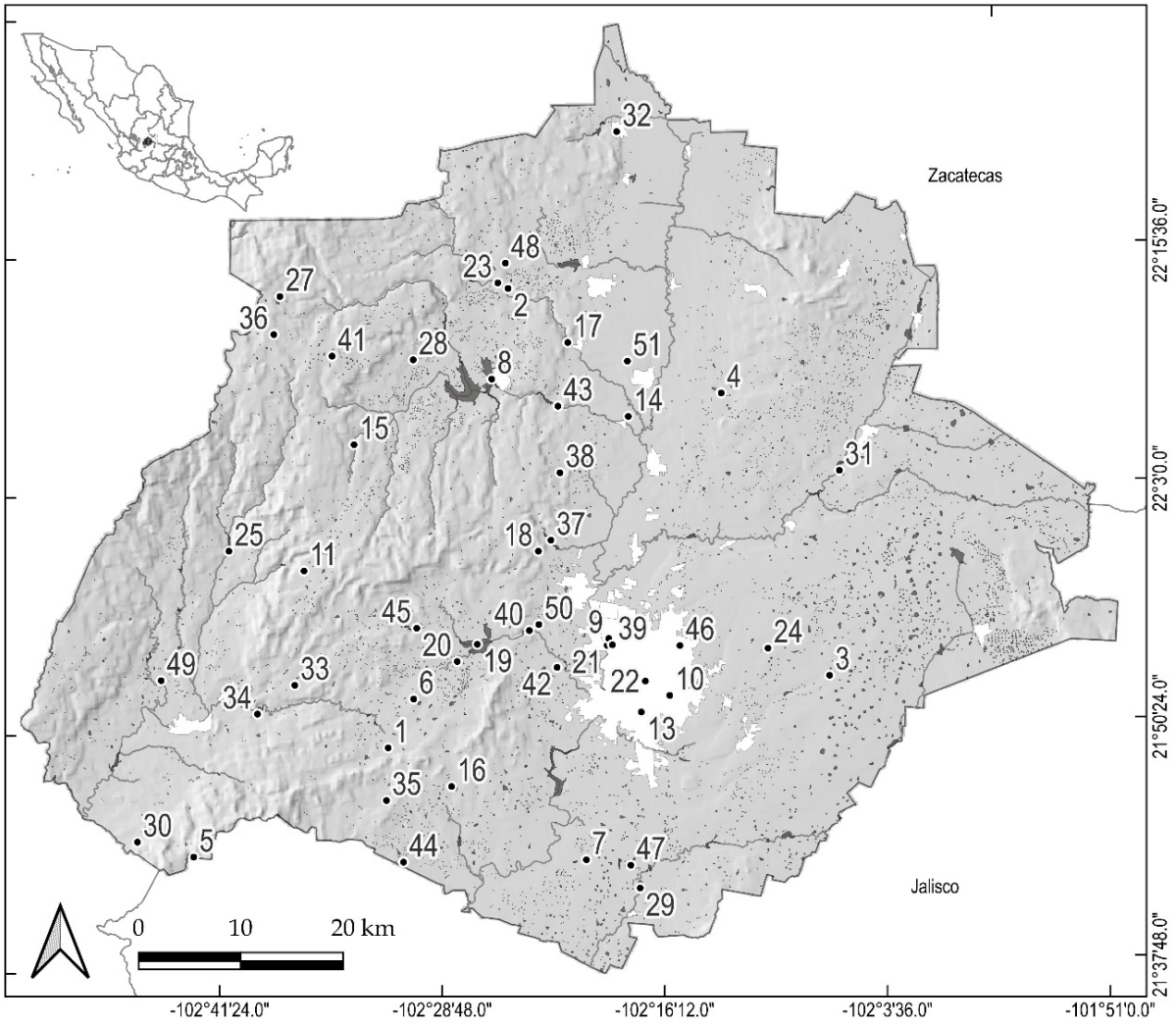

Simbology

- Localities with Records
- Urban areas
- Water elements
- Rivers

Proyection UTM 13N
DATUM:WGS 84
V. Beraud-Macías

1. Los Huijolotes Dam; 2.Tunel de Potrerillo Dam; 3. Sandovales Dam; 4.Channels Adolfo Lopez Mateos; 5.Los Alamitos Dam; 6. Near to the road to Town Tapias Viejas; 7.Pond in Rancho Hermanos Rodríguez; 8.Presidente Calles Dam; 9.Pond La Mezquitera UAA; 10.El Cedazo Dam; 11.Pond in Mesa Montoro; 12.UAA Pond; 13.Parque Rodolfo Landeros Gallegos Pond; 14.El Salto del Burro Pond; 15. EBAZ Pond; 16.Los Caños Dam; 17.San Blas de Pabellón Dam, Pabellón de Hidalgo; 18. Arroyo Seco Dam; 19. Abelardo Rodríguez Dam; 20. Pond 1 and 2 near Abelardo Rodríguez Dam; 21.Pond in Botanic Garden UAA; 22.Parque Hidalgo Pond; 23.Pond a hole 2.5 N of Tortugas Town; 24. La Colorada Pond; 25. La Codorniz Dam; 27.La Araña Dam; 28. Pond next to the town La Congoja; 29.Peñuelas Dam; 30.Pond at Mesa del Roble; 31.El Llavero Dam; 32. Small ditch in house of Allende Street, Cosio; 33.Pond El Sauz; 34.Malpaso Dam; 35.Pond El Ocote; 36.Barranca del Abuelo; 37.Creek next to Chichimeco Dam; 38.El Garabato Dam; 39.Pond Near Rectory of the UAA; 40.Los Arquitos Dam; 41.Paraje Don Pepe; 42.El Cariñan Pond; 43.El Jocoqui Dam; 44.Pond on the side Of Villa Hidalgo-Ags. Road; 45.Pond in Gracias a Dios; 46.Santa Elena Dam; 47.Pond El Jagüey; 48.Pond Las Camas; 49.Pond in The way to Peña Blanca; 50.Granja San Jacobo; 51.Pond in INIFAP.

Figure 1: Map of the localities where the species presented in this work were found.

Note: The locations shown on the map are also written in the legend of each image.

Algae

Figure 2:

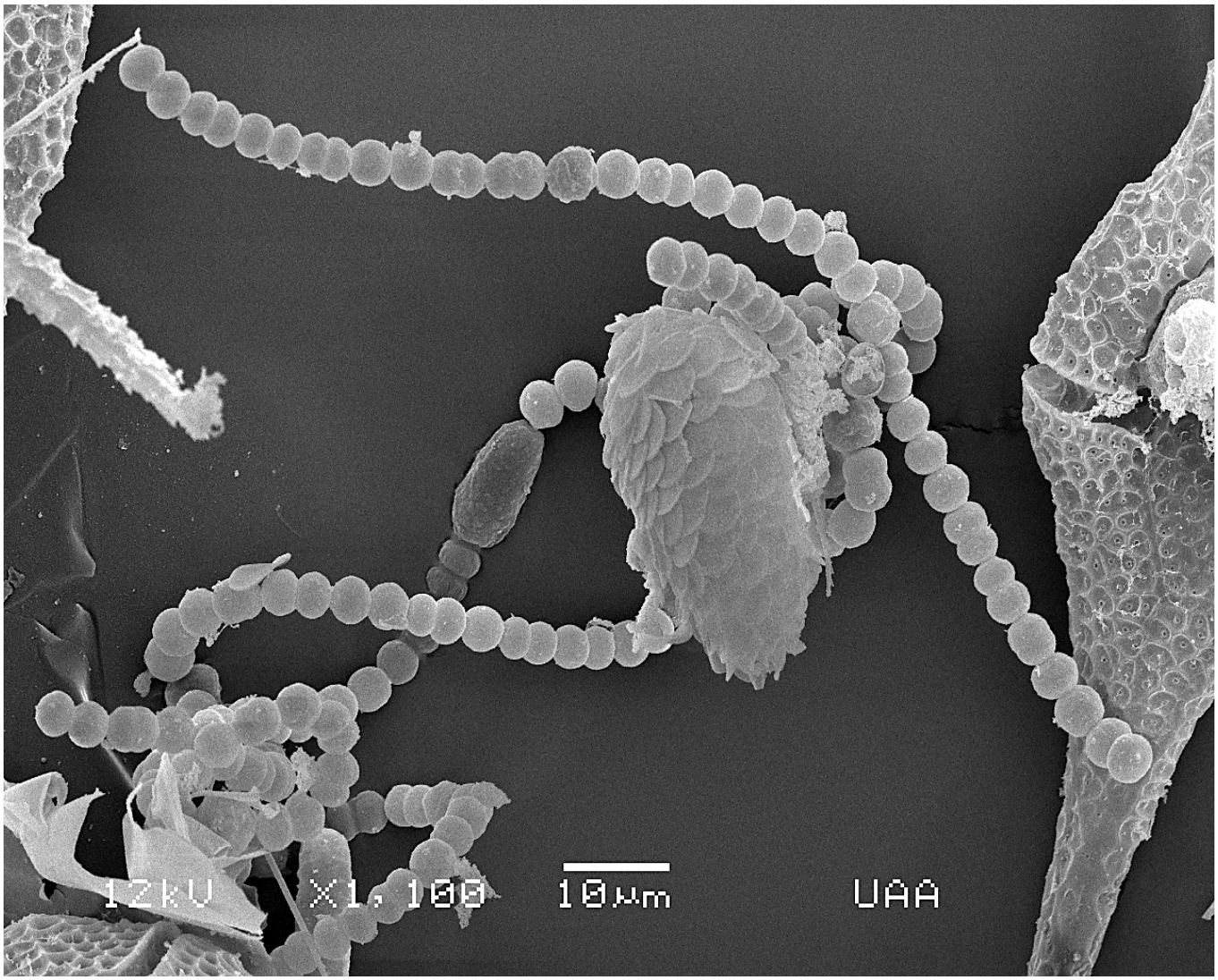

Figure 3: ***Anabaena*** **sp. &** ***Mallomonas*** **sp.** Two microalgae, the first one (Cyanophyta), is a filament showing the heterocyst that has the function of food reserve and reproduction. The second, a cell with silica scales (Chrysophyta), coexists with the first and forms part of the Phytoplankton. Collected at Los Huijolotes dam, Ags.

Author: Araceli Adabache Ortiz & Marcelo Silva Briano

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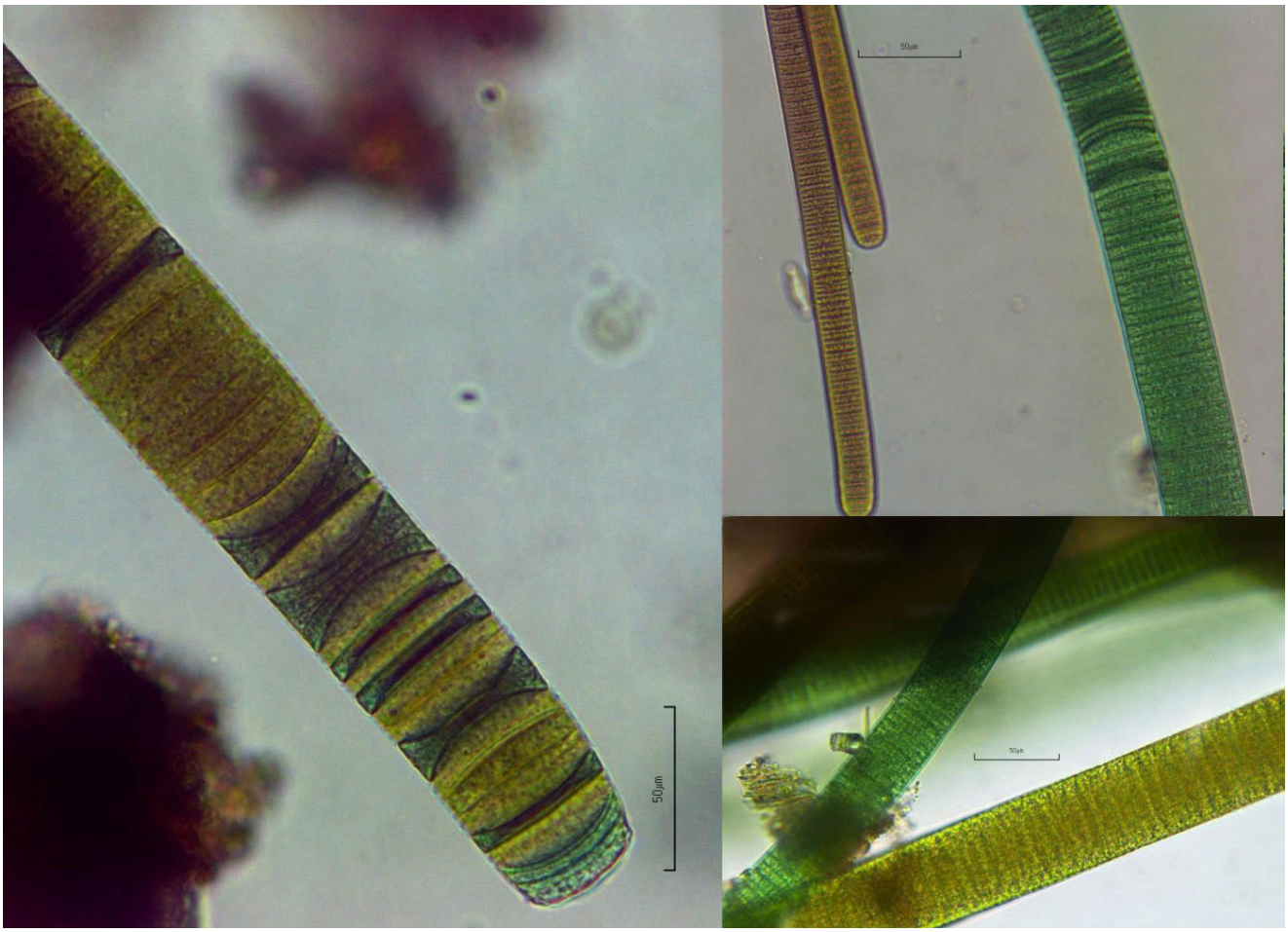

Figure 4: *Oscillatoria* sp. Cyanophyta filamentous algae that forms part of the blooms in the water bodies of the state and that can cause lack of oxygen and poisoning in domestic and wild animals such as dogs, squirrels, rabbits, etc. Collected in Canal in Pueblo Adolfo López Mateos. Pabellón de Arteaga, Ags.

Author: Martín Carlos González Alcalá

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Figure 5: *Anabaena* sp. & *Vorticella* sp. Cyanophyta algae and Ciliate protozoa, which are found cohabiting and serving as substrate Cyanophyta to ***Vorticella* sp.**, to filter the food it needs. They live in dams and ponds in the state. Collected at Los Alamitos dam. Calvillo, Ags. 27 November 2020.

Author: Ángel Alcalá Pavia

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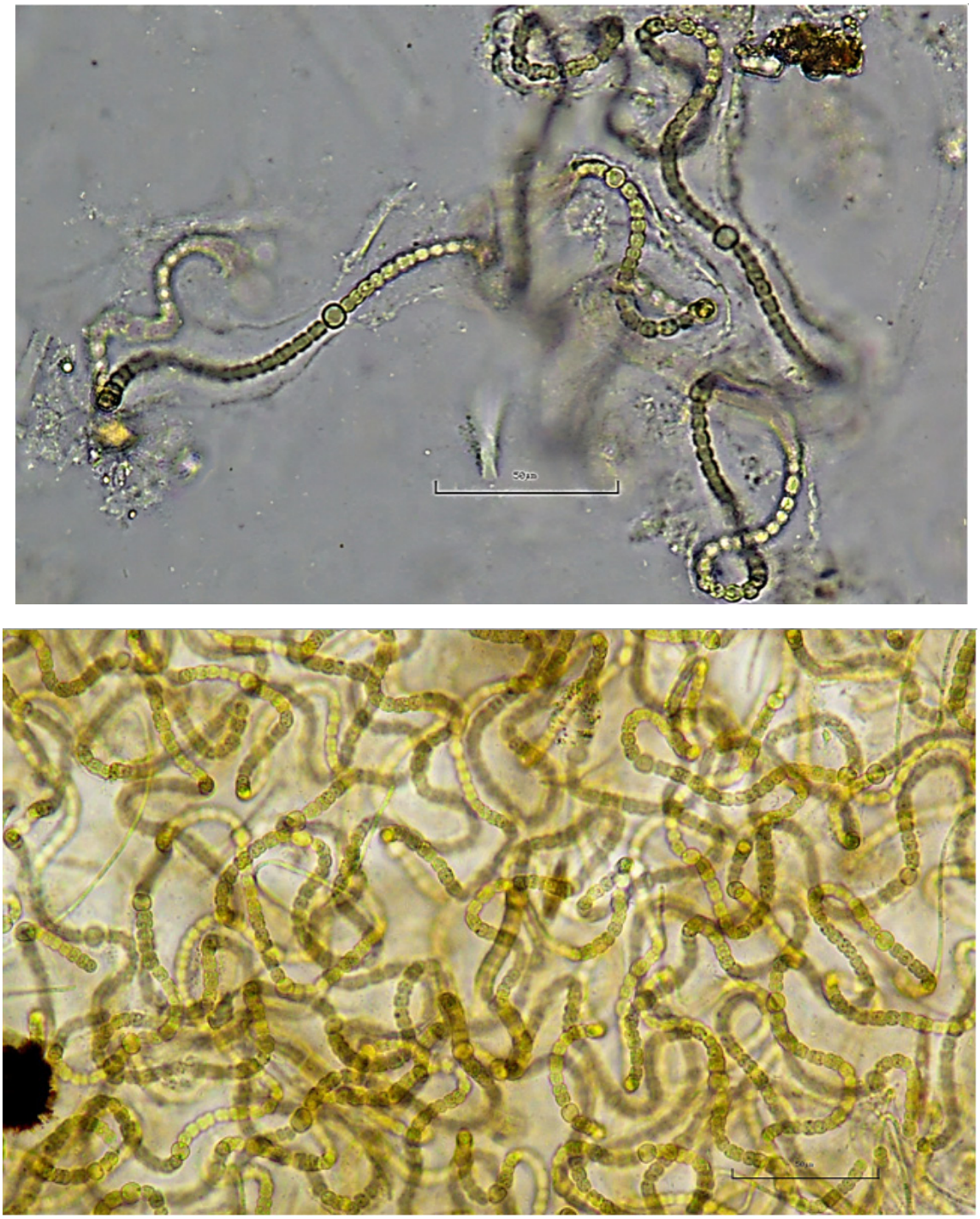

Figure 6: *Nostoc* sp. Cyanophyta showing aggregates of filaments showing heterocysts (round, transparent cells), and vegetative cells. Collected in a pond near the road to the town of Tapias Viejas. Jesús María, Ags. 20 November 2021.

Author: Laura Elena Torres Enríquez

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Figure 7: ***Gloeotrichia intermedia.*** Small Cyanophyta algae, living in small ponds. Its ghostly shape makes it unique with its orange color. Integral part of the phytoplankton of the water bodies, showing its heterocyst whose function is that of food reserve in the anterior part of the filament. Collected in a pond in Rancho Hermanos Rodriguez, Ags.

Author: Frida Sabine Álvarez Solís

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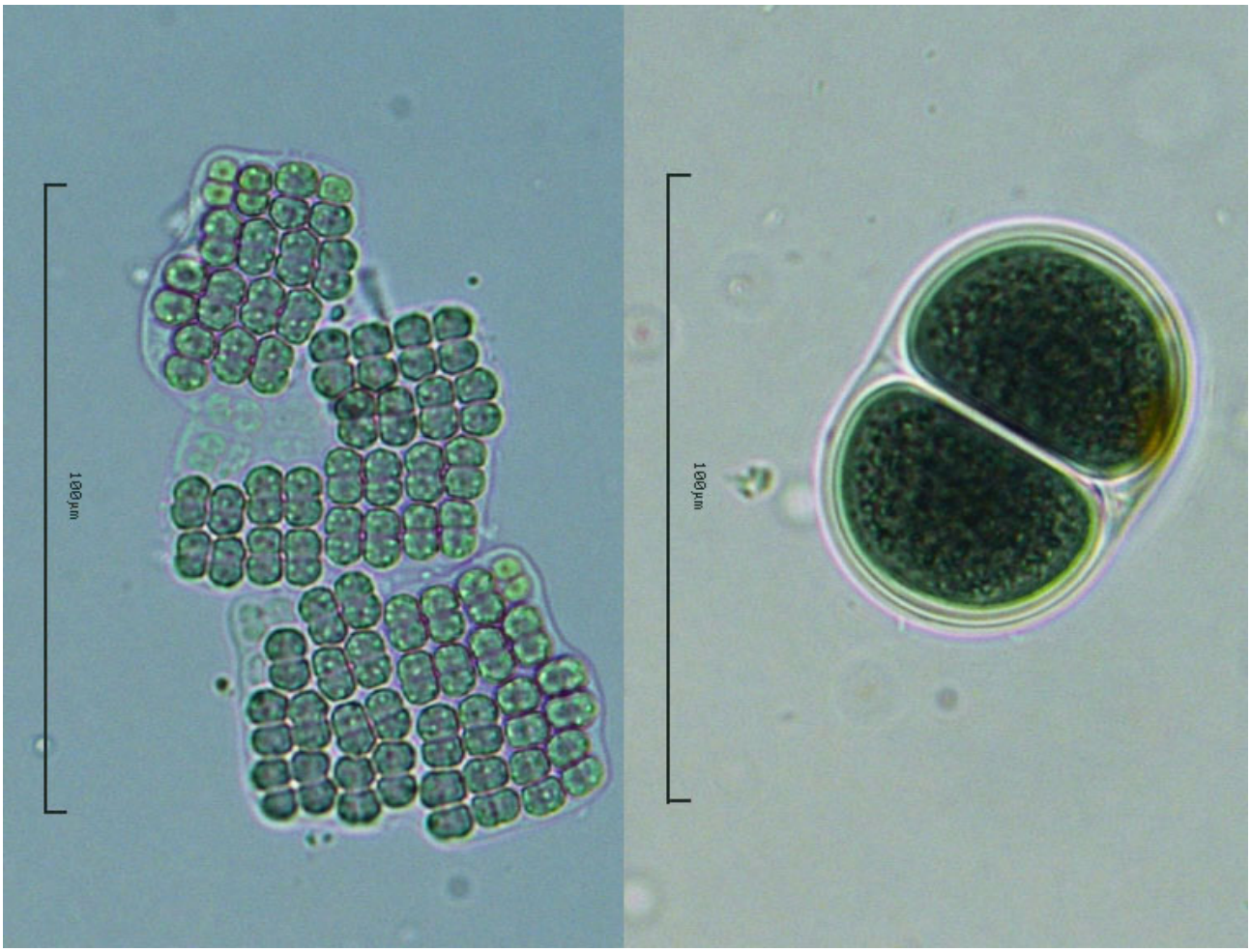

Figure 8: ***Merismopedia*** **sp. &** ***Chroococcus*** **sp.** Small Cyanophyta algae, living in small ponds. The first is a colony of clusters of four-packed cells embedded in muscilage. The second is a cell divided into two, with two membranes. Members of the phytoplankton of water bodies. Collected in pond near El Ocote dam, Ags. 28 August 2023.

Author: Fernanda Calderón

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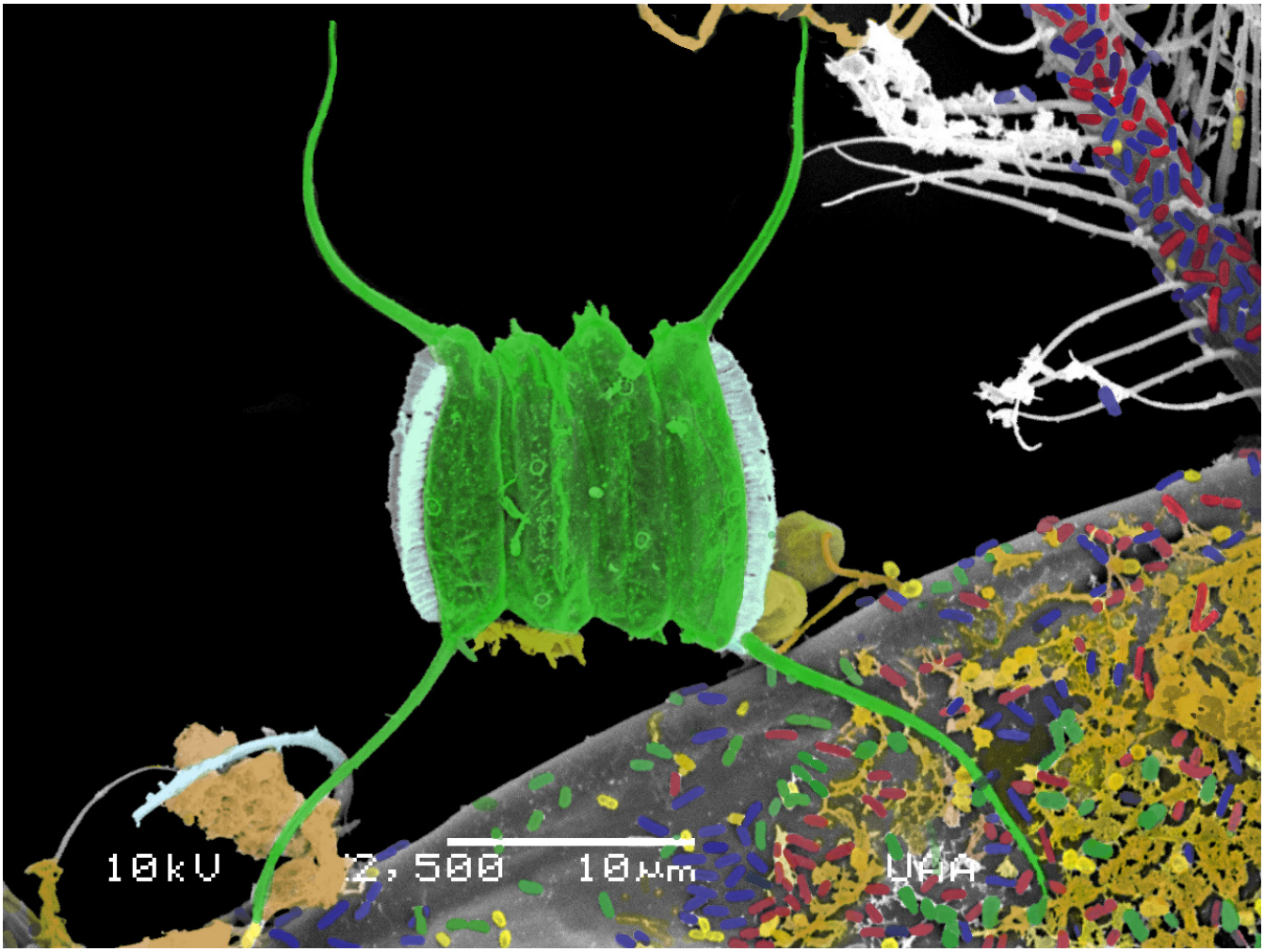

Figure 9: ***Desmodesmus quadricauda*****.** Chlorophyta algae, which is common in the water bodies of Aguascalientes. Collected at pond La Mezquitera. UAA, Ags. (PHOTOSHOP treatment).

Author: Marcelo Silva Briano & Araceli Adabache Ortiz

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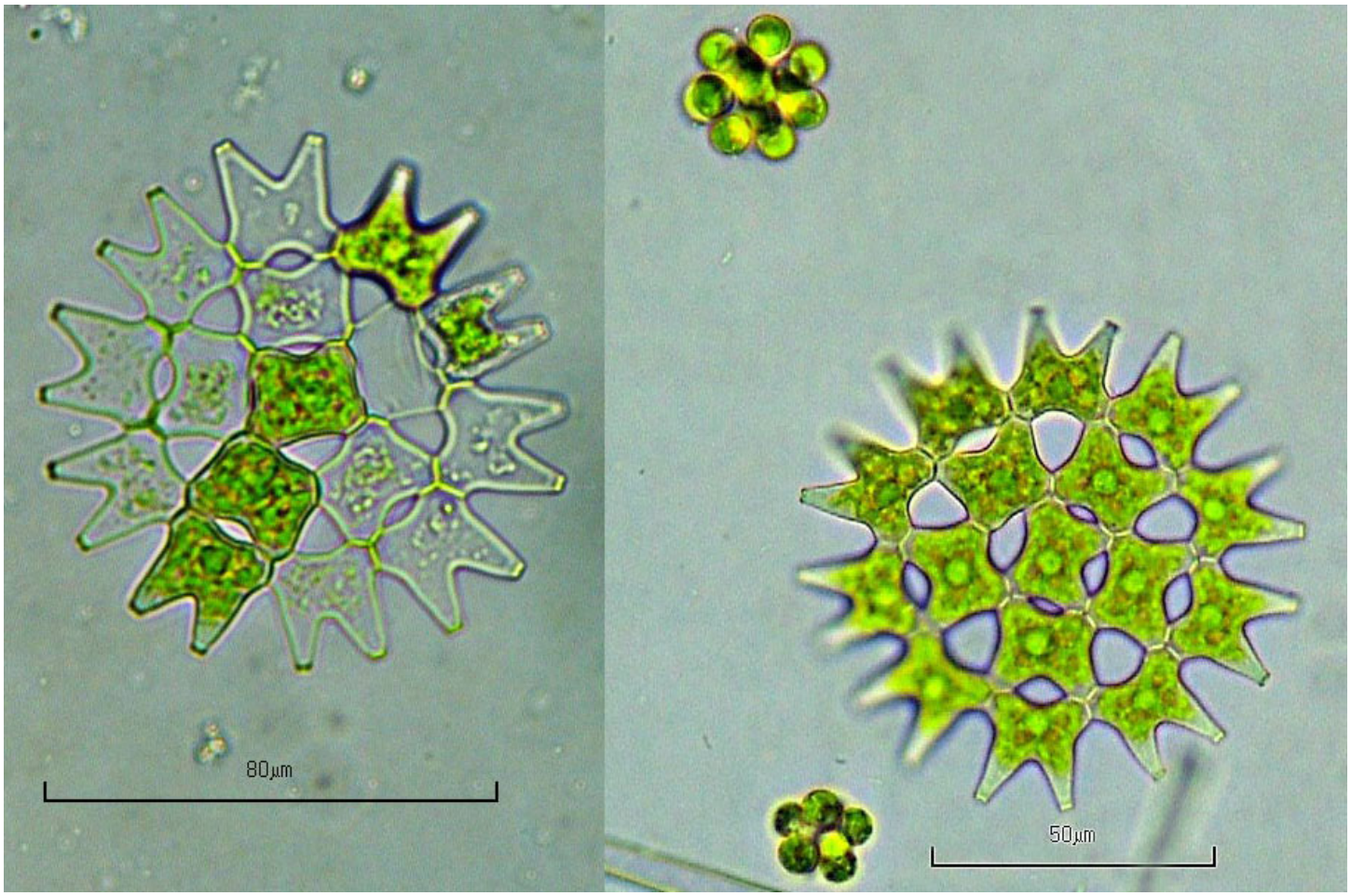

Figure 10: ***Pediastrum duplex*****.** Chlorophyta algae that inhabits the ponds of Aguascalientes. It is part of the food chain as a primary producer, since it oxygenates the water bodies where it lives. Collected at El Cedazo dam, Ags.

Author: Ekaterina Retes Pruneda

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Figure 11: *Oedogonium* sp. Chlorophyta filamentous alga showing the oogonium containing the female gametes that will receive the male gametes. The transparent rings of cell division on one side of the oogonium can also be seen. Left, ***Staurastrum* sp**., another Chlorophyta, is observed. Collected at pond in Barranca del Abuelo. Sierra Fría. San José de Gracia, Ags. February 2022.

Author: Laura Elena Torres Enríquez

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Figure 12: *Closterium* sp. Chlorophyta algae, member of the phytoplankton of the state of Aguascalientes. It is responsible for the oxygenation of water bodies because it carries out photosynthesis with green chloroplasts. Its food reserve is contained in the circular pyrenoids found along the body of the algae. Collected in El Terrero pond. Calvillo, Ags.

Author: Frida Sabine Álvarez Solís & Rocío Natalia Armas Chávez

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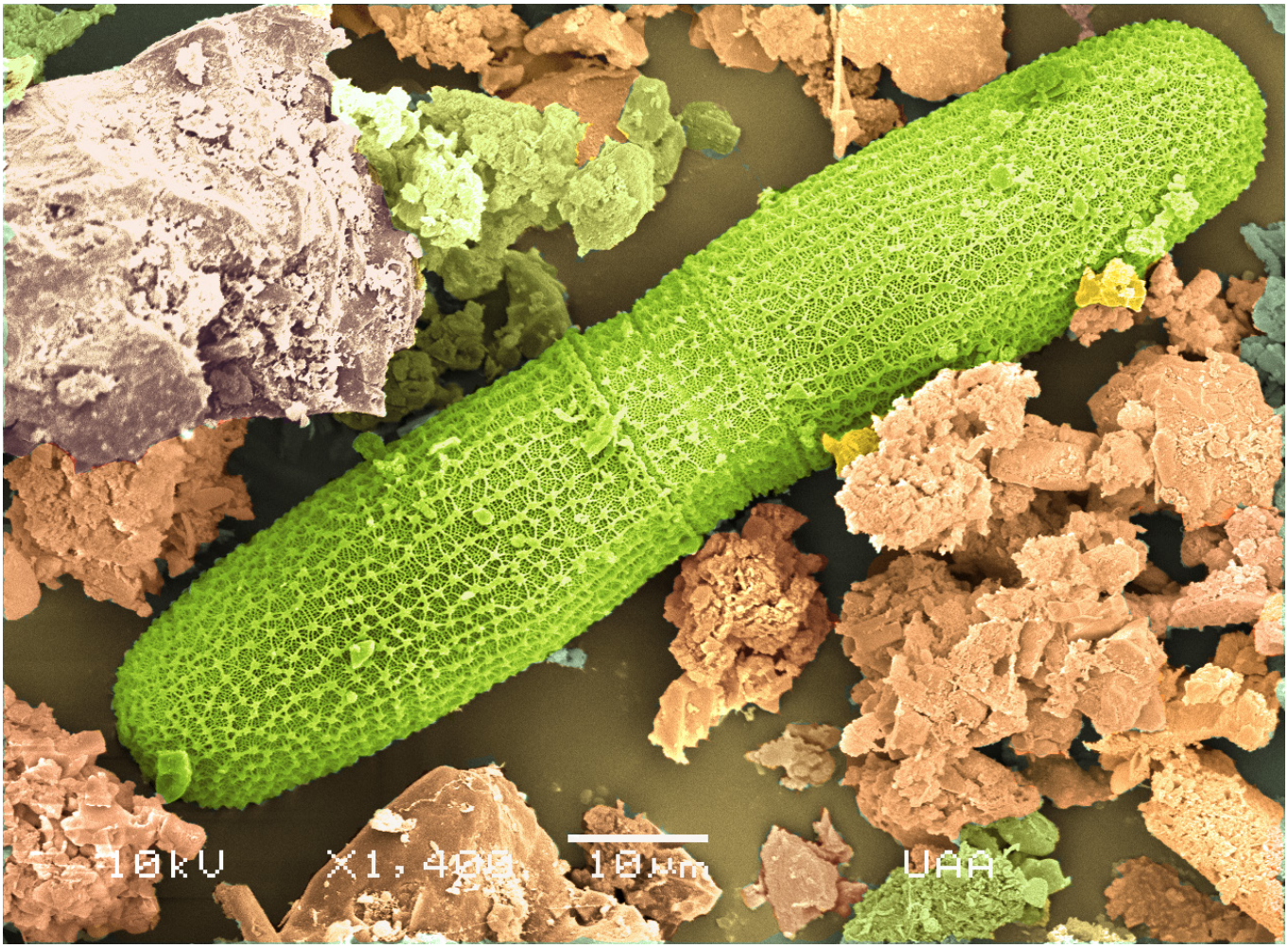

Figure 13: *Pleurotaenium* sp. Chlorophyta that inhabits the water bodies of Aguascalientes. It floats more easily due to the ornamentation of its cell wall that forms its cell which is formed by two semi-cells. Collected in Mesa Montoro pond. Calvillo, Ags.

Author: Marcelo Silva Briano & Araceli Adabache Ortiz

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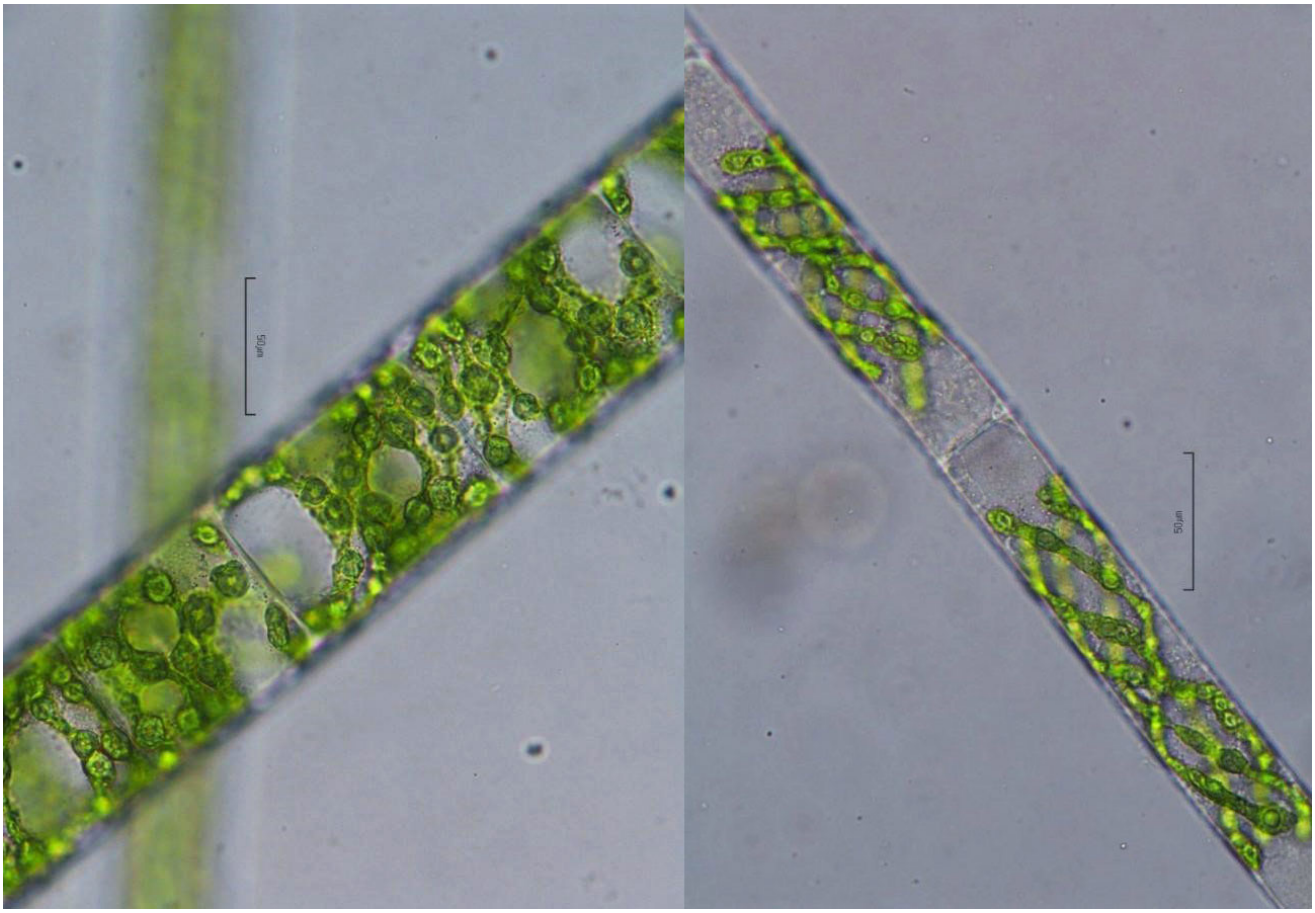

Figure 14: *Spyrogira* sp. Chlorophyta filamentous algae distinguished by its bright green color and spiral chloroplasts, hence its name. Collected in creek next to El Chichimeco dam. Jesús María, Ags.

Author: Rocío Natalia Armas Chávez & Frida Sabine Álvarez Solís

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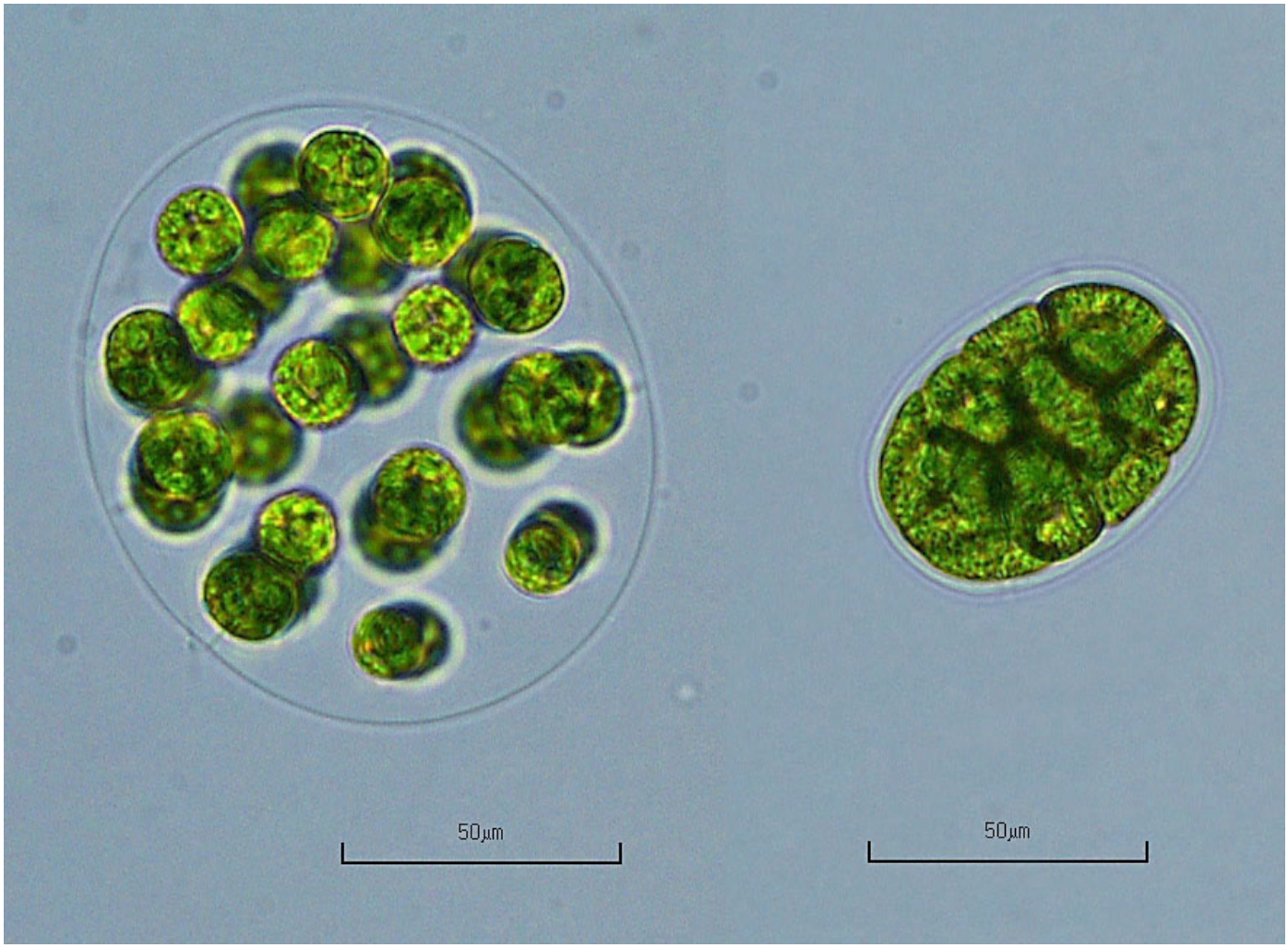

Figure 15: ***Eudorina elegans*** **&** ***Pandorina morum*****.** Chlorophytes Volvocales algae that inhabit the ponds of Aguascalientes. They are part of the food chain as primary producers, since they oxygenate the water body where they live. Collected in UAA pond, Ags.

Author: Estefanía Guzmán Huerta

Laboratory de Ecología

Figure 16: *Gomphonema* sp. A diatom living in colonies attached to a filamentous chlorophyte alga in ponds, along with some protists. Collected at UAA pond, Ags.

Author: Fernanda Calderón

Laboratorio de Ecología

Figure 17: *Navicula* sp., *Alaucoseira granulata* & *Cosmarium* sp. The first two are Chrysophyta (oval-shaped Pennal diatoms and filament-shaped Central diatoms respectively). The third is a Chlorophyta: Desmidiaceae with their large chloroplasts. They are part of the food chain producing oxygen in the ponds and dams of the state. Collected in Parque Rodolfo Landeros Gallegos pond, Ags.

Author: Frida Sabina Álvarez Solís

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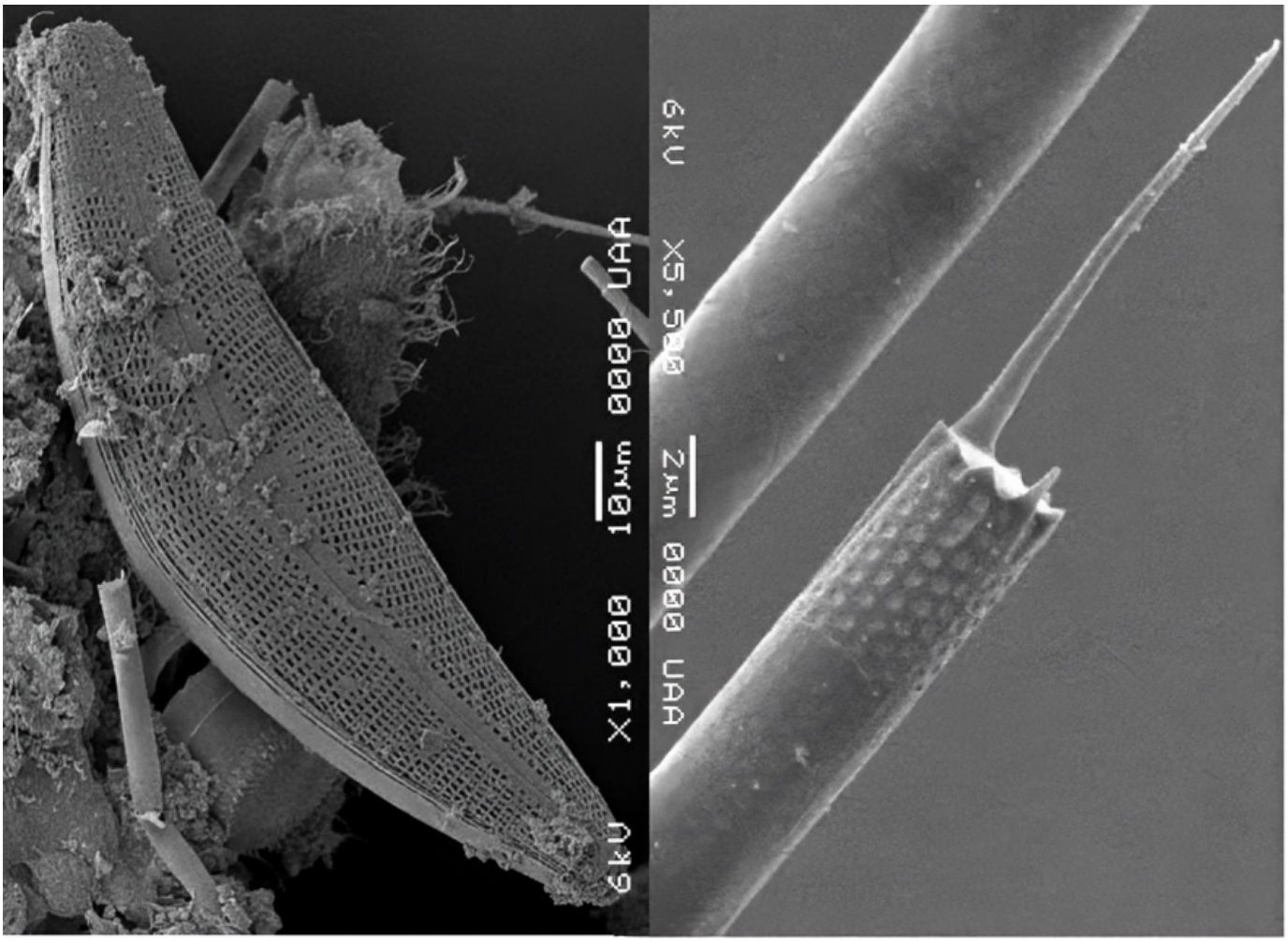

Figure 18: ***Cymbella*** **sp. &** ***Alaucoseira granulata.*** Two diatoms, the one in the left image is a Pennal, the right image is a Central, which coexist with the zooplankton in the water bodies of the state, being members of the phytoplankton. Collected at El Salto del Burro pond, Ags. 31 July 93.

Author: Araceli Adabache Ortiz & Marcelo Silva Briano

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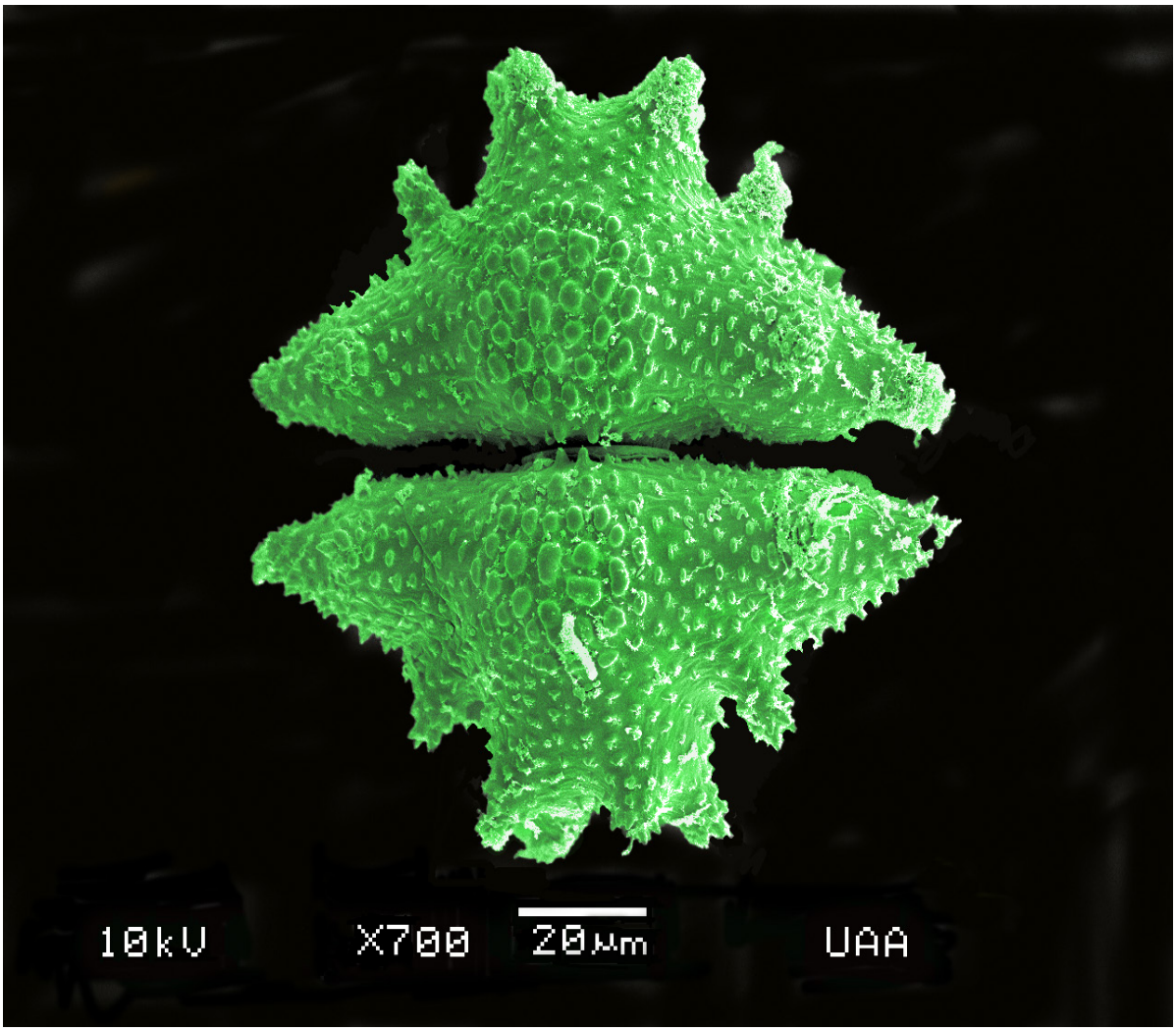

Figure 19: *Cosmarium* sp. Chlorophyta green algae, found in the water bodies of Aguascalientes. This type of algae provides oxygen to invertebrates that live cohabiting with the algae. Collected at the UAA pond, Ags.

Author: Araceli Adabache Ortiz

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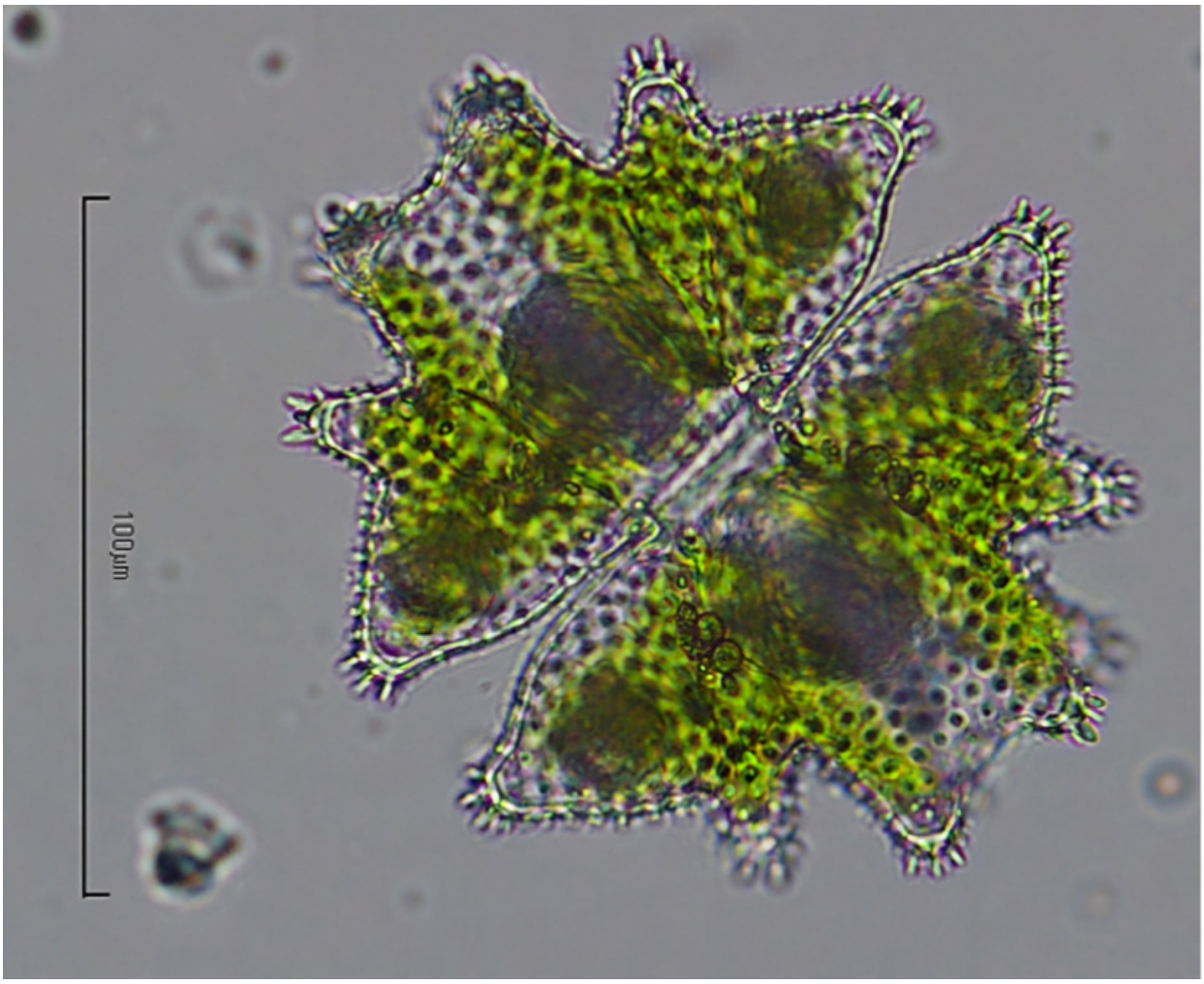

Figure 20: *Cosmarium* sp. Small alga Chlorophyta, which lives in the ponds of the state. Its exceptional architecture allows to see the beauty of its shape. It is an integral part of the phytoplankton, contributing to the generation of oxygen in water bodies. This image is the same species as the previous one, only this one is a digital image and the previous one was taken with a scanning electron microscope with Photoshop treatment and collected in the UAA pond. Collected at EBAZ pond. San José de Gracia, Ags.

Author: Porfirio Jassiel López Hernández

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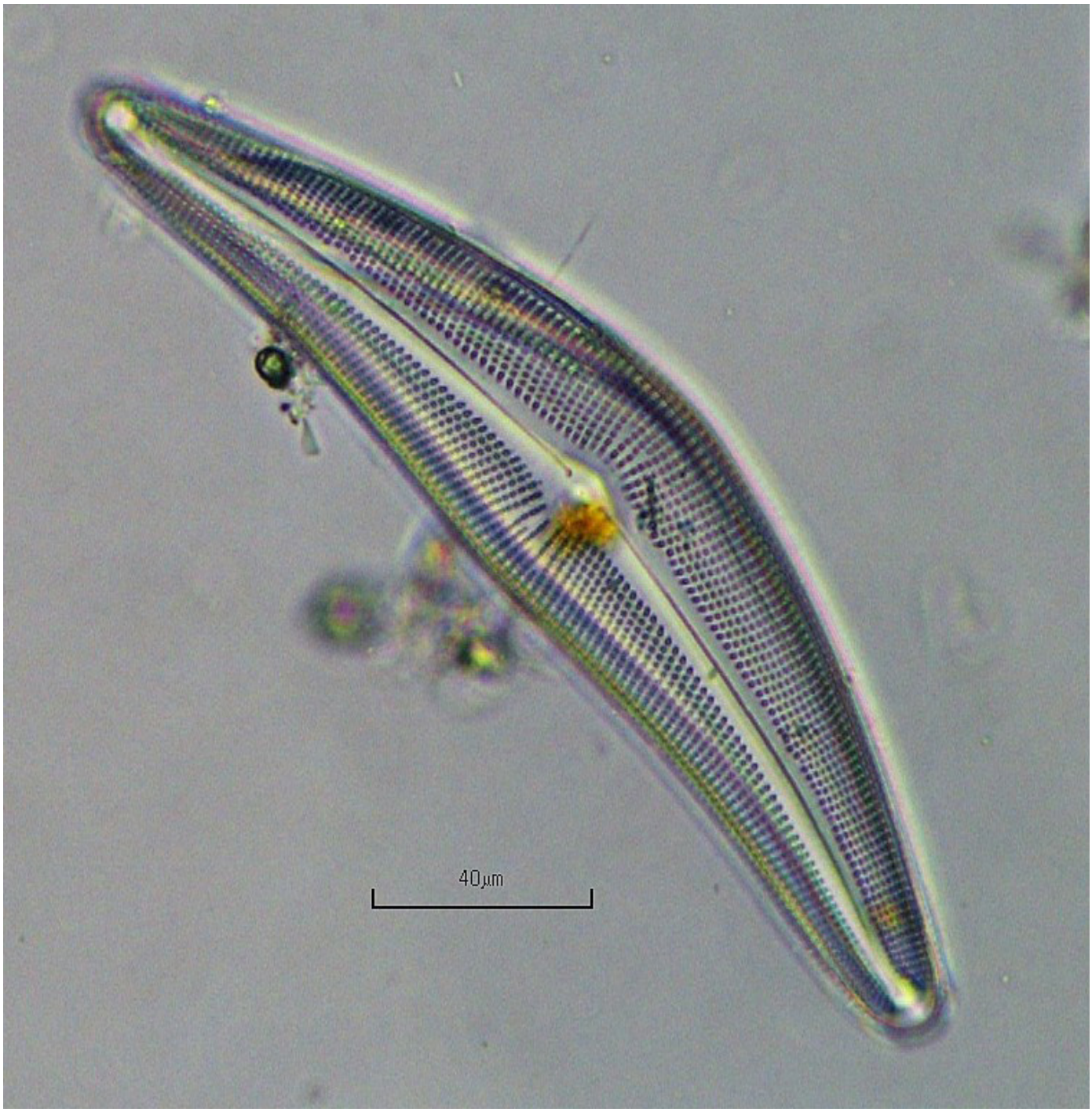

Figure 21: *Cymbella* sp. A diatom that lives in the ponds coexisting with the plankton. Collected at Parque Rodolfo Landeros Gallegos pond, Ags.

Author: Ana katerina Retes Pruneda

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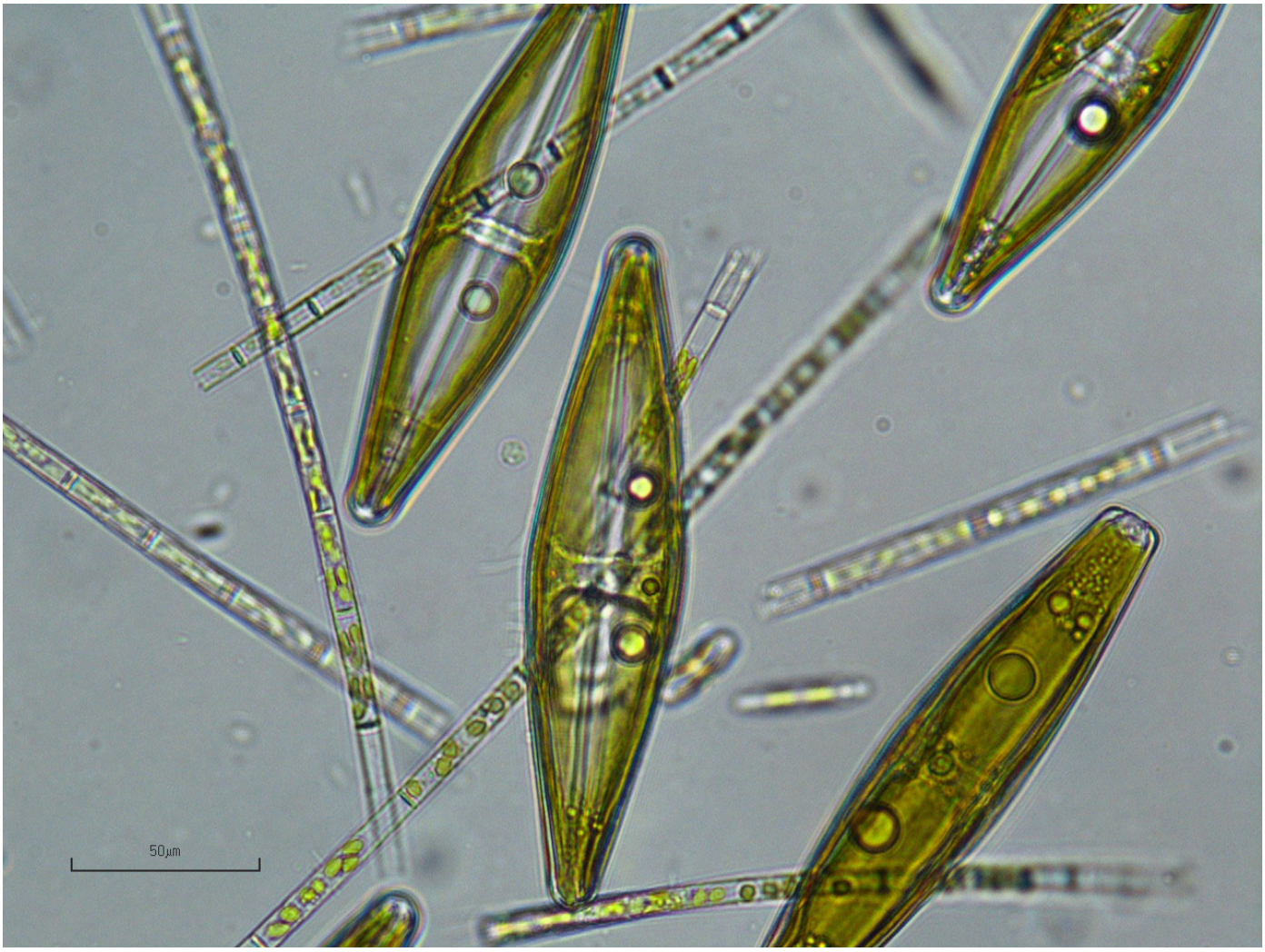

Figure 22: *Navicula* sp. Small diatom (Pennales), member of the phytoplankton of the water bodies of the state. It also coexists with the diatom ***Alaucoseira granulata*** (Centrales). Collected in Parque Rodolfo Landeros Gallegos pond, Ags.

Autor: Frida Sabine Álvarez Solís

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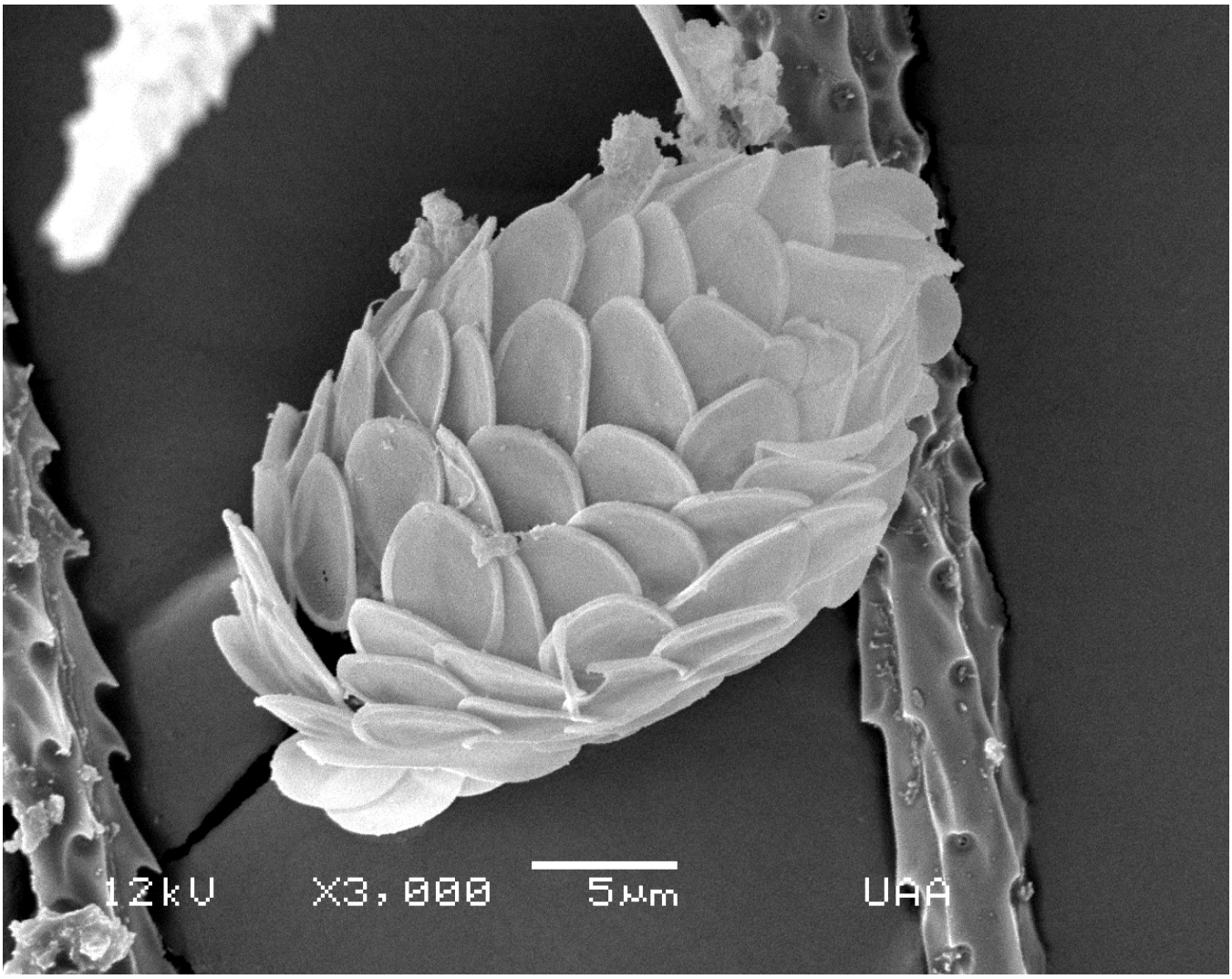

Figure 23: ***Mallomonas*** **sp.** Micro alga of the Chrysophyta group that lives as part of the phytoplankton of the ponds and dams of the state. The cell shows its silica scales that cover it. Collected in Huijolotes dam, Ags.

Author: Araceli Adabache Ortiz & Marcelo Silva Briano

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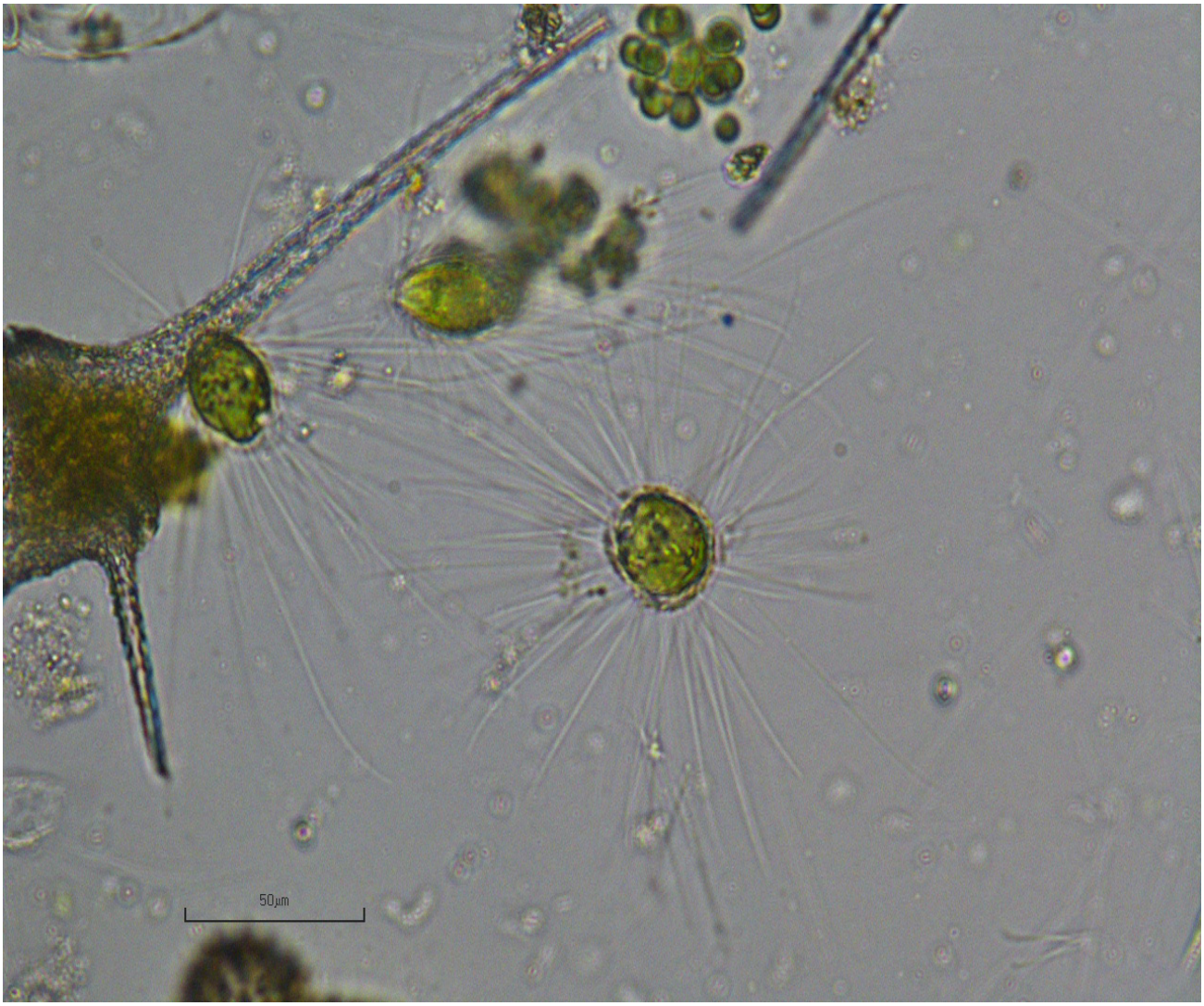

Figure 24: *Mallomonas* sp. Central and right image, Chrysophyta algae that is characterized by its multiple projections, in addition to having scales on the surface of its cell. The dinoflagellate ***C. hirundinella*** (Pyrrophyta) is also observed on the left side with two cell projections). Both present in small pools and ponds in the state. Collected at Los Alamitos pond. Calvillo, Ags. 20 September 2020.

Author: Ángel Alcalá Pavia

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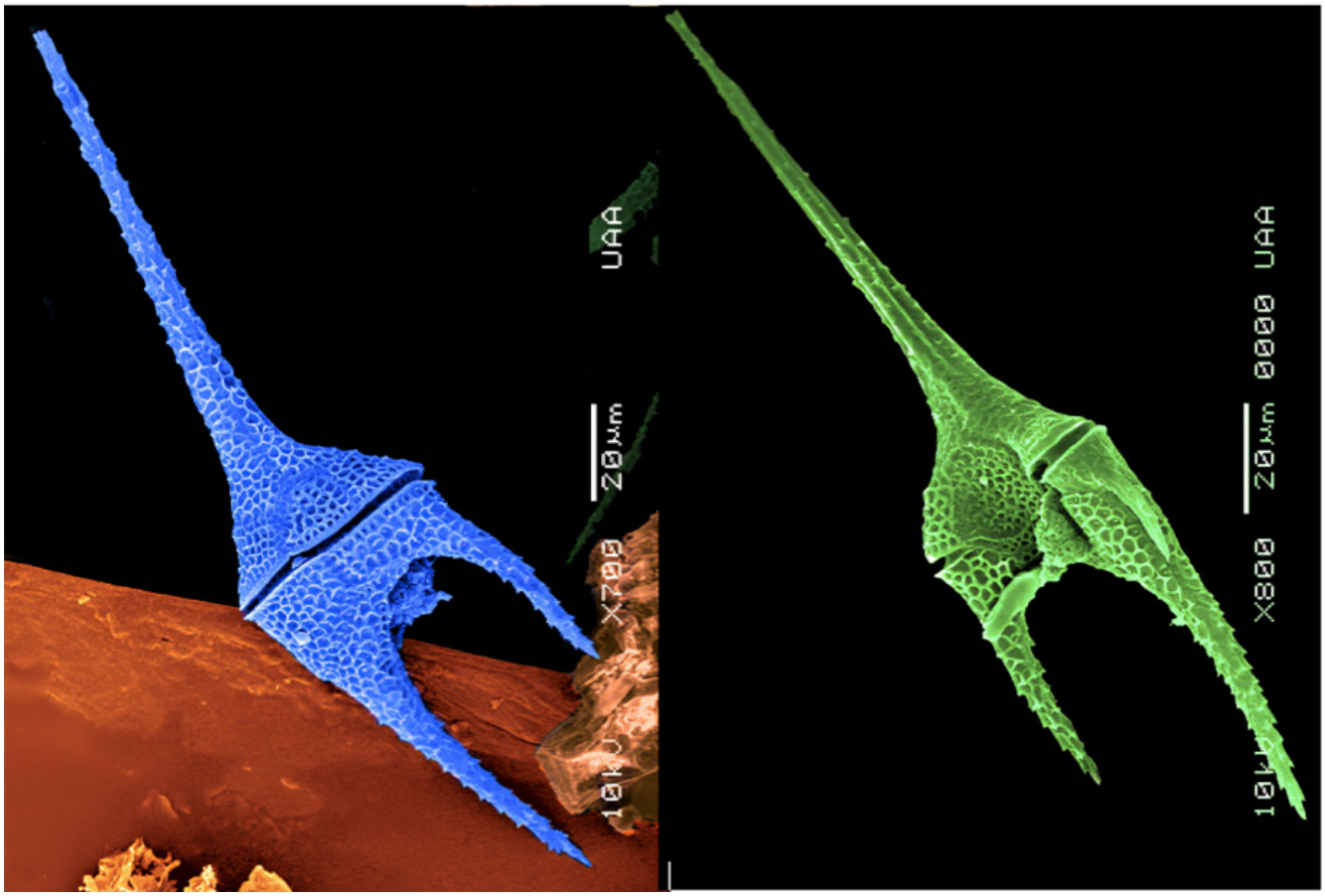

Figure 25: ***Ceratium hirundinella*****.** Micro algae or protista belonging to the dinoflagellates. It reproduces in astronomical quantities as blooms in ponds, lagoons and dams in the state. Images, left, dorsal view, right, ventral view. Collected at Los Caños dam, Ags.

Author: Araceli Adabache Ortiz & Marcelo Silva Briano

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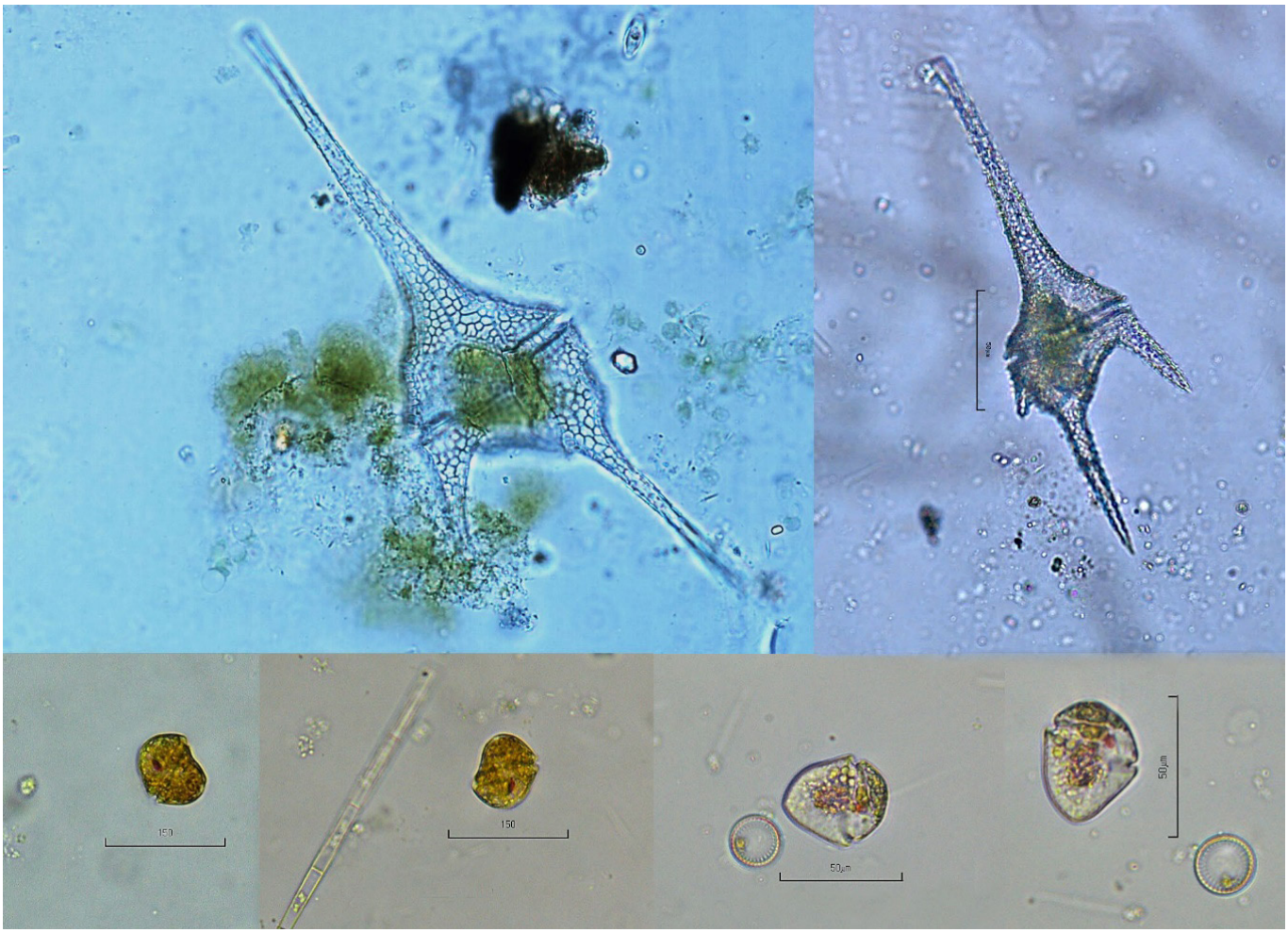

Figure 26: ***Ceratium hirundinella*****.** Above, armed dinoflagellate, cingulum present in the middle part of the cell. Collected at Presa Arroyo Seco. Jesús María, Ags. 10 December 2018. ***Peridinium*** **sp.** Left below (with inset), scarcely found in water bodies in the state. Both the epi and hypocone can be observed. Brownish yellow in color due to its pigments, the cingulum is observed in the middle part of the cell. Collected in Parque Hidalgo pond, Ags. ***Gymnodinium*** **sp.**, center and right below. Unarmored cell showing the sulcus dividing the epi and hypocone. Species scarce in Aguascalientes. Collected at Parque Hidalgo pond, Ags. 2 July 2019. 7 April 2021.

Author: Marcelo Silva Briano and others

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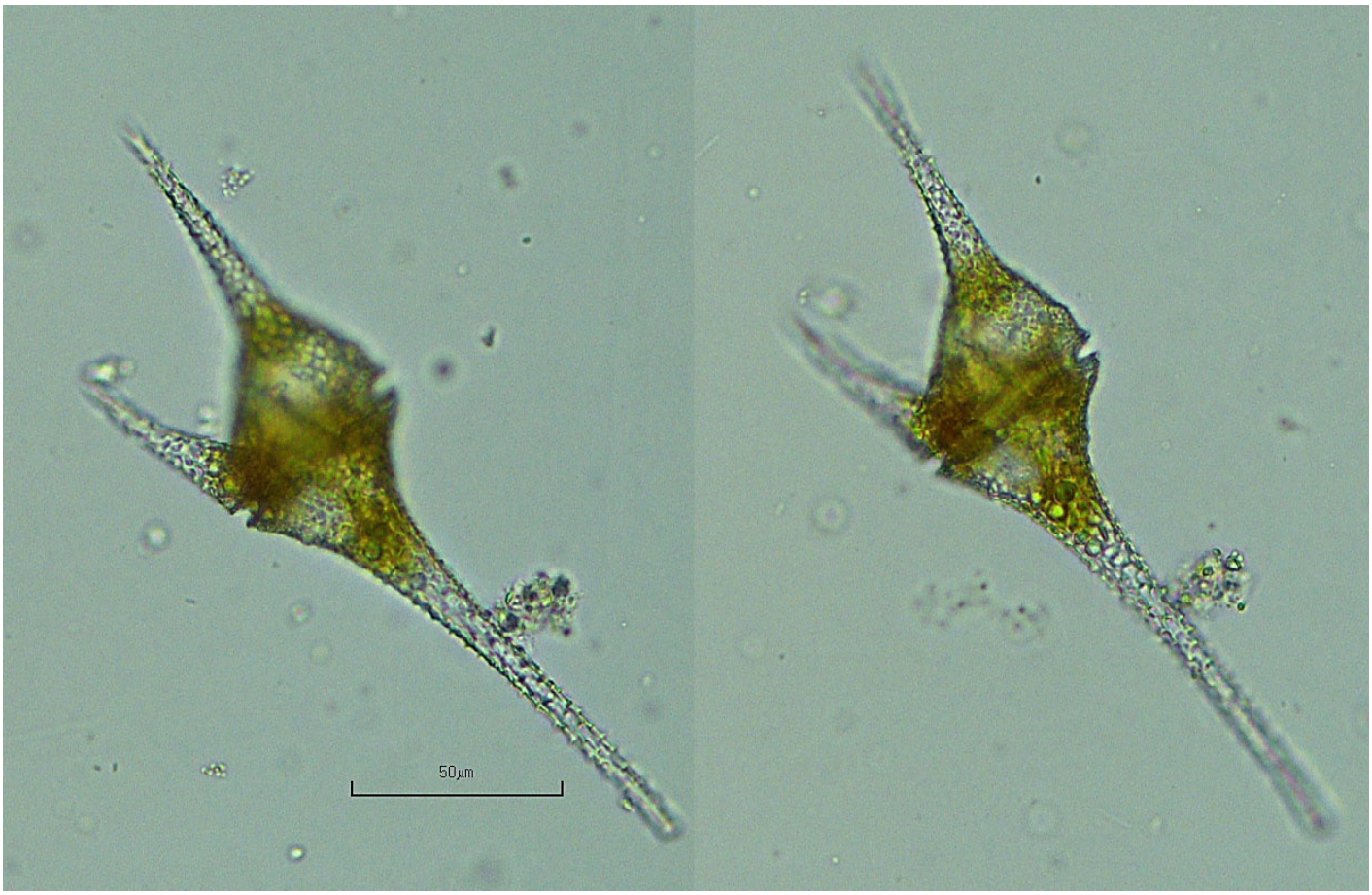

Figure 27: ***Ceratium hirundinella*****.** A dinoflagellate typical of freshwater bodies. It sometimes produces large blooms where it lives. It is the same species as the previous one found in Parque Hidalgo pond. Collected in El Garabato pond. Pabellón de Arteaga, Ags.

Author: Estefanía Guzmán Huerta

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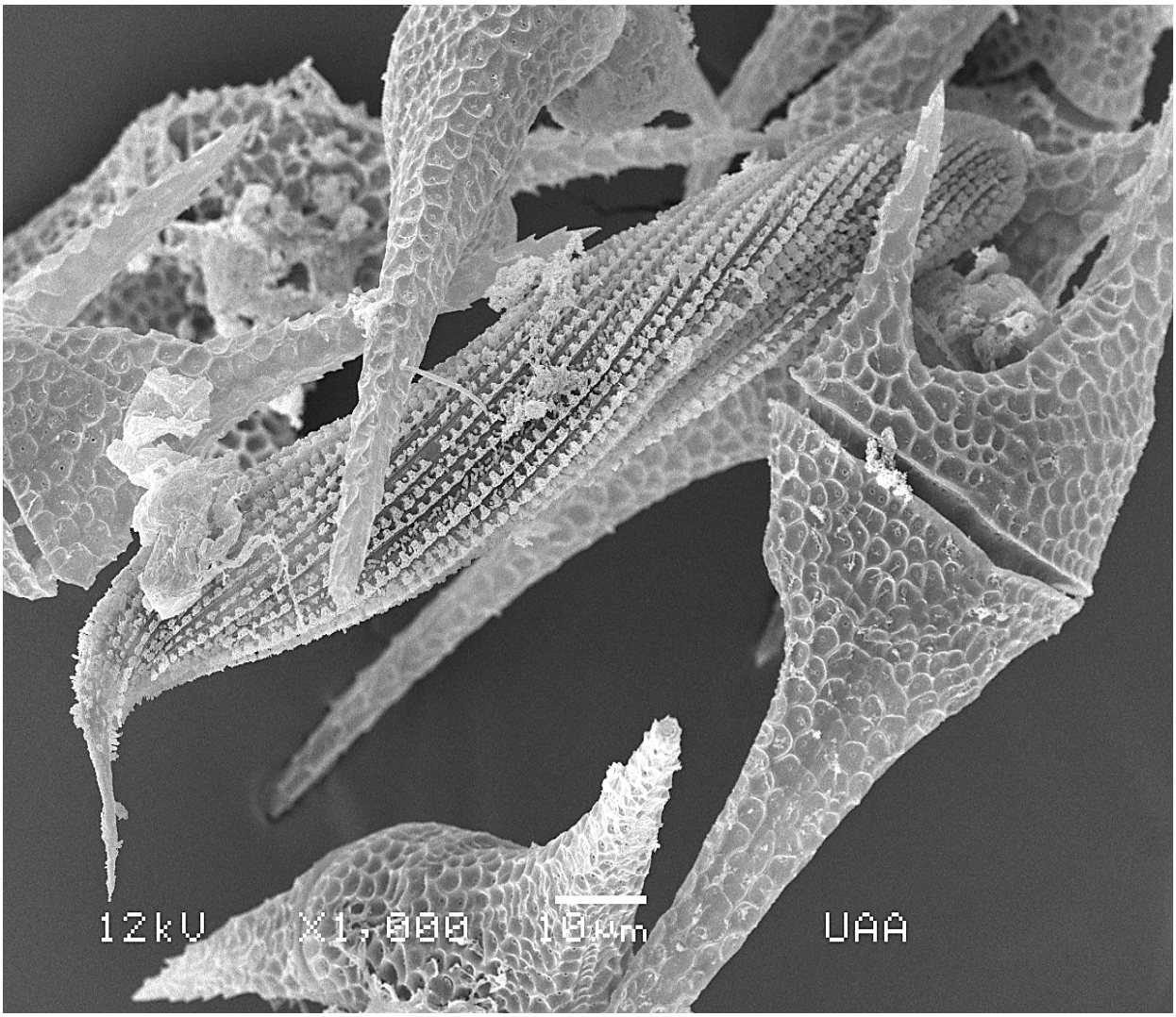

Figure 28: ***Lepocinclis spyrogira*** **&** ***Ceratium hirundinella*****.** Two microalgae or protists, the first (Euglenophyta), showing spiral ornamentation of the periplast. The second (Phyrrophyta), exhibiting its armature divided by a transverse groove the upper part (epitheca) and the lower part (hypotheca). Collected in Los Huijolotes dam, Ags.

Author: Araceli Adabache Ortiz & Marcelo Silva Briano

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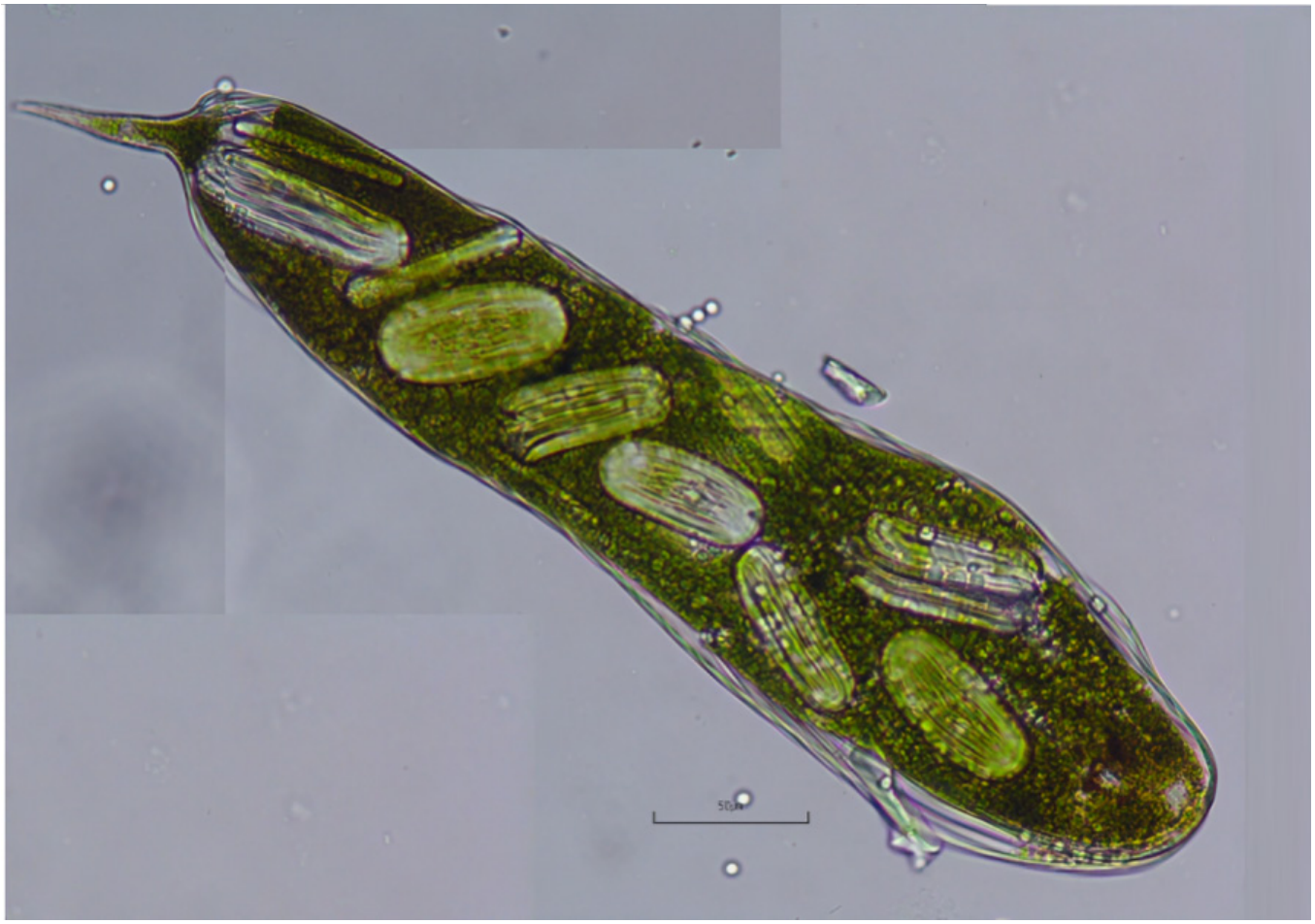

Figure 29: *Lepocinclis* sp. Euglenid of large size, reaching up to more than 500 microns in length. It shows its cauda, the striped periplast and the paramilon bodies with cylindrical-oval shape. Collected at San Blas dam. Pabellón de Arteaga, Ags. 31 July 2019.

Author: Martín Carlos González Alcalá

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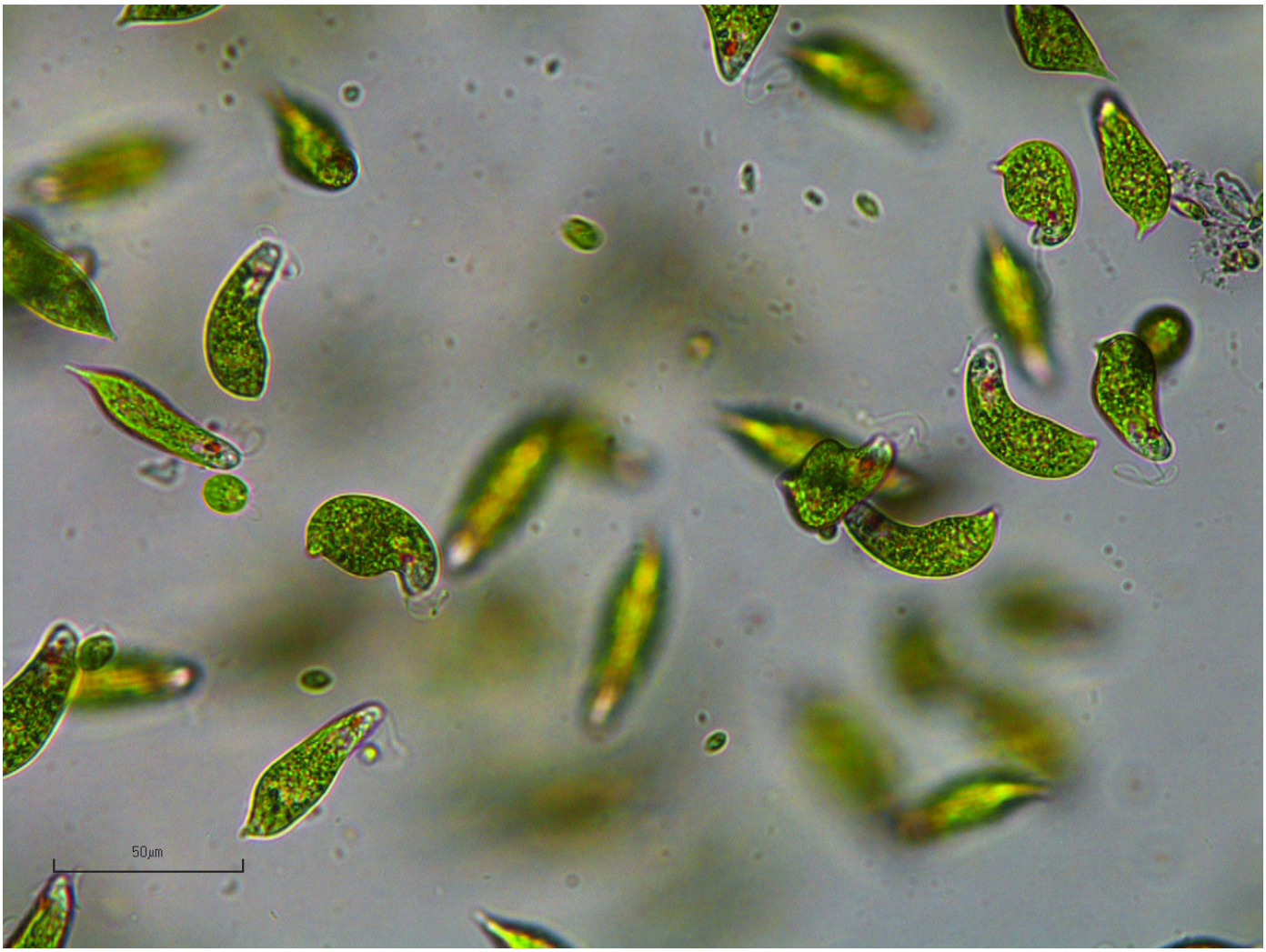

Figure 30: ***Lepocinclis acus*****.** Group of small euglenids with different metabolic movements (amoeboid) typical of euglenids and showing their whip-like flagellum. They are inhabitants of small puddles and ponds in the state Collected in puddle near the rectory building of the UAA, Ags. 3 April 2019.

Author: Frida Sabine Álvarez Solís

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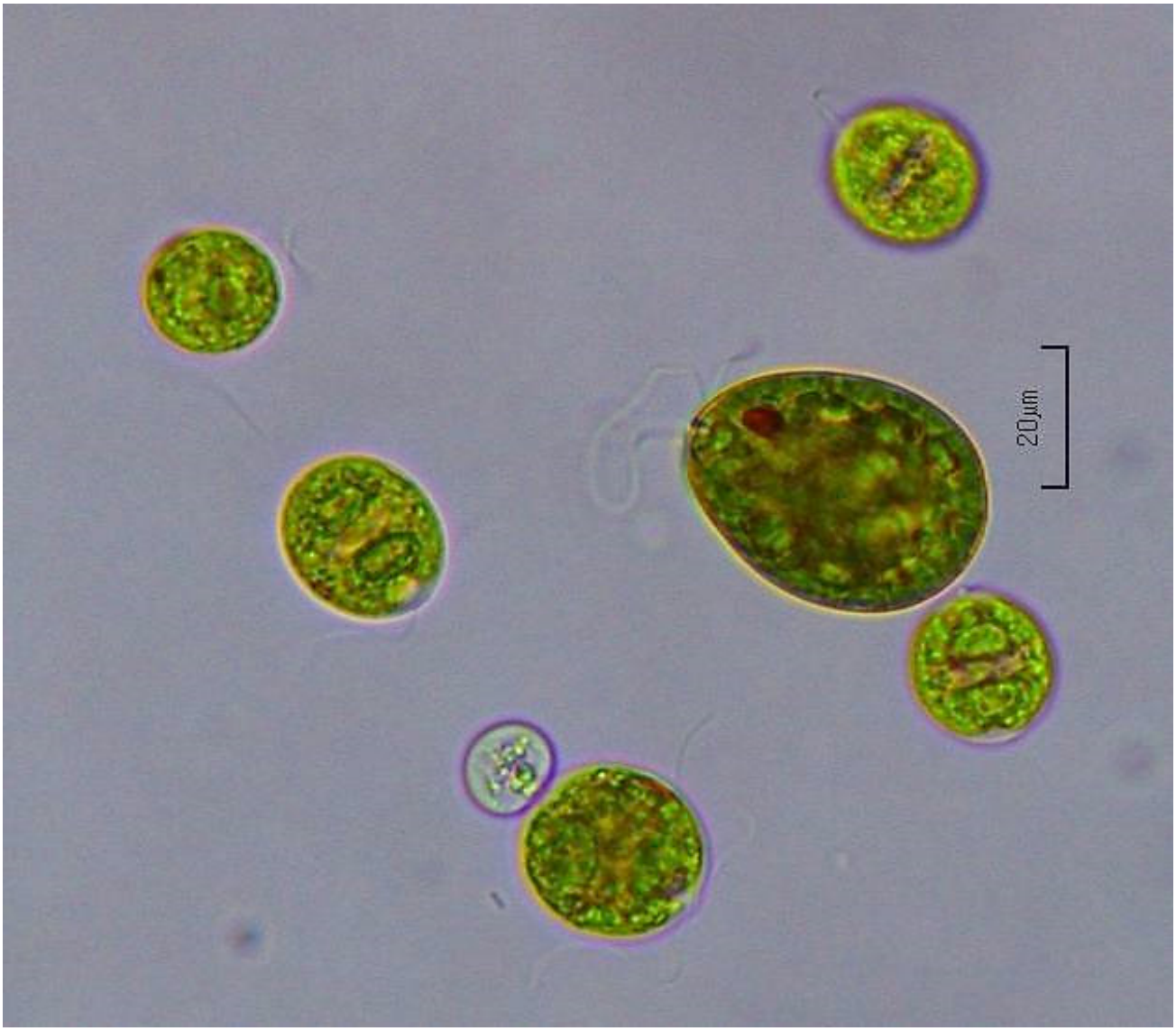

Figure 31: *Euglena inflata*. An Euglenophyta (see flagella and red stigma), living in ponds. ***Chlamydomonas* sp.** Five Chlorophytes flagellated individuals, members of the Phytoplankton that live as part of the food chain of the state's water bodies. Collected in the UAA pond, Ags.

Author: Rocío Natalia Armas Chávez & Frida Sabine Álvarez Solís

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Figure 32: ***Euglena ehrenbergii*****.** This large Euglenid is present in the ponds of Aguascalientes. Its large stigma and the wiggly shape of its elongated body stand out. It presents many chloroplasts of intense green color. Parque Hidalgo pond. April 16, 2021.

Author: Aleksandra Baquero Mariaca

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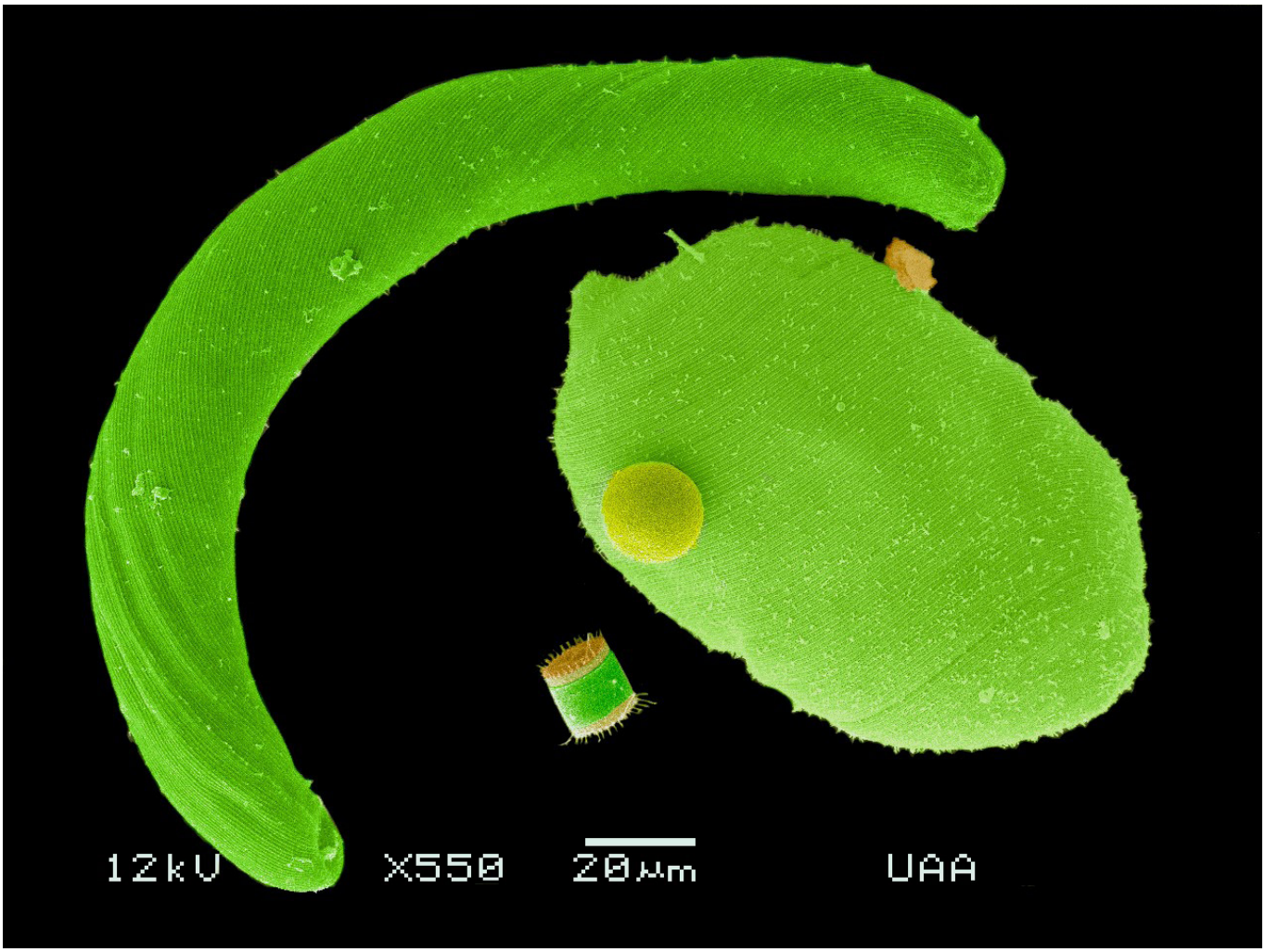

Figure 33: ***Euglena ehrenbergii*****.** Euglenido that can change shape, two can be observed: the globular shape and the elongated shape, due to the metabolia, which is the ability to change the shape of the body. Its periplast or membrane or cell wall, has a diagonally grated ornamentation as seen in the two images. The image shows a round epibiont, which is probably a small ciliate that is attached to the periplast. There are remains of a tubular filament belonging to an unidentified central diatom. Collected at Parque Hidalgo pond. February 1, 2022.

Author: Araceli Adabache Ortiz & Marcelo Silva Briano

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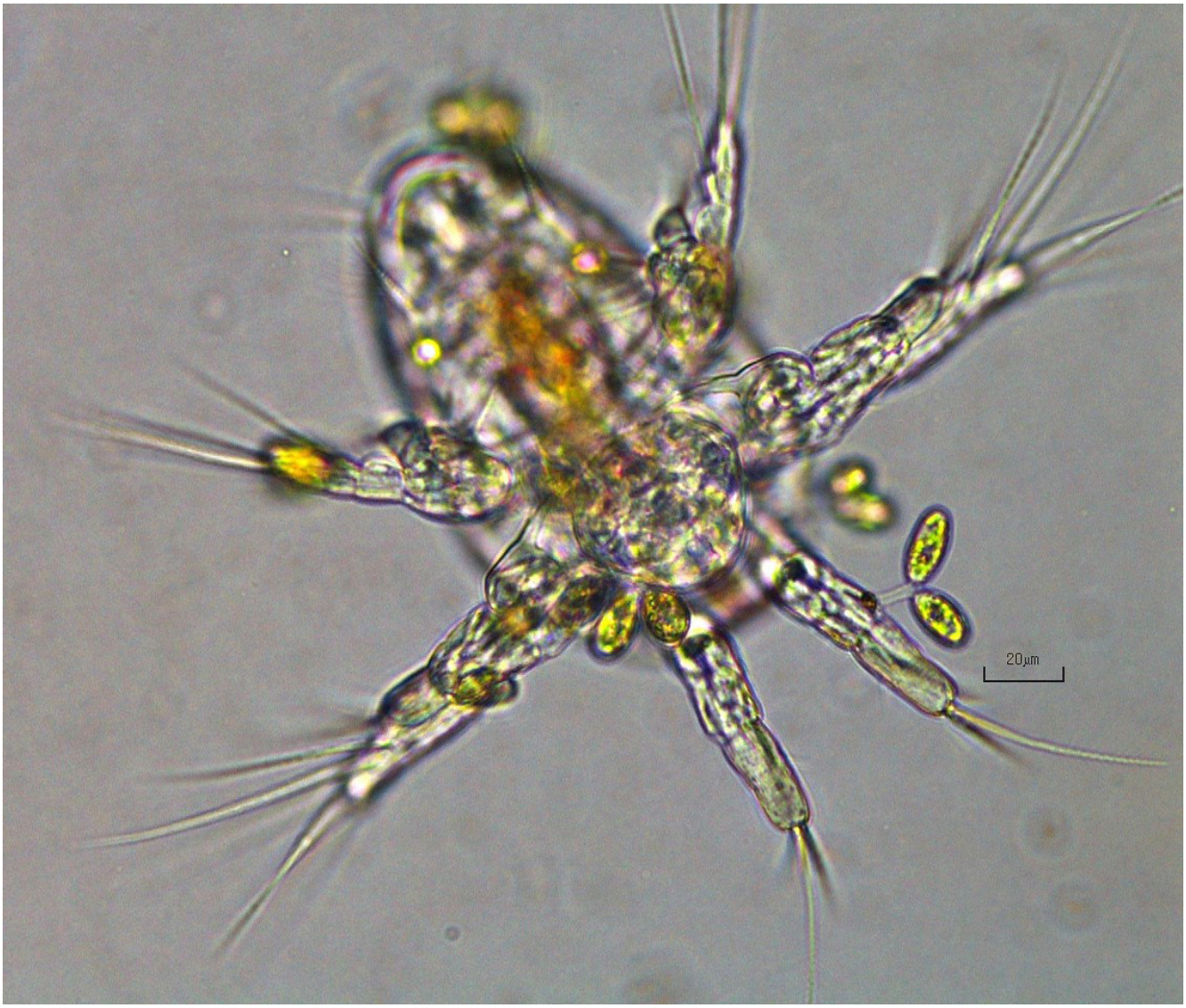

Figure 34: *Colacium* sp. An oval-shaped Euglenido with a small peduncle attached to the left appendage of a copepod larva. This genus is found in zooplankton organisms such as rotifers, cladocera and copepods. Collected at El Cedazo dam, Ags.

Author: Ekaterina Retes Pruneda

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Protists

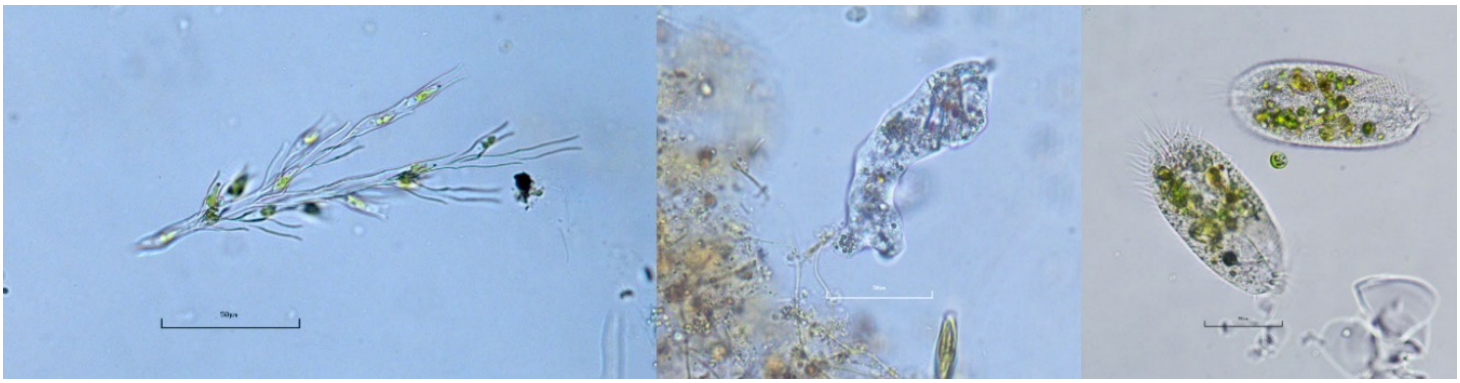

Figure 35:

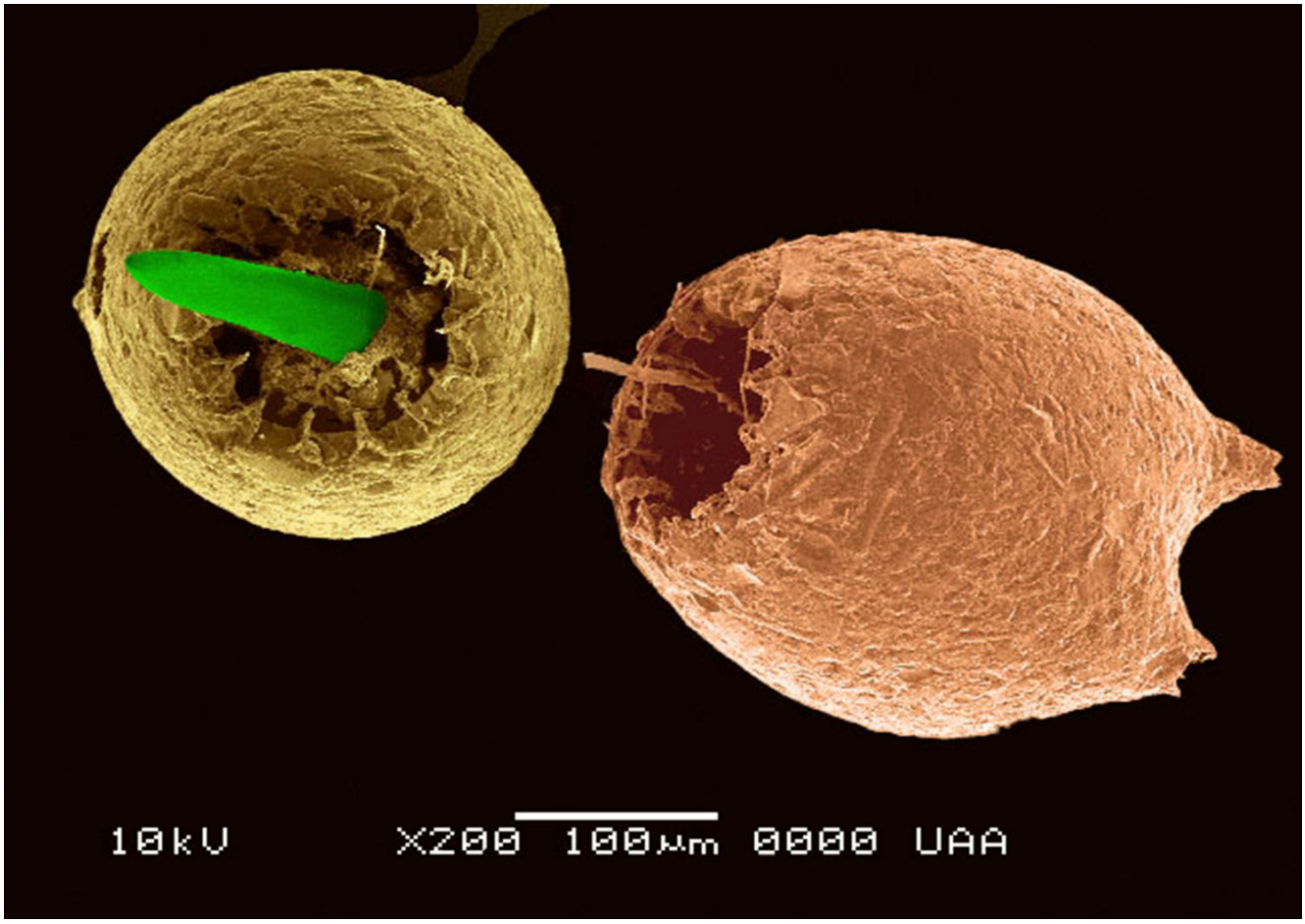

Figure 36: ***Difflugia corona*****.** Sarcodine protist that lives on a theca and lives in the water bodies of the state. It feeds on all types of organisms with its pseudopods, in this case it is engulfing a ***Closterium*** **sp.** (Chlorophyta). Collected at El Tecuancillo dam. Rincón de Romos, Ags.

Author: Marcelo Silva Briano & Araceli Adabache Ortiz

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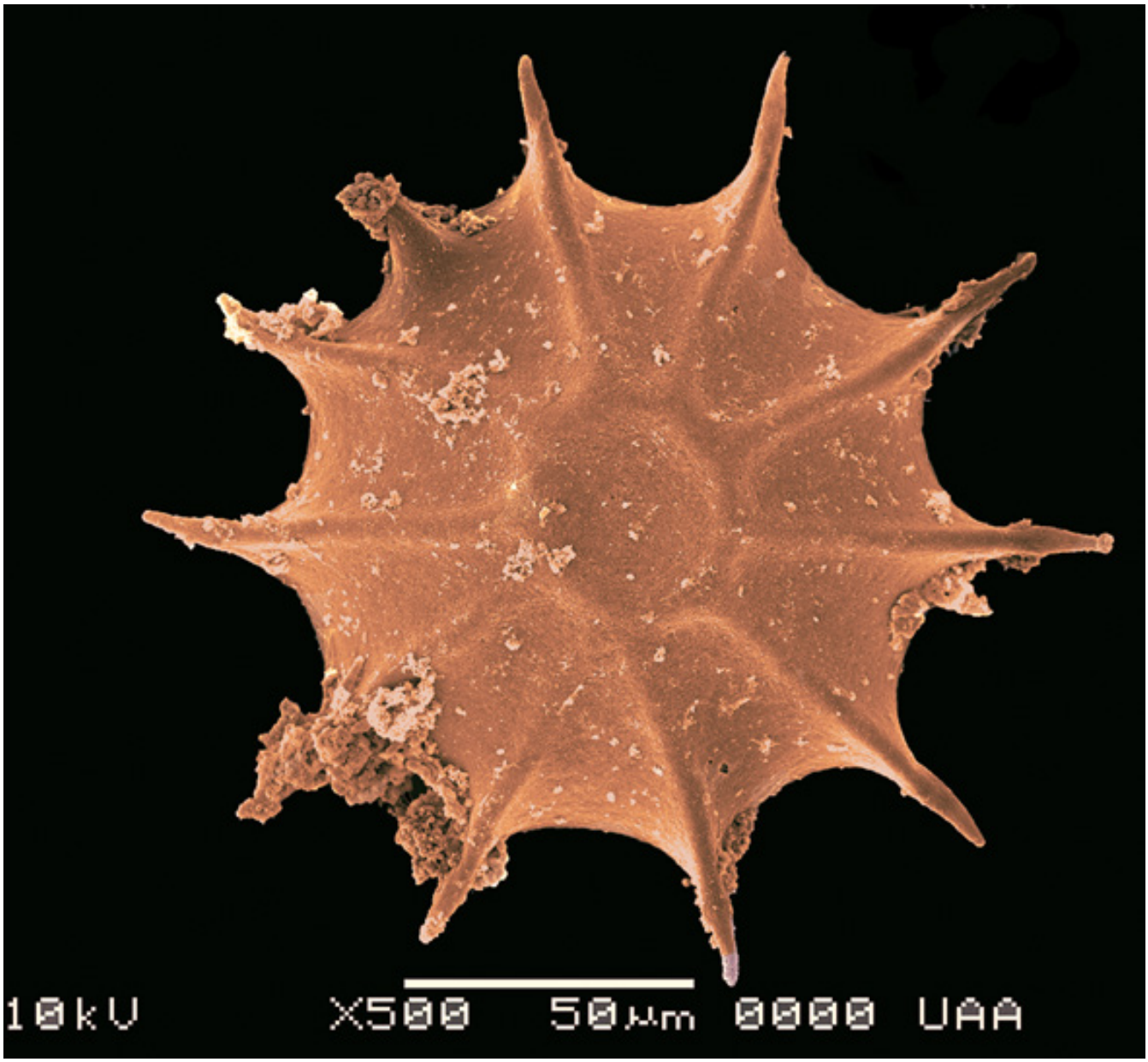

Figure 37: ***Arcella dentata*****.** Sarcodine protist. A testacid amoeba that lives by capturing prey for food. They live floating on the surface of the bodies of water in the state of Aguascalientes. There are several species in the state with different forms of testa. Collected at Aguascalientes state.

Author: Marcelo Silva Briano & Araceli Adabache Ortiz

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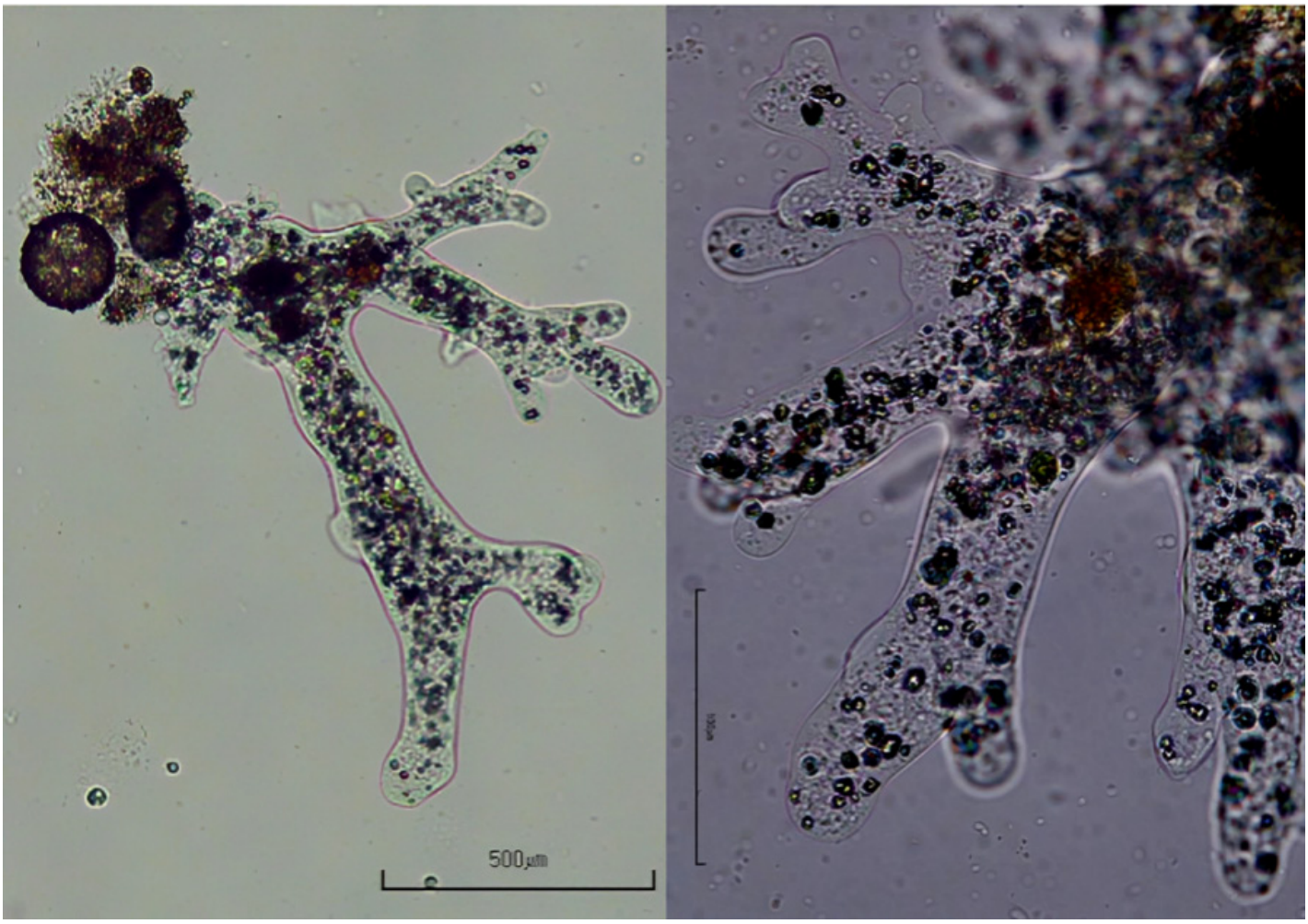

Figure 38: ***Polychaos fasciculatum*****.** Sarcodine protist, giant amoeba of more than 1mm in length. It is a predator that phagocytizes everything in its path. Left image, this amoeba enguys another theched amoeba called ***Difflugia*** **sp.** (upper left). Collected at Arroyo Seco dam. Jesús María, Ags.

Author: Porfirio Jassiel López Hernández

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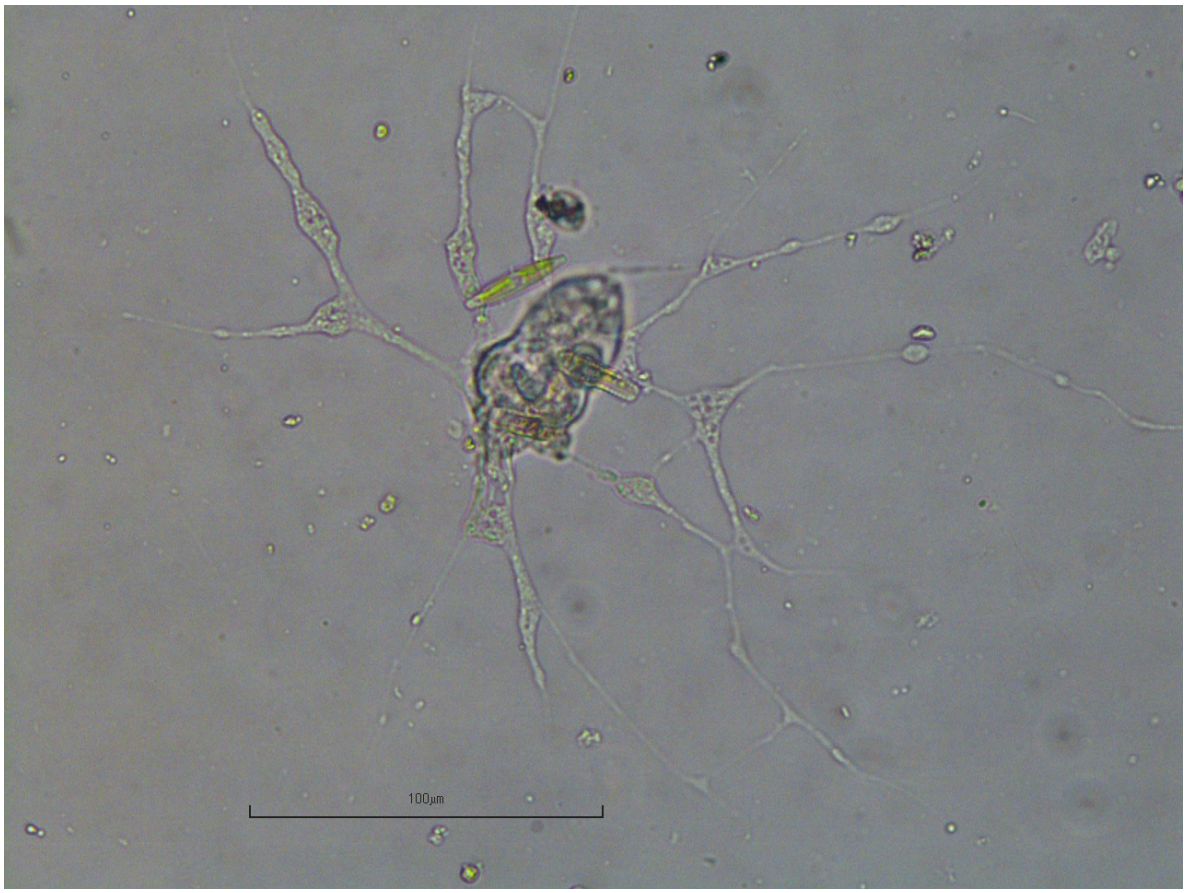

Figure 39: ***Claparedellus lachmannii*** Khanipour Roshan and Clauß, 2021. Small free-living freshwater foraminifera, probably new species. The shell may be spherical, pyriform, ovoid or irregular, with a hyaline wall that elongates during locomotion. The testes are colorless, although they may appear yellowish or brownish from ingested food. This species feeds on filamentous algae, coccals, cyanobacteria, diatoms, rotifers and yeasts. It has been found in dried moss on a tree in Jüterbog, Germany, in 2018. In 2021, a specimen of material was isolated from among submerged basalt blocks in Gooimeer Lake, The Netherlands, and two more were collected in 2023. In 2022, another specimen was isolated from sediment free-living protist. Inhabitant of small ponds and pools. Collected in UAA pond, Ags. 20 Aug. 2018.

Author: Frida Sabine Álvarez Solís

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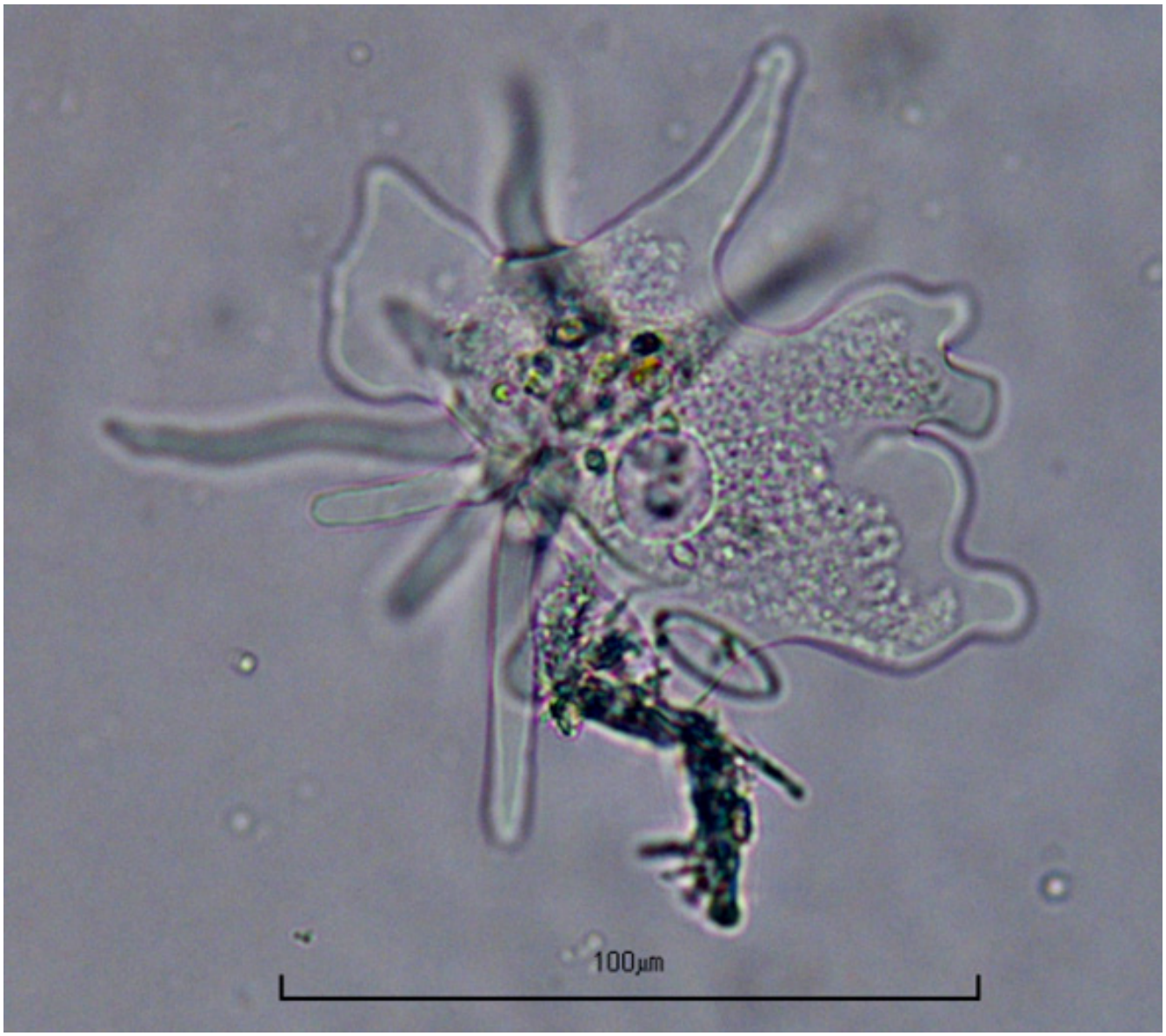

Figure 40: ***Polychaos dubia*****.** A small amoeba that extends its numerous pseudopods to capture food in the body of water where it lives. The pseudopods are several of different shapes. Collected in UAA pond, Ags. 27 February 2018.

Author: Porfirio Jassiel López Hernández & Frida Sabine Álvarez Solís

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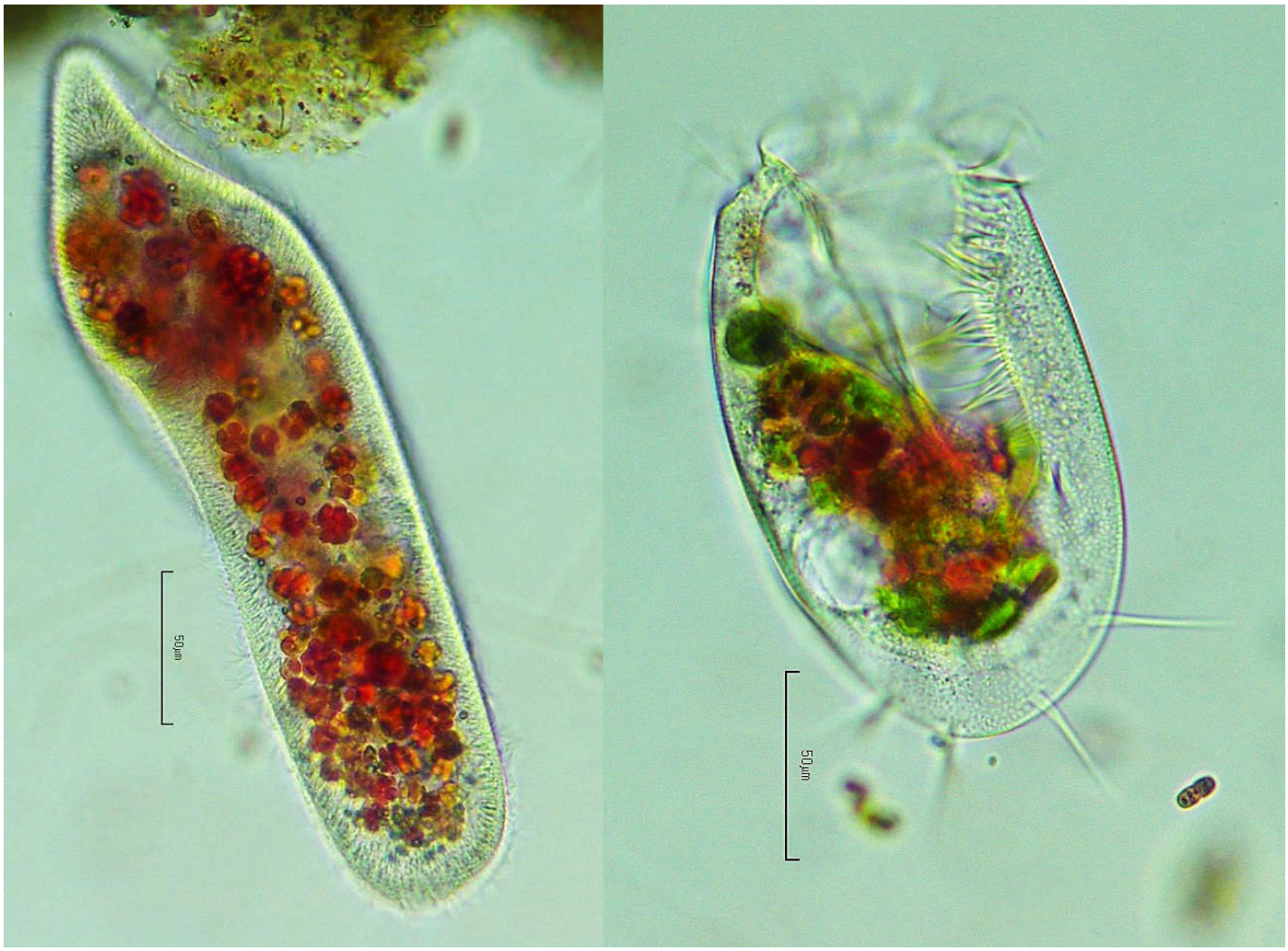

Figure 41: ***Paramecium aurelia*** (left) and ***Euplotes sp.*** (right). Two ciliate protists that are part of the zooplankton of the water body they inhabit. Both feed on microalgae. UAA pond, Ags. 6 June 2019.

Author: Frida Sabine Álvarez Solís & Rocío Natalia Ármas Chávez

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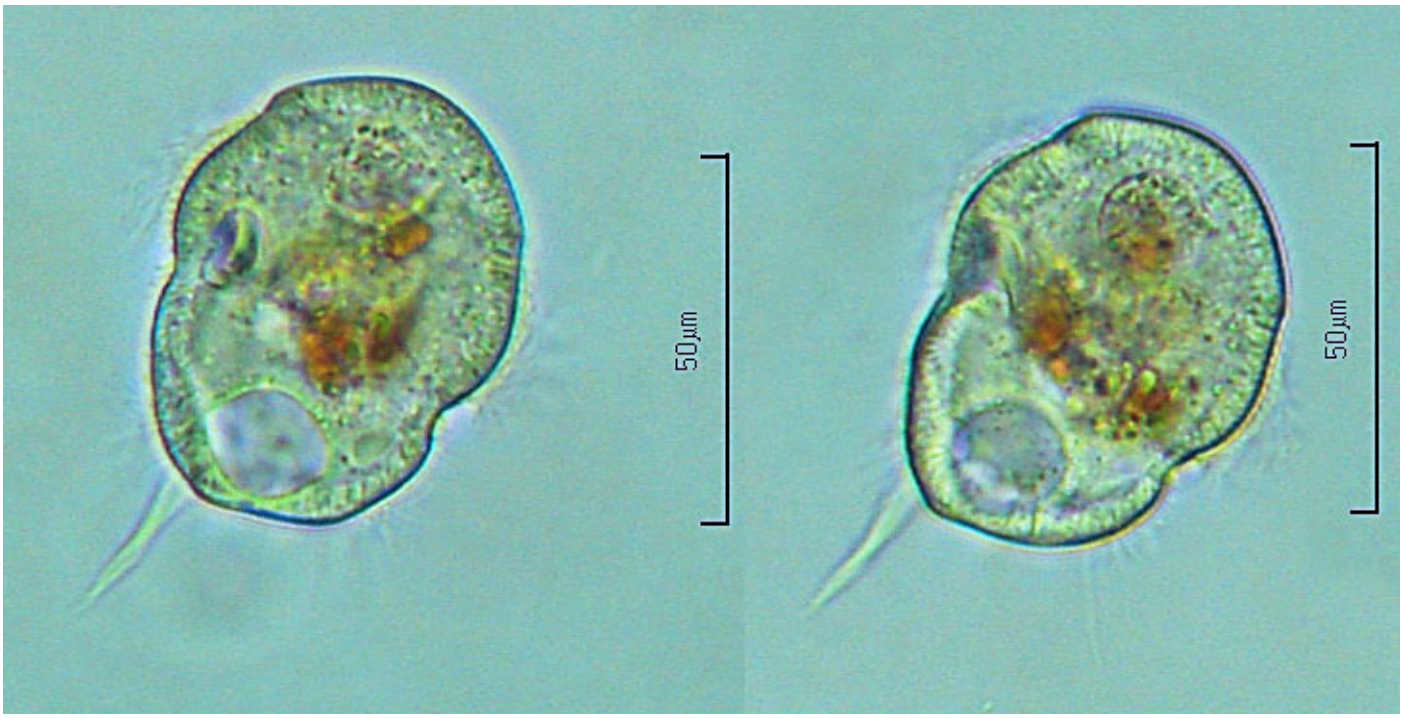

Figure 42: *Urocentrum* sp. Two ciliate members of the genus. This protist behaves a little like a spinning top. Shows a caudal tuft of cilia, loosely attaches to debris and the cells often a appears to spin around. Feeds mostly on suspended bacteria. The members of this genus has trichocysts (see the cell border) and a contractile vacuole with radiating collecting canals. Text taken from Patterson 1998. Collected in a UAA pond, Ags. 6 June 2019.

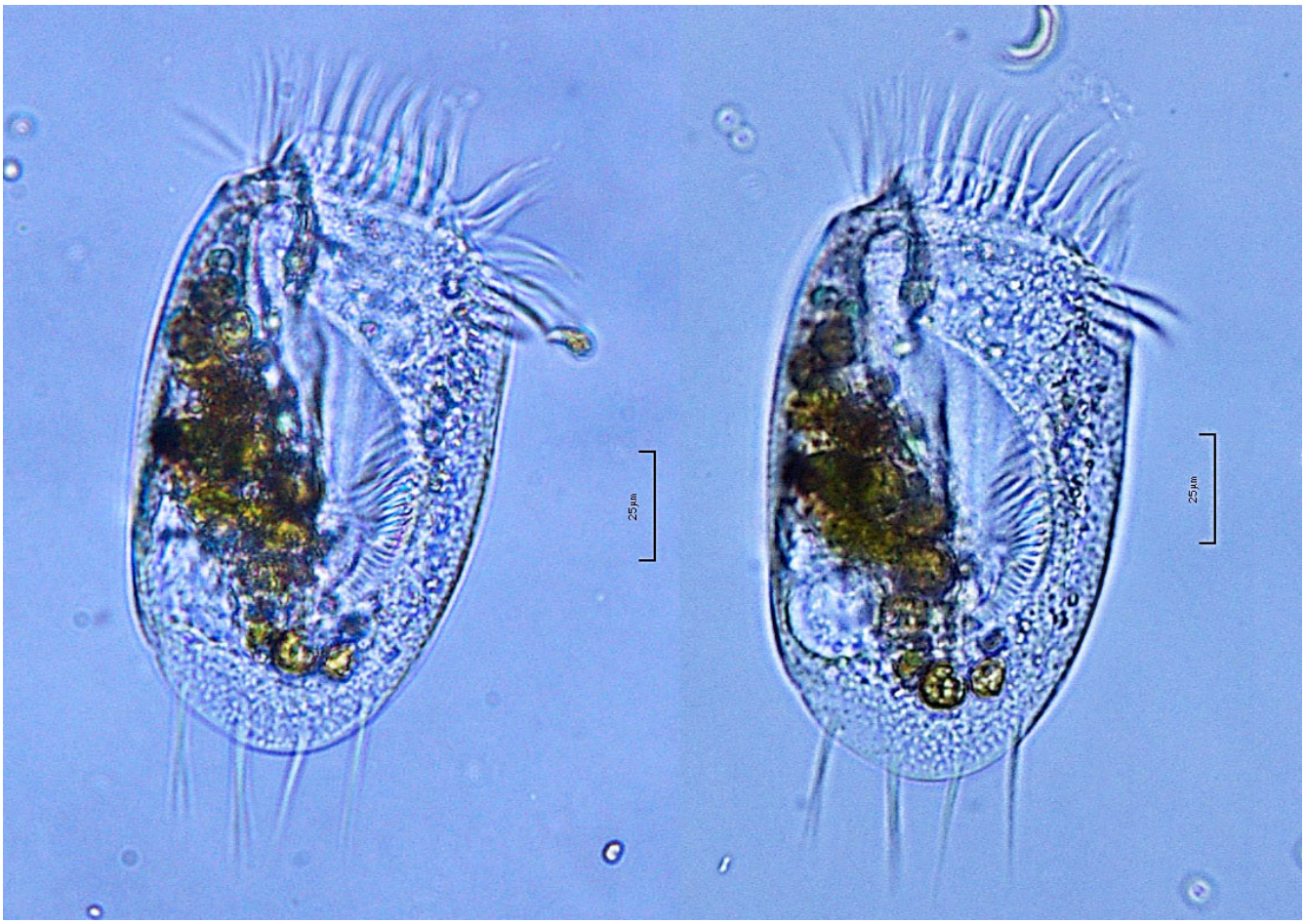

Figure 43: *Euplotes* sp. A small ciliate that lives among organic matter and feeds on it. It uses its long cirri to move around. Collected at El Garabato pond. Pabellón de Arteaga, Ags.

Author: Estefanía Guzmán Huerta

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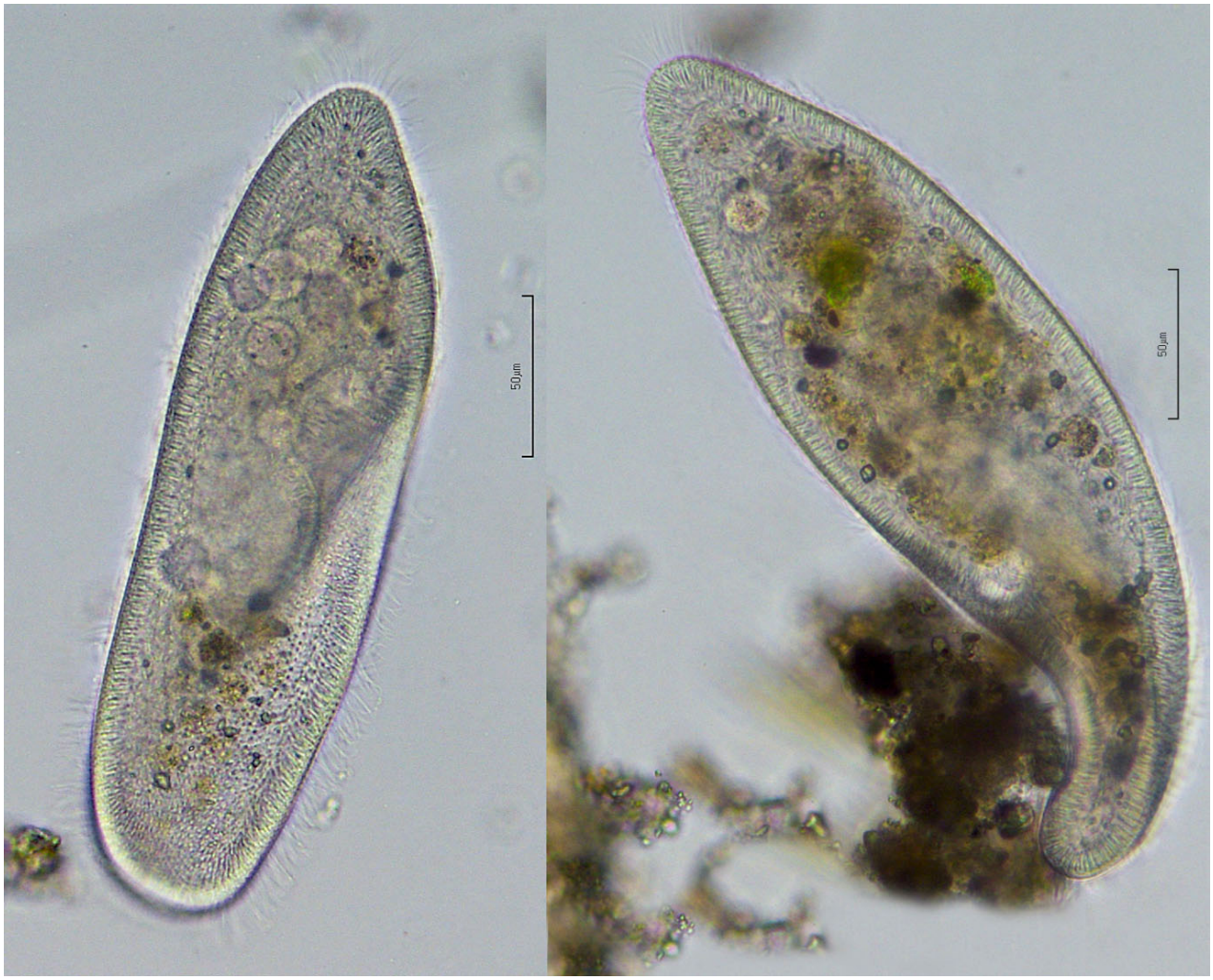

Figure 44: *Paramecium* sp. Small ciliate that inhabits the water bodies of the state. It forms part of the food chain. Its large food vacuoles can be observed and in the lower part of what corresponds to the oral area, where the cytostome (mouth) is located. Collected at Los Arquitos dam. Jesús María, Ags.

Author: Fernanda Calderón

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Figure 45: *Vorticella* sp. y *Oxytricha* sp. Left, ***Vorticella* sp.** hanging from the almost invisible peduncle. Right, ***Oxytricha* sp.** with its ciliature around the cytostome (mouth). The two ciliates are coexisting in the state's ponds and dams. Both collect particles and microalgae from the environment for feeding. Collected in UAA pond, Ags. 16 December 2020.

Author: Leslie Darlene Serrano

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Figure 46: ***Stylonychia*** **sp.** A ciliate shows three tail cirri, the body is rigid, with a well-developed adoral zone of membranelles. They are member of the food chain of the water bodies of the state. Collected at La Araña dam. Sierra Fría. San José de Gracia, Ags. 8 July 2023.

Author: Araceli Adabache Ortiz & Marcelo Silva Briano

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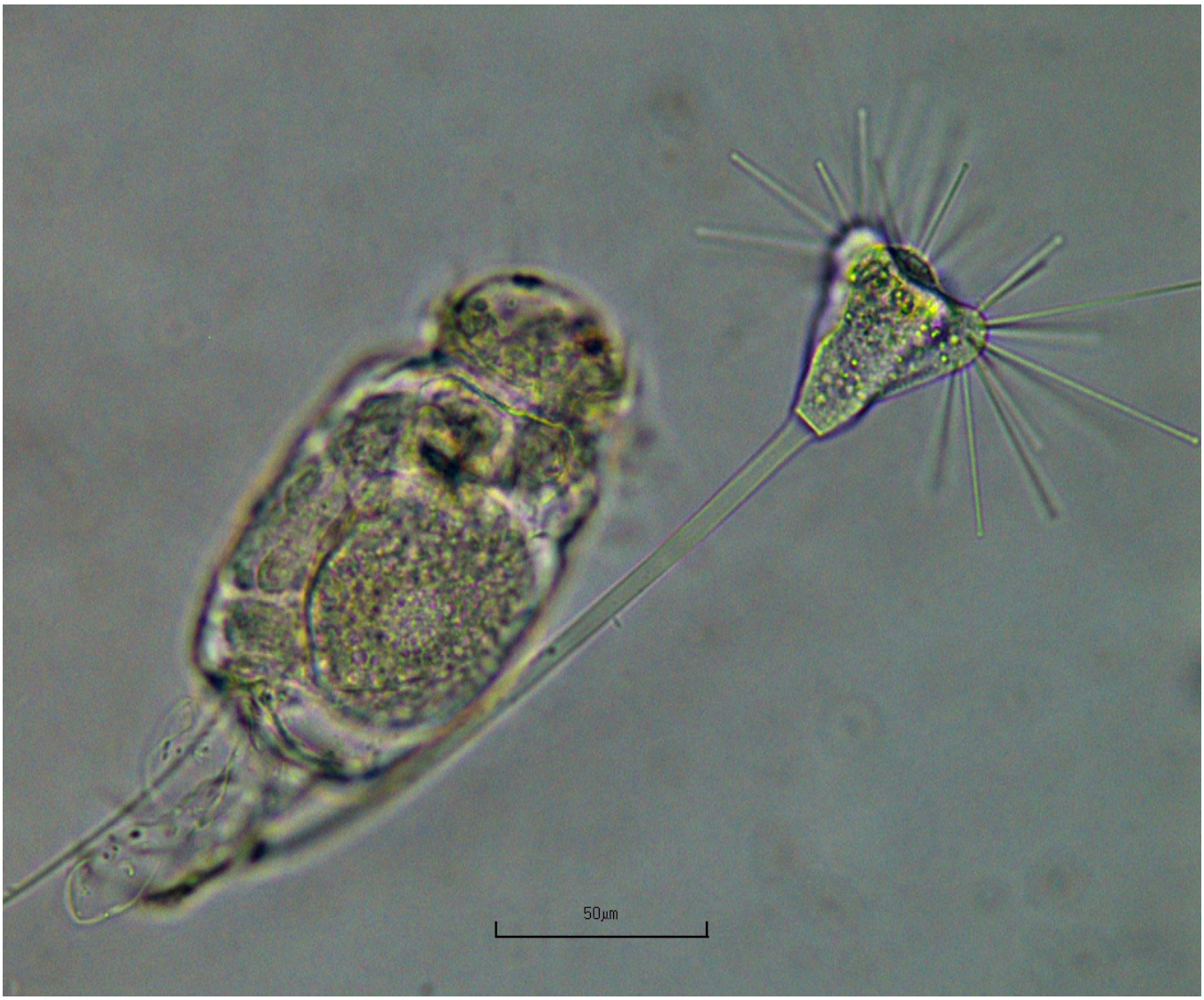

Figure 47: *Tokophrya* sp. Ciliate Suctorio ciliate, on a rotifer **(*Filinia cornuta*)** showing its tentacles that contain haptocysts (round structures located in the distal part), which suck the contents of the prey. Collected in UAA pond, Ags.

Author: Ana Ekaterina Retes Pruneda

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Figure 48: *Epistylis* sp. Particle-filtering ciliate. Common in the pond-dwelling state above other members of zooplankton. Collected at UAA pond.

Author: Porfirio Jassiel López Hernández

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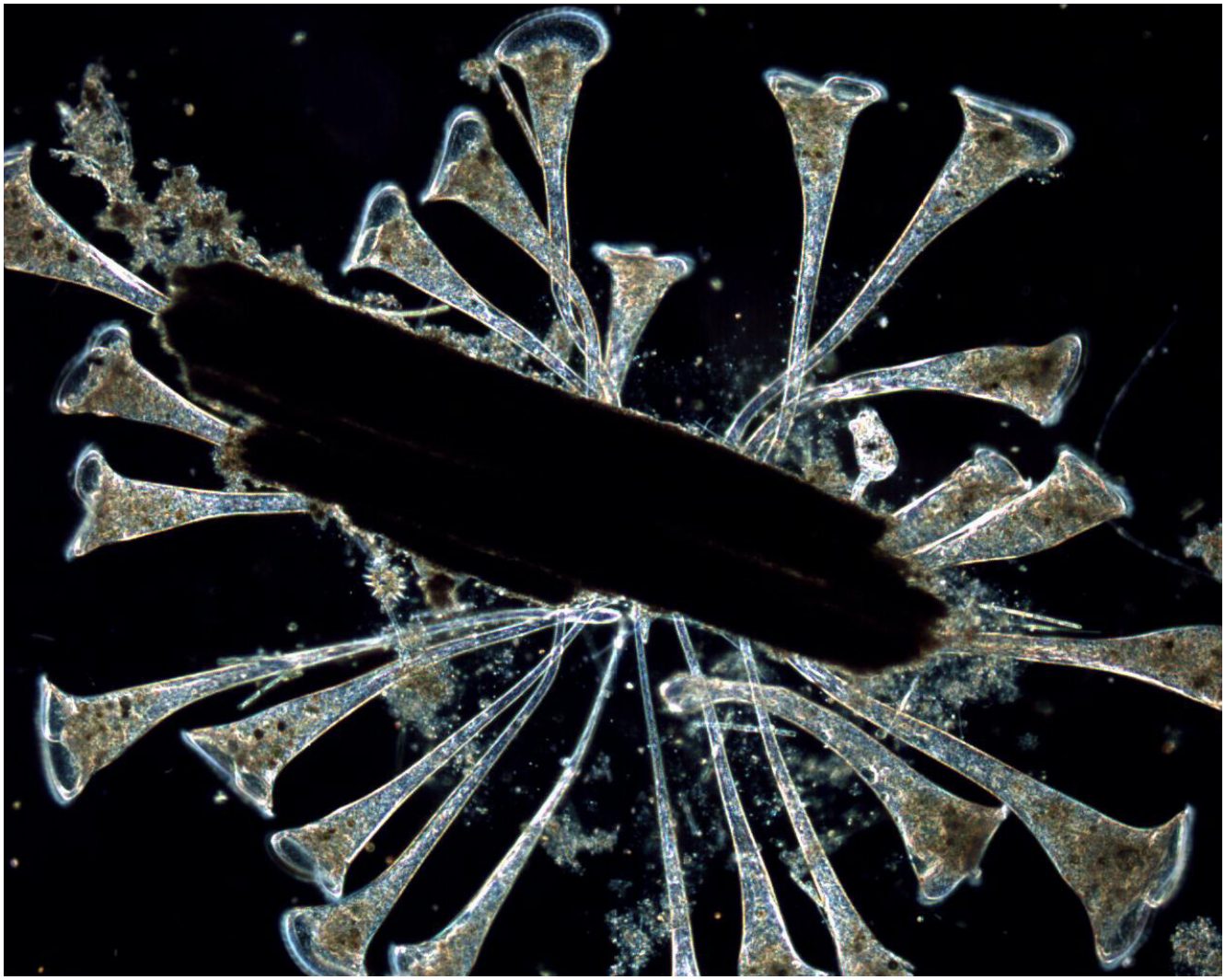

Figure 49: *Stentor* sp. Ciliate protist that sometimes appears as a group. Common in the water bodies of Aguascalientes. Collected at Abelardo Rodríguez pond. Jesús María, Ags.

Author Araceli Adabache Ortiz & Montserrat Delfina Reyes Flores

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Figure 50: *Spirostomum* sp. & *Stentor* sp. Two huge ciliates. The first is a ciliate lake that is dedicated to go around the environment sliding and feeding on the food particles available in the environment. In the case of Stentor, it can be observed in the middle of a mass of organic matter that is trying to extract the nutritious part, besides feeding by filtering the microalgae that are swarming. Collected in a fish tank located in Laboratorio No. 1, Ecología. Edificio 202. Universidad Autonóma de Aguascalientes. Ags. 7 June 2024.

Author: Ana Valeria Árias Magaña & Mireya del Rocío Hernández Villalobos

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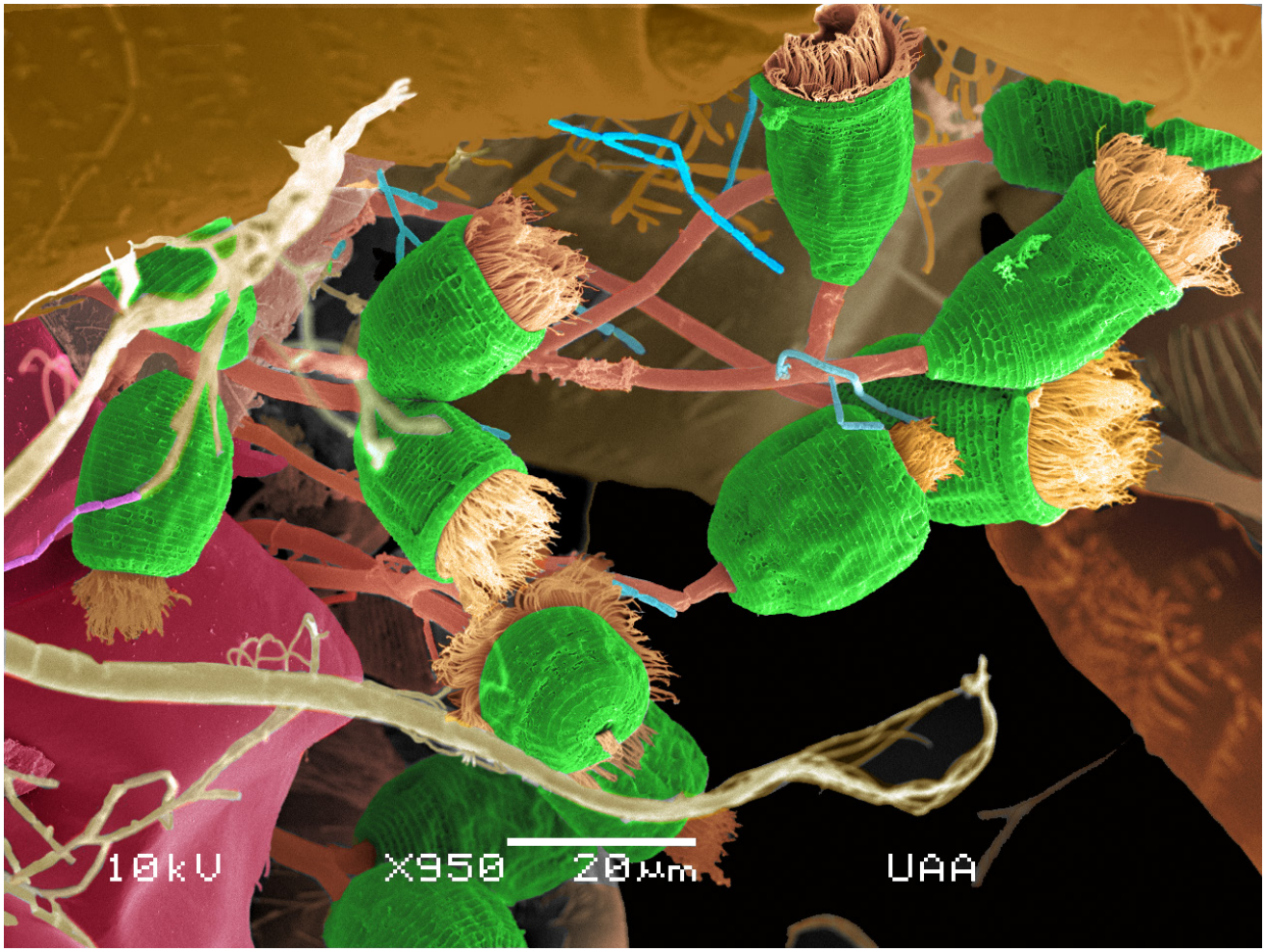

Figure 51: *Epistylis* sp. Colonial ciliate protist that lives on members of the zooplankton as is the case of ***Moina micrura*** which is invaded by this protist in the second pair of antennae. Collected at La Mezquitera pond UAA, Ags.

Author: Marcelo Silva Briano & Araceli Adabache Ortiz

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Figure 52: *Frontonia* sp. Predatory ciliate that consumes both phytoplankton and zooplankton. The left image is the normal shoe sole shape, the right is deformed due to the voracity of the organism as it has consumed diatoms **(*Fragilaria* sp.)** larger than itself, as well as others. Collected at Arroyo Seco dam. Jesús María, Ags.

Author: Marcelo Silva Briano & Araceli Adabache Ortiz

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Figure 53: ***Paramecium bursaria*****. A** ciliate that is filled with Zoochlorella sp., an endosymbiont Chlorophyta microalgae that is hosted by this Paramecium in large numbers and both benefit from the algae providing nutrients and the ciliate providing protection. Note the large cytostome that this species has, which is observed as a large hole in the center of the cell. Collected at La Araña dam. Sierra Fría. San José de Gracia, Ags. 8 July 2023.

Author: Araceli Adabache Ortiz & Marcelo Silva Briano

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Figure 54: *Euplotes* sp. Ciliate with modified structures in the form of cirri, which look like legs to move on organic matter. Collected in puddle near UAA pond, Ags. 22 Jan. 2021.

Author: Leslie Darlene Serrano

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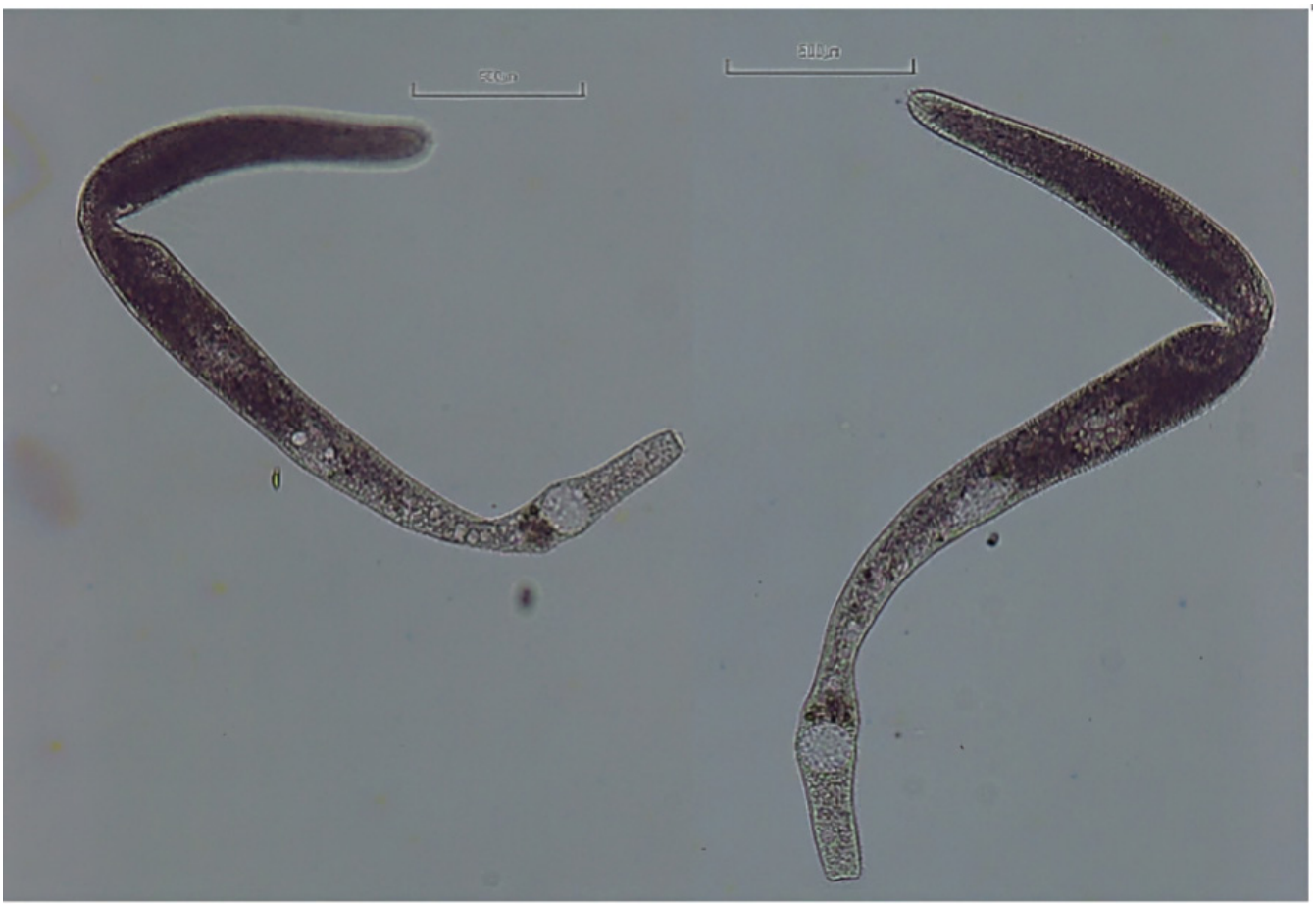

Figure 55: ***Unidentified ciliate.*** Ciliate that lives in ponds and dams in the state. It is a very long ciliate, measuring more than 1 millimeter in length. The anterior part looks like the trunk of a seahorse. Collected in pond near UAA pond, Ags. 14 Jan. 2021.

Author: Leslie Darlene Serrano

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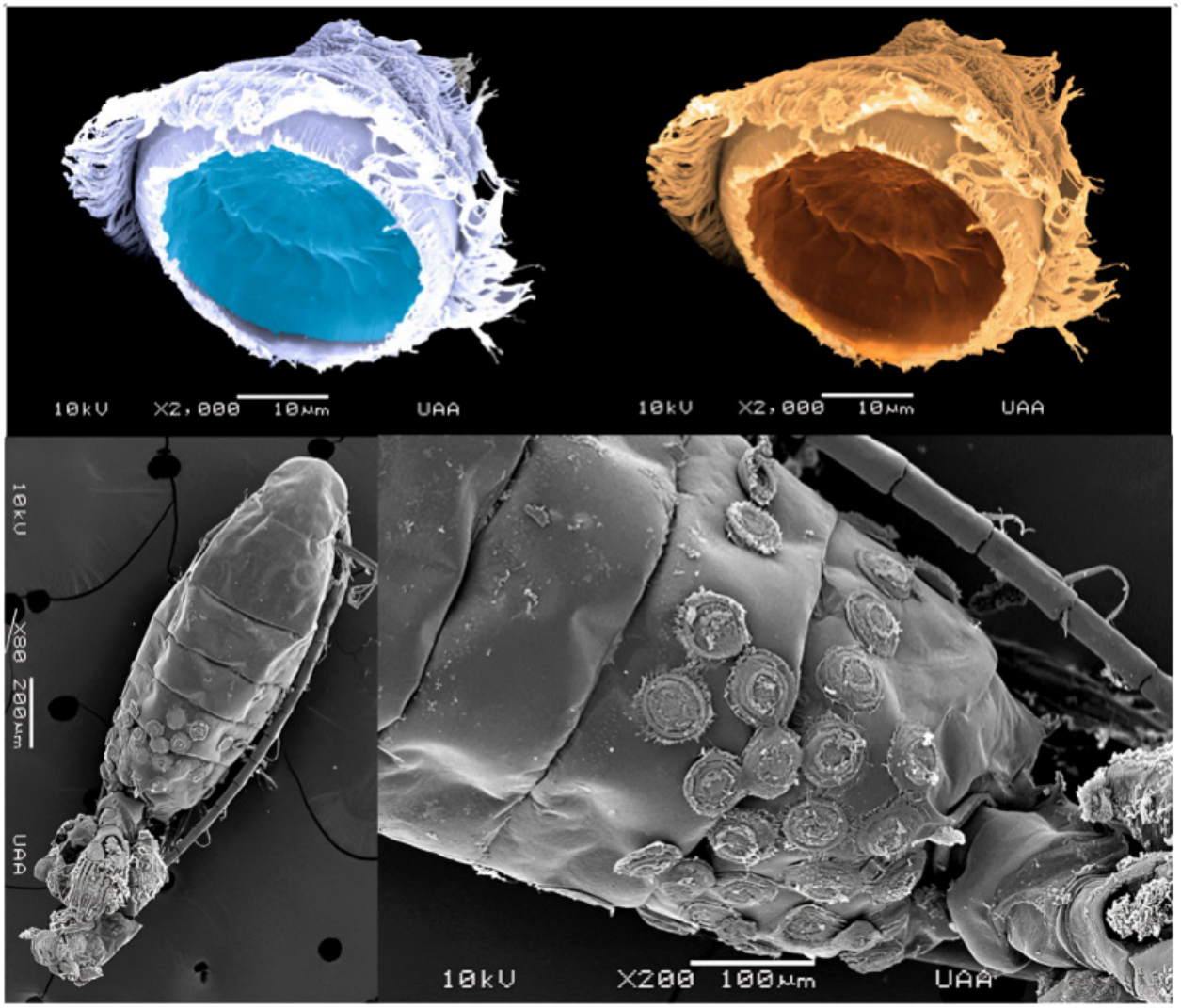

Figure 56: ***Trichodina diaptomi*****.** Small ciliate that lives in the water bodies of the state. This protozoan settles in the dorsal part of the cephalon of the Calanoid copepods, ***Mastigodiaptomus albuquerquensis*** and ***M. montezumae*** and sticks to them using a kind of suction, even the mark it leaves on the surface of the carapace can be observed. The copepod serves as transport (foresia), in order to efficiently reach the bacteria on which it feeds. The cingulum of calcium denticles (blue and brown) is used to pierce the species it attacks, but apparently does not harm the copepod. This ciliate was collected in Bordo 1 and 2 near Presidente Abelardo Rodríguez dam. Jesús María, Ags.

Author: Araceli Ababache Ortiz, Marcelo Silva Briano & Montserrat Delfina Reyes Flores

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Invertebrates

Figure 57: ***Keratella cochlearis*** **var.** ***tecta*****,** ***Daphnia D. pulex*****,** ***Acanthocyclops robustus.***

CNIDARIA

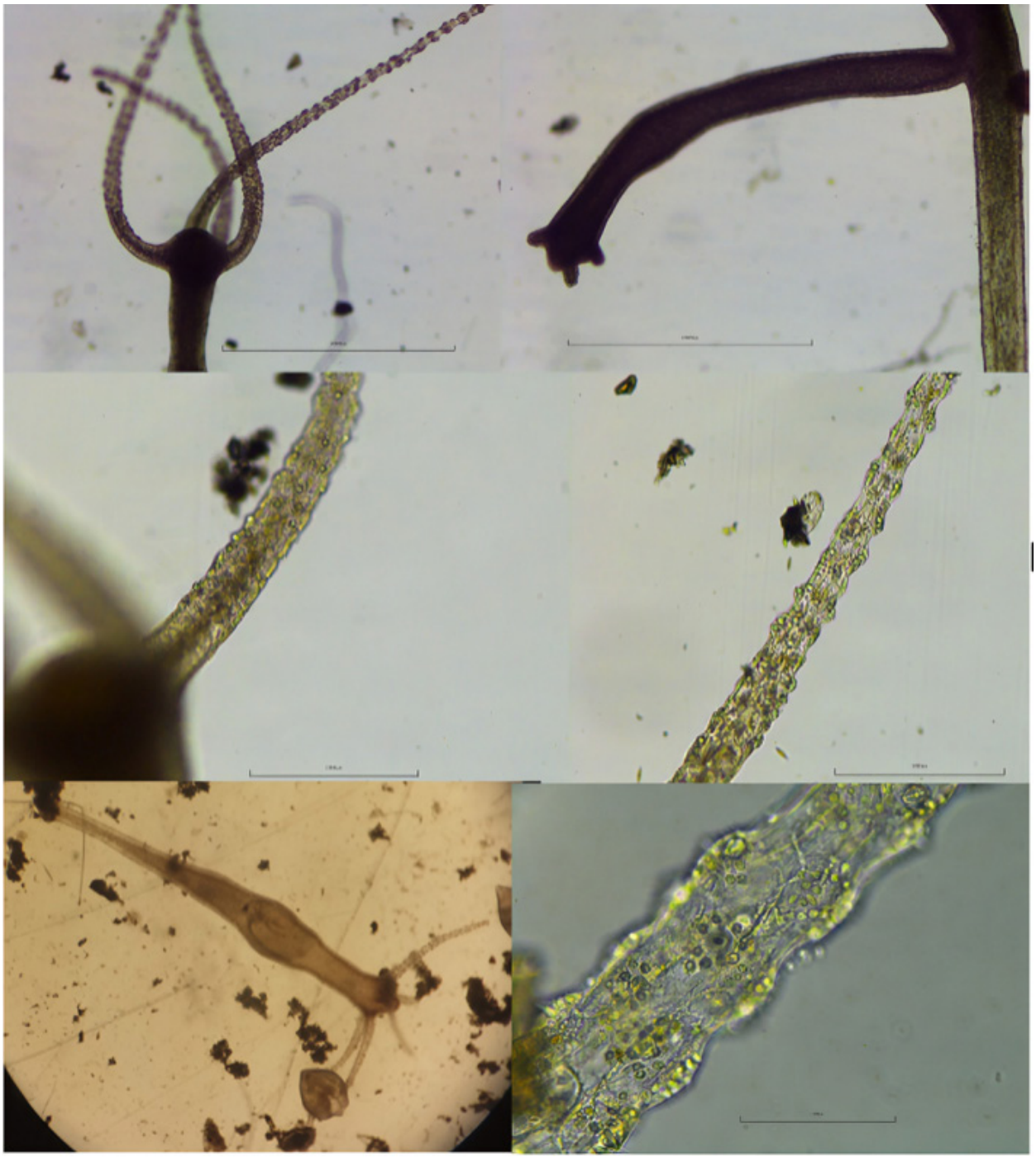

Figure 58: ***Hydra vulgaris.*** Small freshwater cnidarian that lives among algae, attaching itself to them and hunting small organisms such as Protists, Cladocerans and others. Above, detail of the tentacles and an offspring produced by gemmation. Below, detail of the tentacle through which it discharges the cnidocytes to paralyze the prey. Collected in the pond of the Botanical Garden of the UAA, Ags.

Author: Frida Sabine Álvarez Solís

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ROTIFERA

Figure 59: ***Asplachna sieboldi.*** A predatory rotifer that devours all protists and invertebrates in its path. It is very voracious. Collected at El Cedazo dam, Ags.

Author: Ekaterina Retes Pruneda

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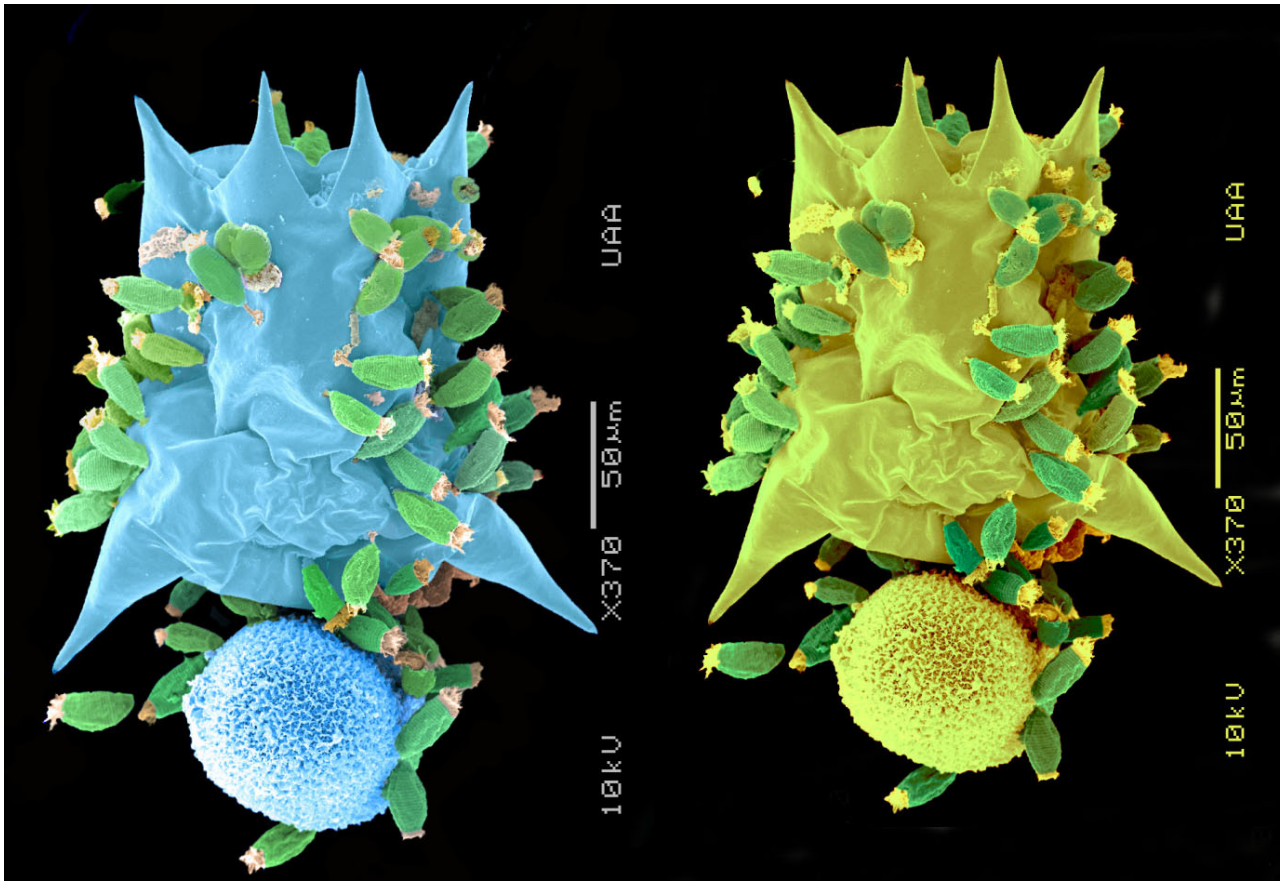

Figure 60: ***Brachionus calyciflorus.*** A rotifer that inhabits the ponds of the state. Sometimes it is invaded by a ciliated protist ***(Scyphidia sp.)***. A great number of organisms settle in the area of the lorica. Collected in Paraje don Pepe pond. Sierra Fría. San José de Gracia, Ags.

Author: Marcelo Silva Briano & Araceli Adabache Ortiz

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Figure 61: ***Brachionus calyciflorus.*** A very common rotifer that inhabits the ponds of the state. This species has several forms, as they have been found in different bodies of water. Female carrying a parthenogenetic egg. Collected at UAA pond, Ags. 16 May 2024.

Author: Ana Valeria Árias Magaña

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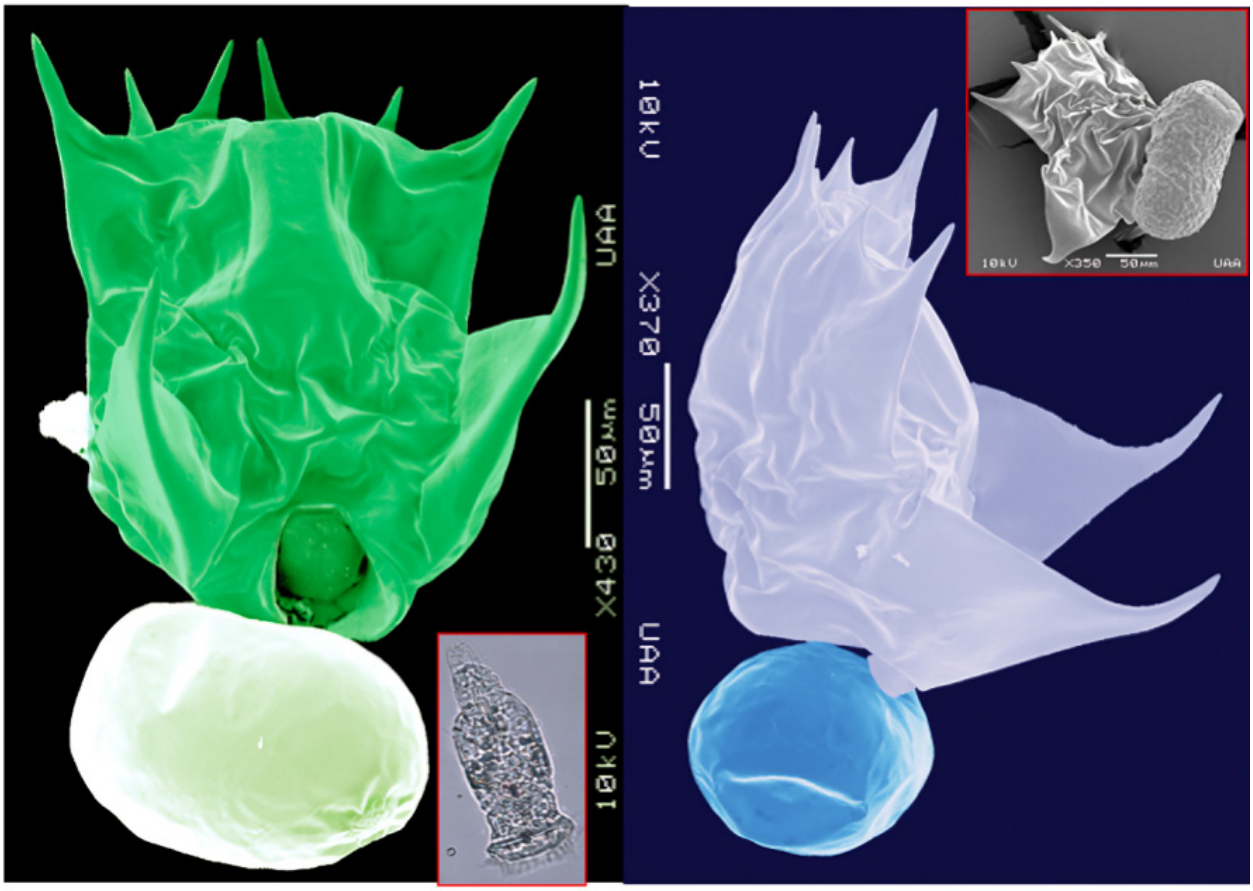

Figure 62: ***Brachionus araceliae.*** Endemic to Mexico, this rotifer lives in the small temporary ponds of the state, although it has also been found in the state of Sonora. It uses its modified posterior spines (wings) to swim and change direction. Color images, females with parthenogenetic eggs. Bottom right image, female with egg fertilized (Box: top right) by male (Box: center). Collected in a pond in a hole 2.5 km north of the town of San José de Gracia, Ags.

Author: Marcelo Silva Briano & Araceli Adabache Ortiz

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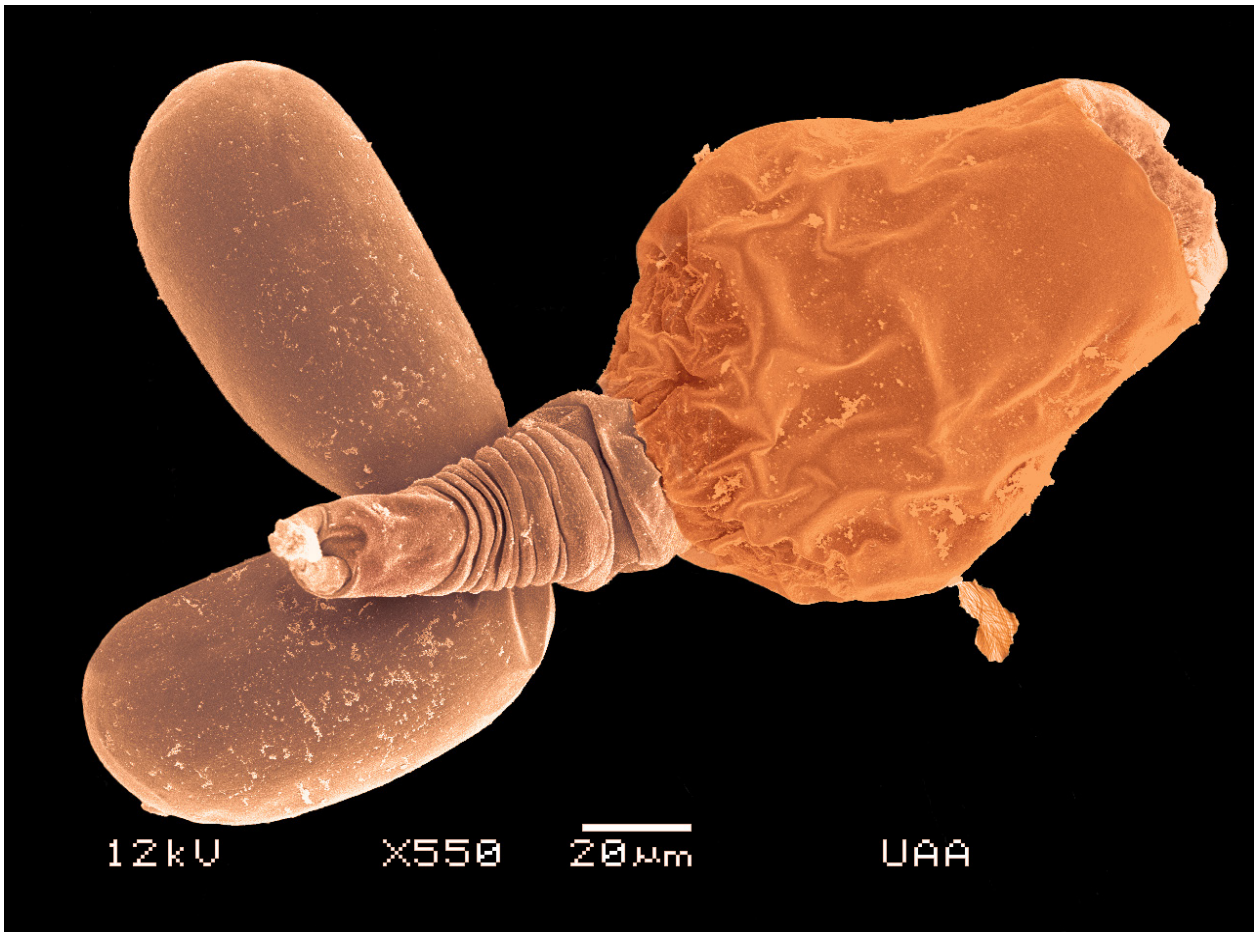

Figure 63: ***Brachionus josefinae.*** A rotifer that lives in the water bodies of the state. It is a new species to science. Species endemic to Mexico. Collected in a pond on the road to the town of Tapias Viejas. Jesús María, Ags.

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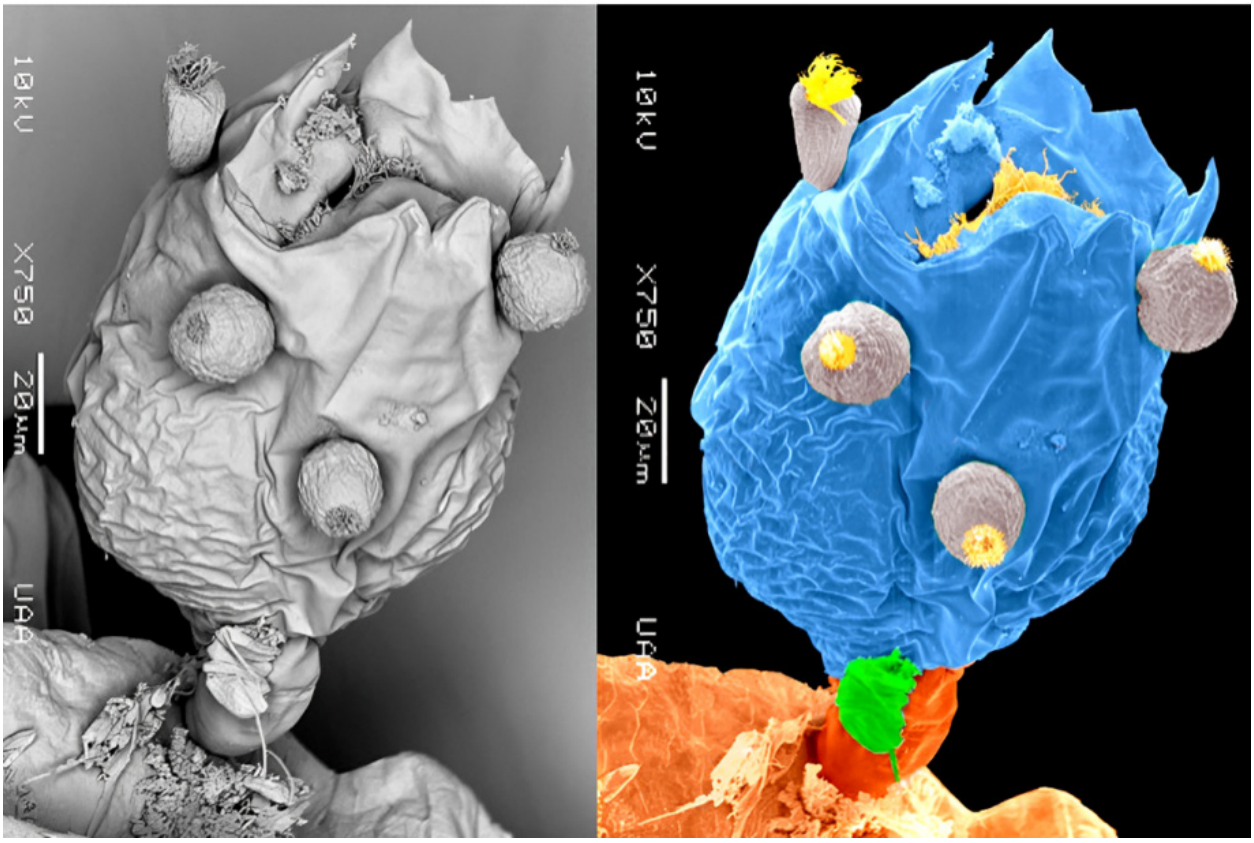

Figure 64: ***Brachionus rubens.*** A rotifer whose foot is attached to the dorsal part of the carapace of ***Moina macrocopa*** (Cladocero crustacean), which usually inhabits the water bodies of the state. In turn, it is invaded by the ciliate protozoan ***Scyphidia*** **sp.** Collected in Parque Hidalgo pond, Ags.

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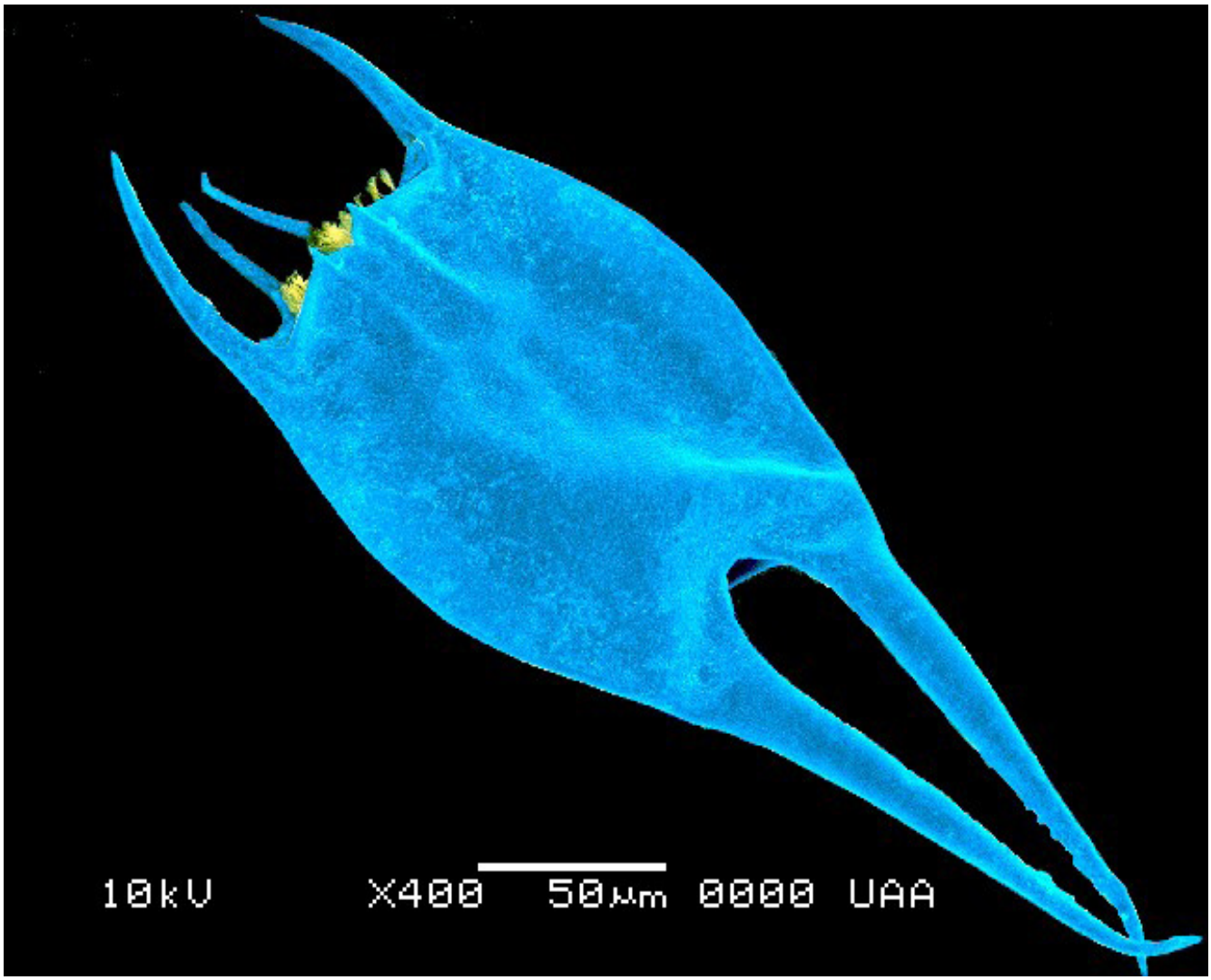

Figure 65: ***Brachionus havanaensis.*** A pond-dwelling rotifer in the state. Sometimes it changes shape and its spines can vary in length and shape. Collected in the state of Aguascalientes.

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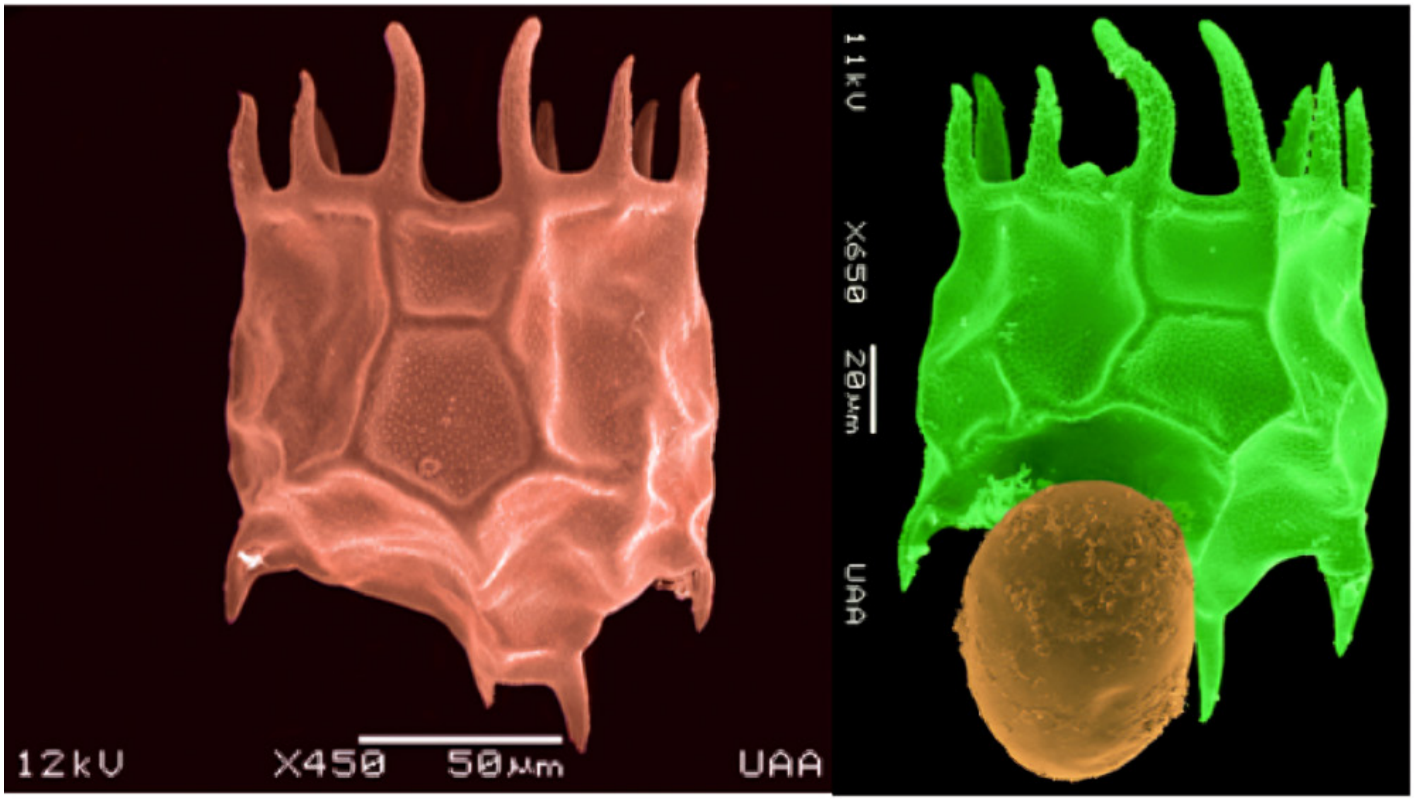

Figure 66: ***Plationus patulus.*** Small rotifer, inhabitant of the ponds of the state, constituting part of the food chain, whose role is to feed the small predators present in the aquatic ecosystems. Left image, complete organism. Upper right image, detail of the anterior spines. Lower right image, detail of posterior spines and egg. Collected in a pond in Aguascalientes.

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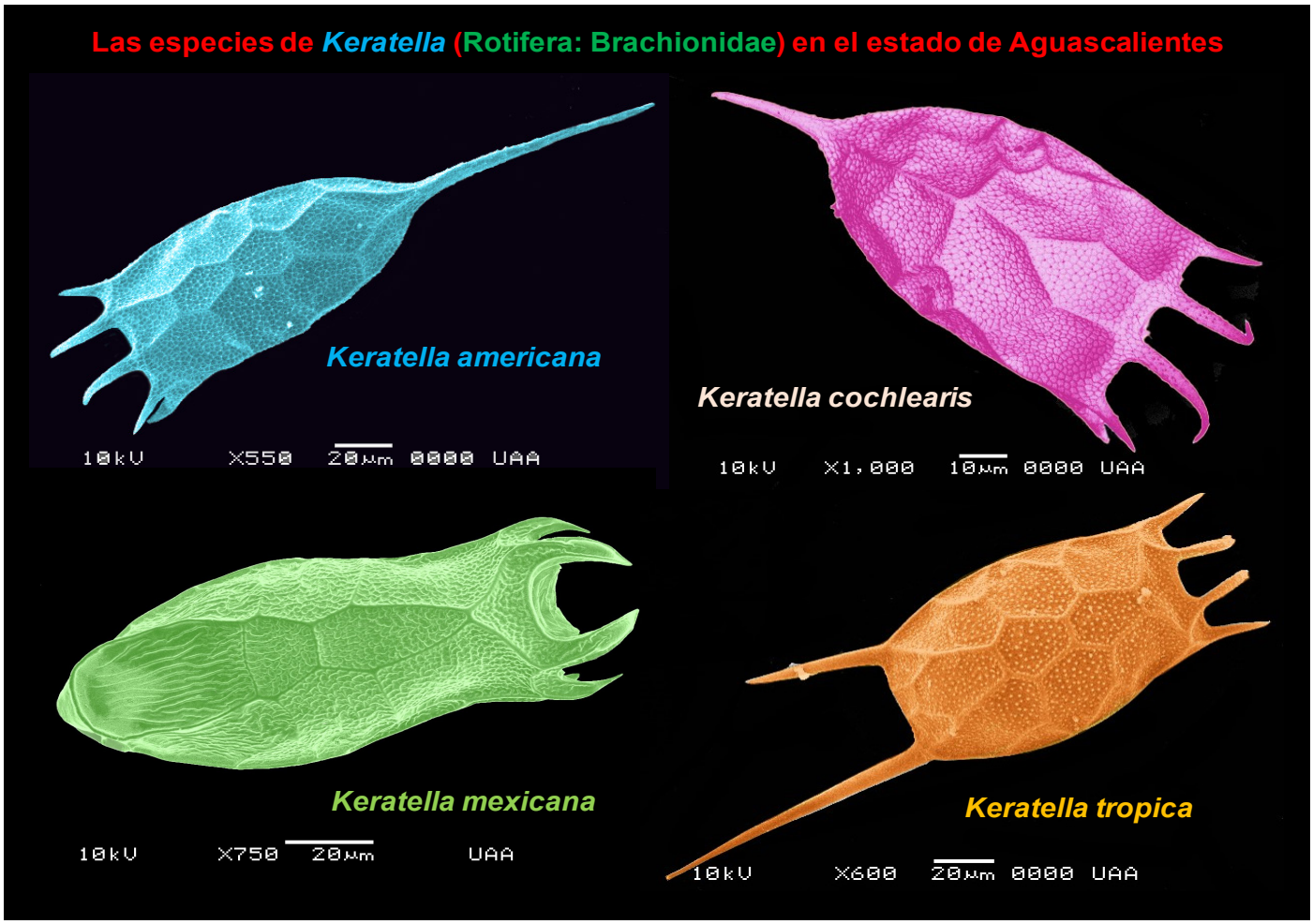

Figure 67: The 4 species of the genus ***Keratella*** of the State of Aguascalientes. These species live in the State, forming part of the food chain of the water bodies they inhabit.

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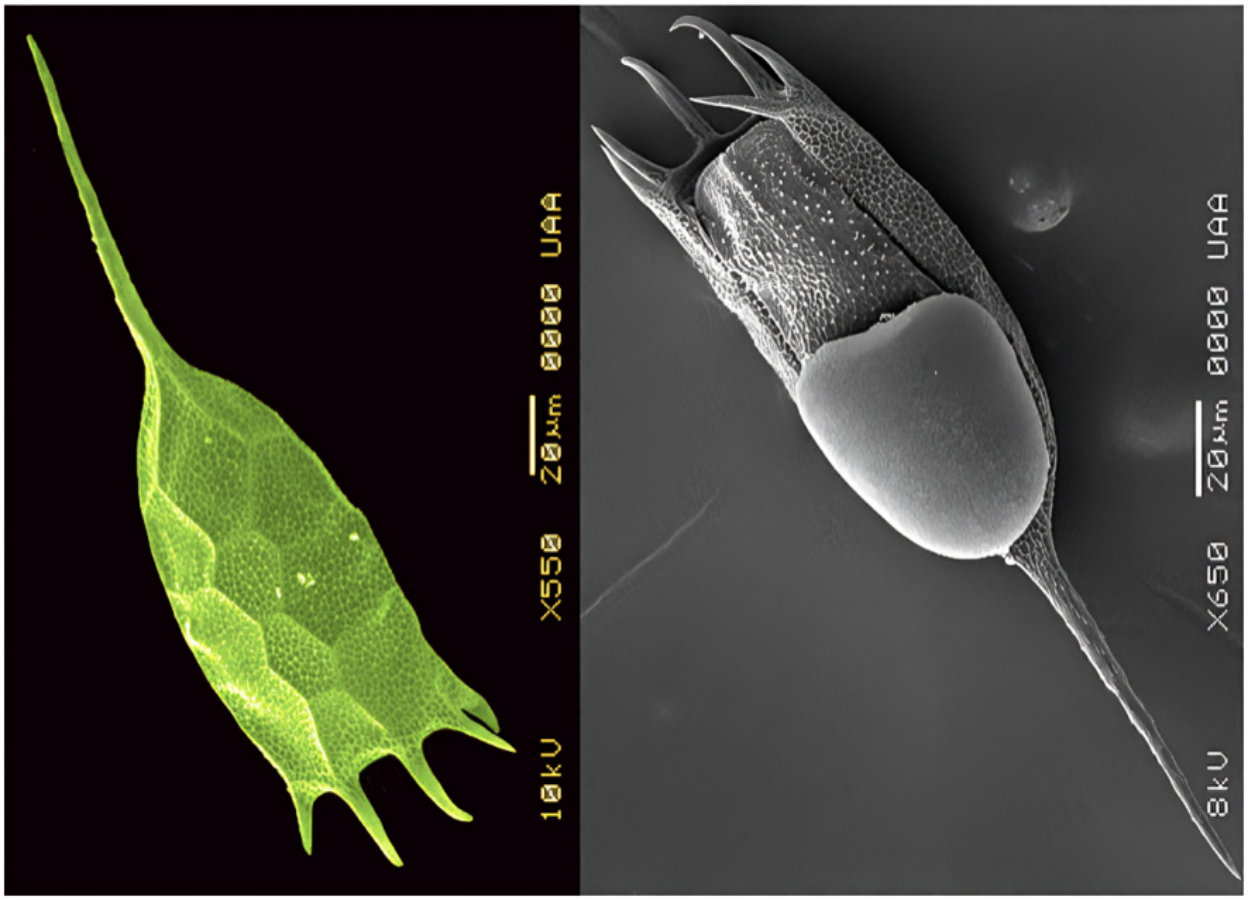

Figure 68: ***Keratella americana.*** Small rotifer, inhabitant of ponds and dams in the state. It is part of the zooplankton of water bodies. They generally feed on bacteria. Left, dorsal view. Right, ventral view showing egg. Presidente Calles dam. San José de Gracia, Ags.

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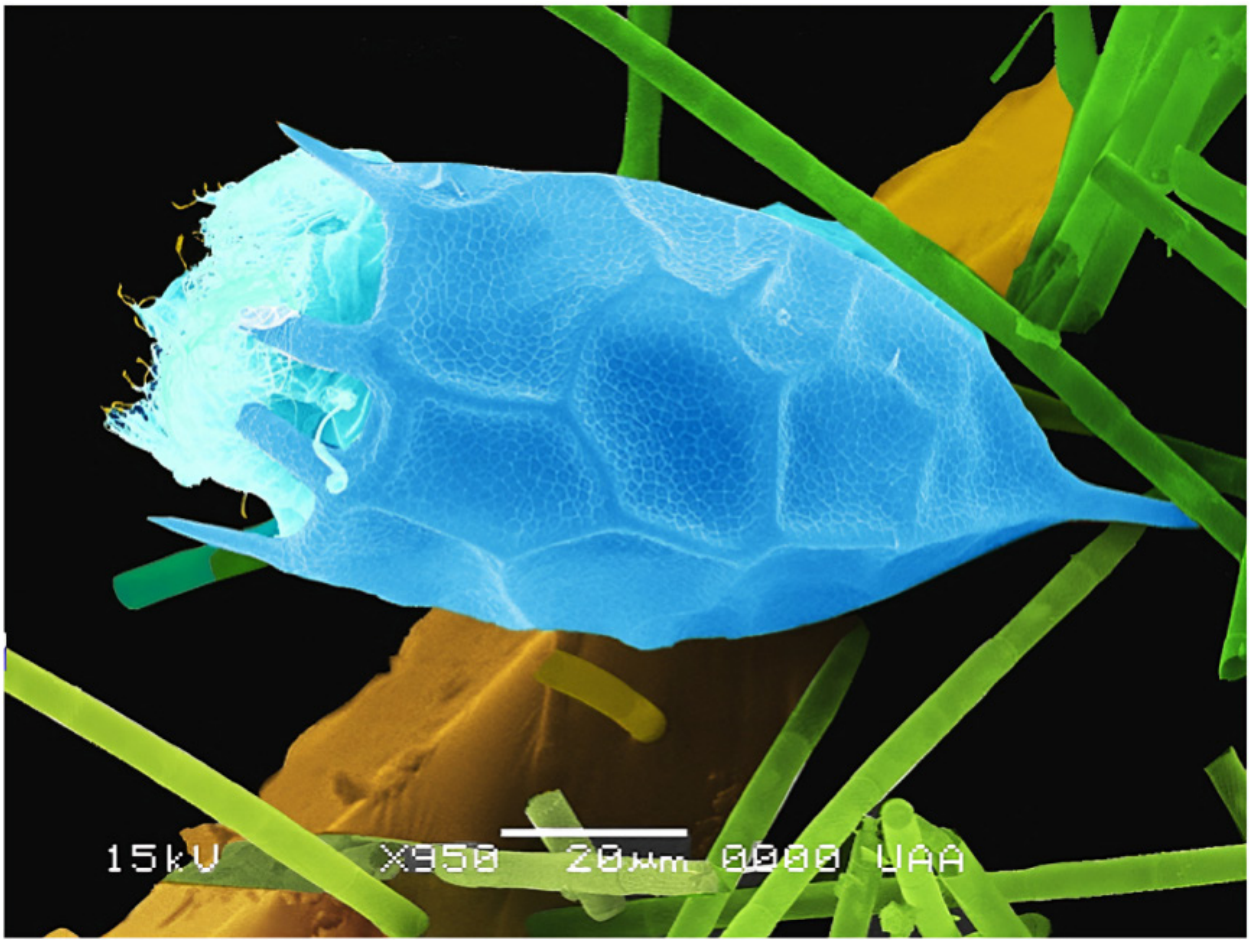

Figure 69: ***Keratella cochlearis.*** Invertebrate that belongs to the group of rotifers, member of the fauna of the small water bodies of the state. It is accompanied by a central diatom called ***Aulacoseira granulata.*** Collected on pond El Salto del Burro. Ags. 31 July 93.

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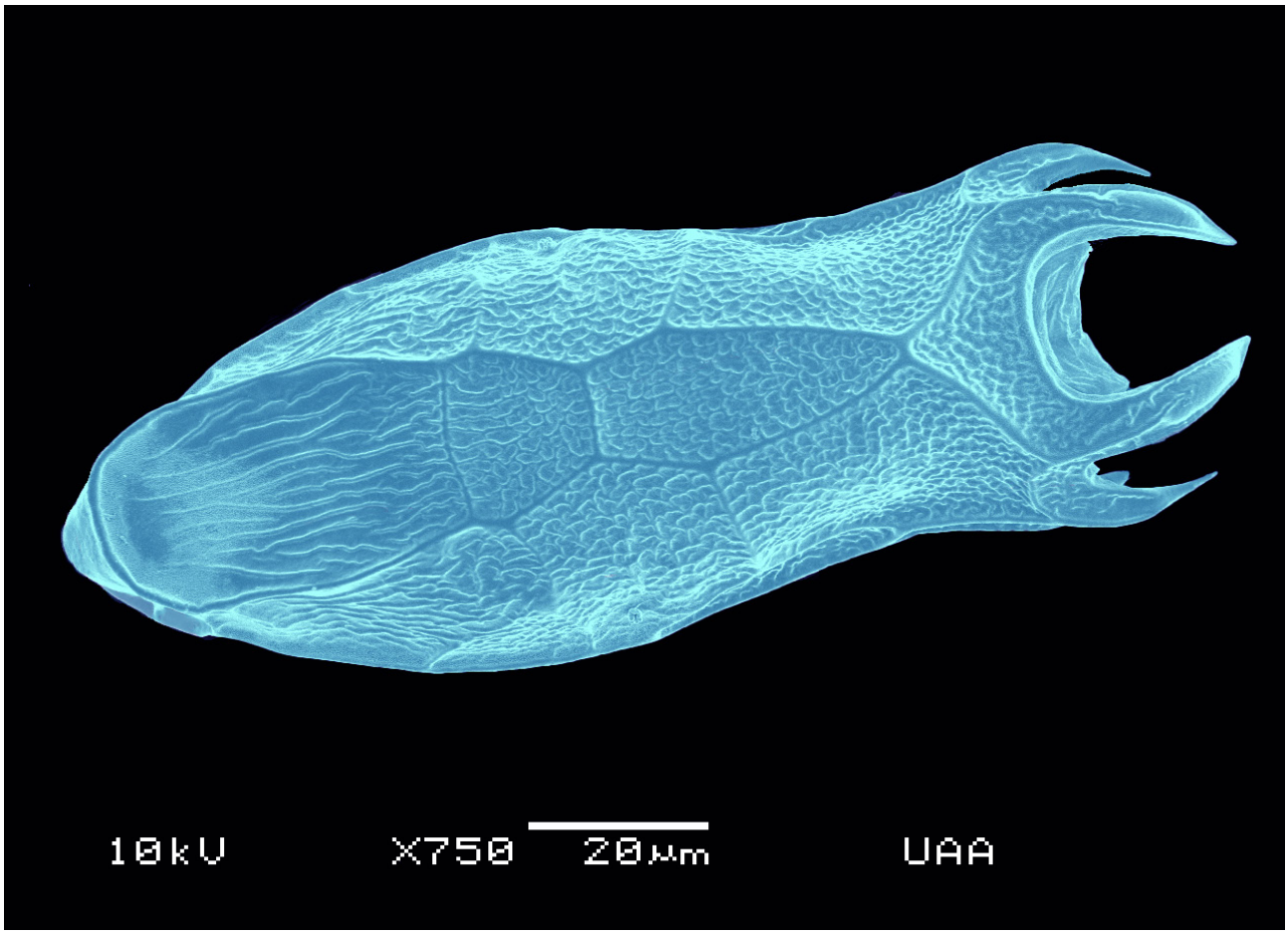

Figure 70: ***Keratella mexicana.*** A rotifer member of the zooplankton. New species for the state and for Mexico. It is part of the food chain of the water bodies of the state. Collected at La Colorada pond. El Llano, Ags.

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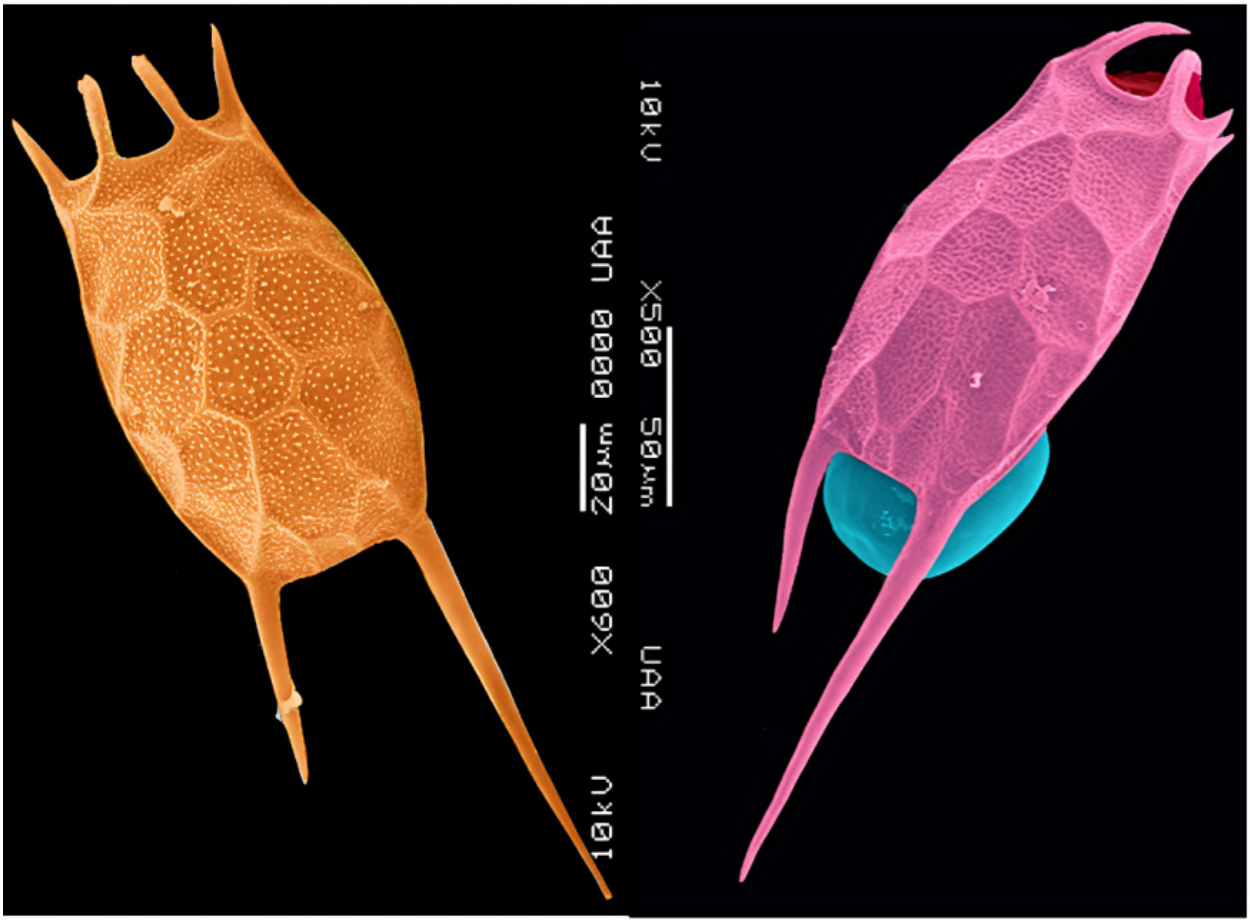

Figure 71: ***Keratella tropica.*** A rotifer that lives in the ponds and bodies of water in the state. It is a common inhabitant that serves as food for predators in the food chain. The lower right inset shows the central facet of the posterior part which is a distinctive character of the species. Collected in La Palma 3 pond. Jesús María, Ags.

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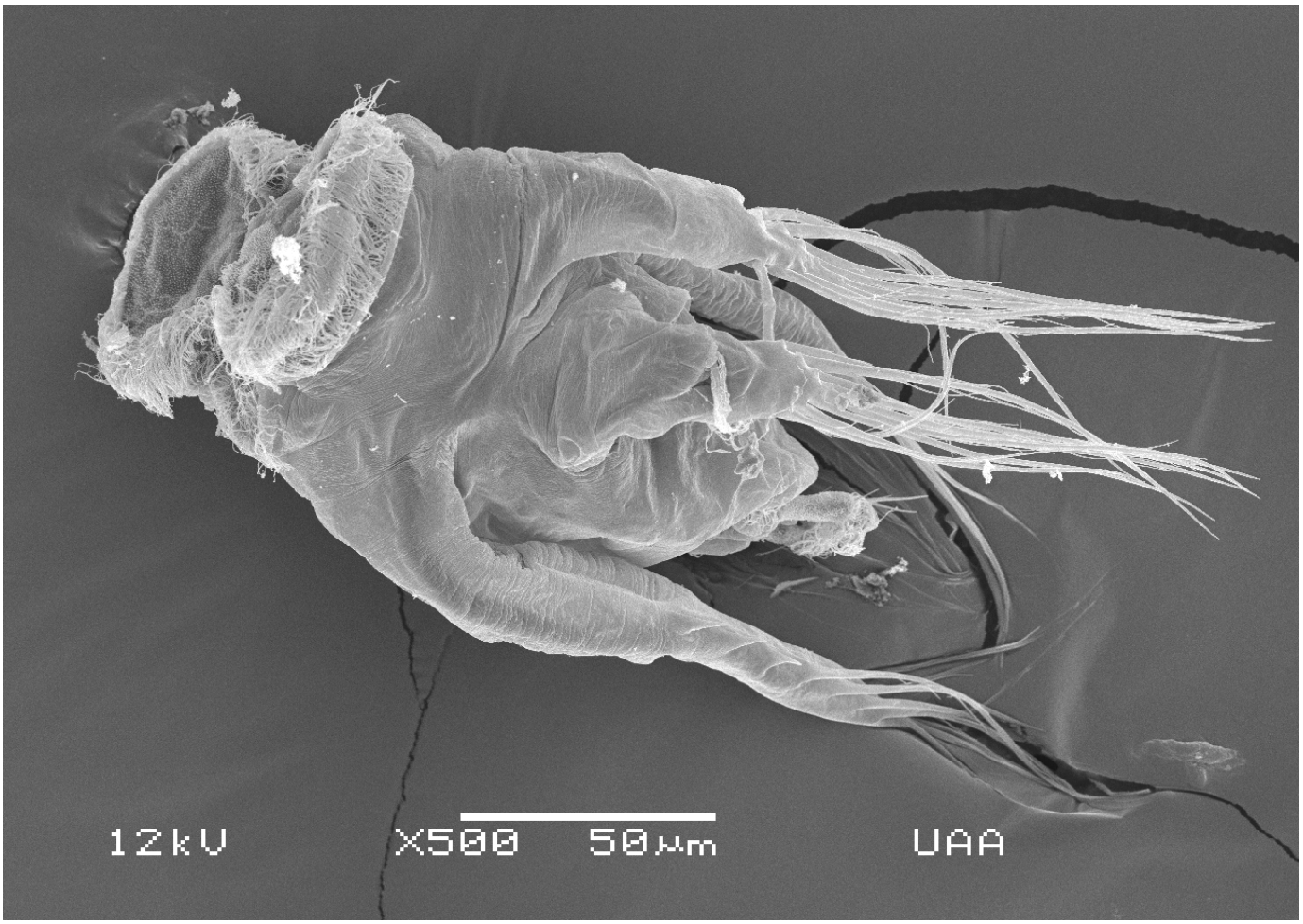

Figure 72: ***Hexarthra mira.*** Small rotifer, inhabitant of small ponds in the state, where it is part of the zooplankton that serves as food for primary consumers. Collected in El Cariñán pond, Ags.

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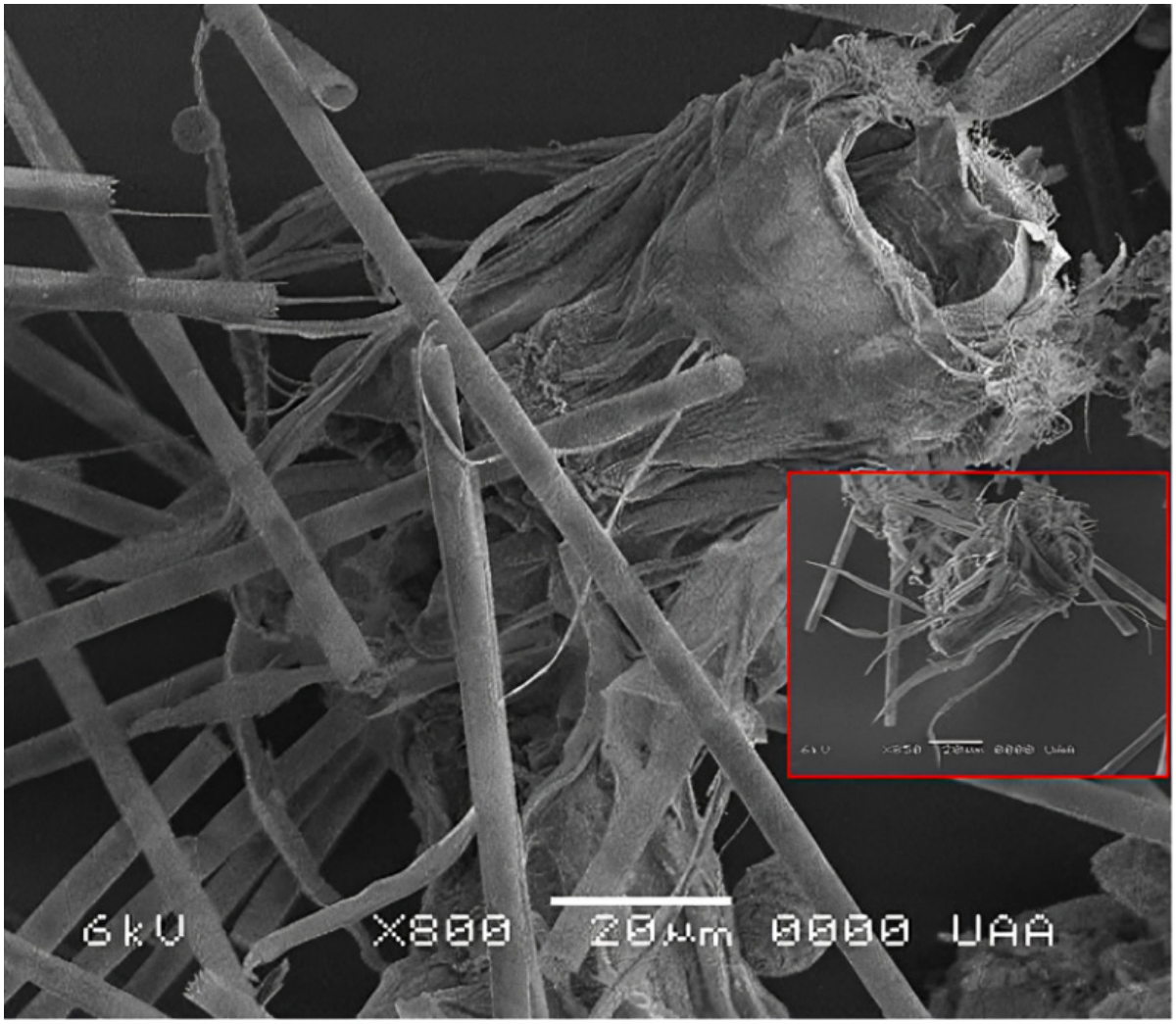

Figure 73: ***Polyarthra dolichoptera.*** Small rotifer (in the image it seems to be screaming), trapped between filaments of the central diatom Alaucoseira granulata, which coexists with this rotifer. Box, the length of the paddles can be appreciated. Collected at La Codorníz dam. Calvillo, Ags. May 18, 2003.

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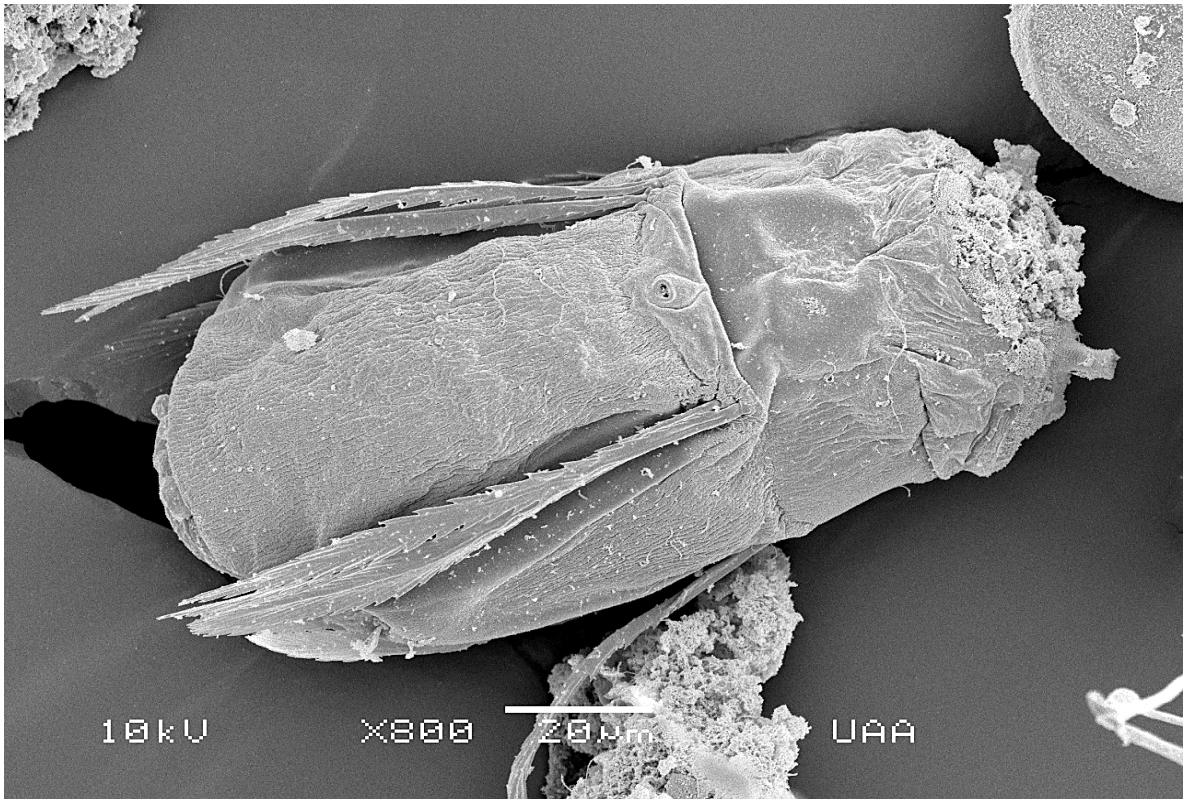

Figure 74: ***Polyarthra vulgaris.*** A small rotifer that lives in the ponds and dams of the state. It is an invertebrate that is part of the food chain. It is a filter-feeder that feeds on microalgae and suspended particles in the ponds and dams of the state. Collected at Rancho Buena Vista pond. Jesús María, Ags.

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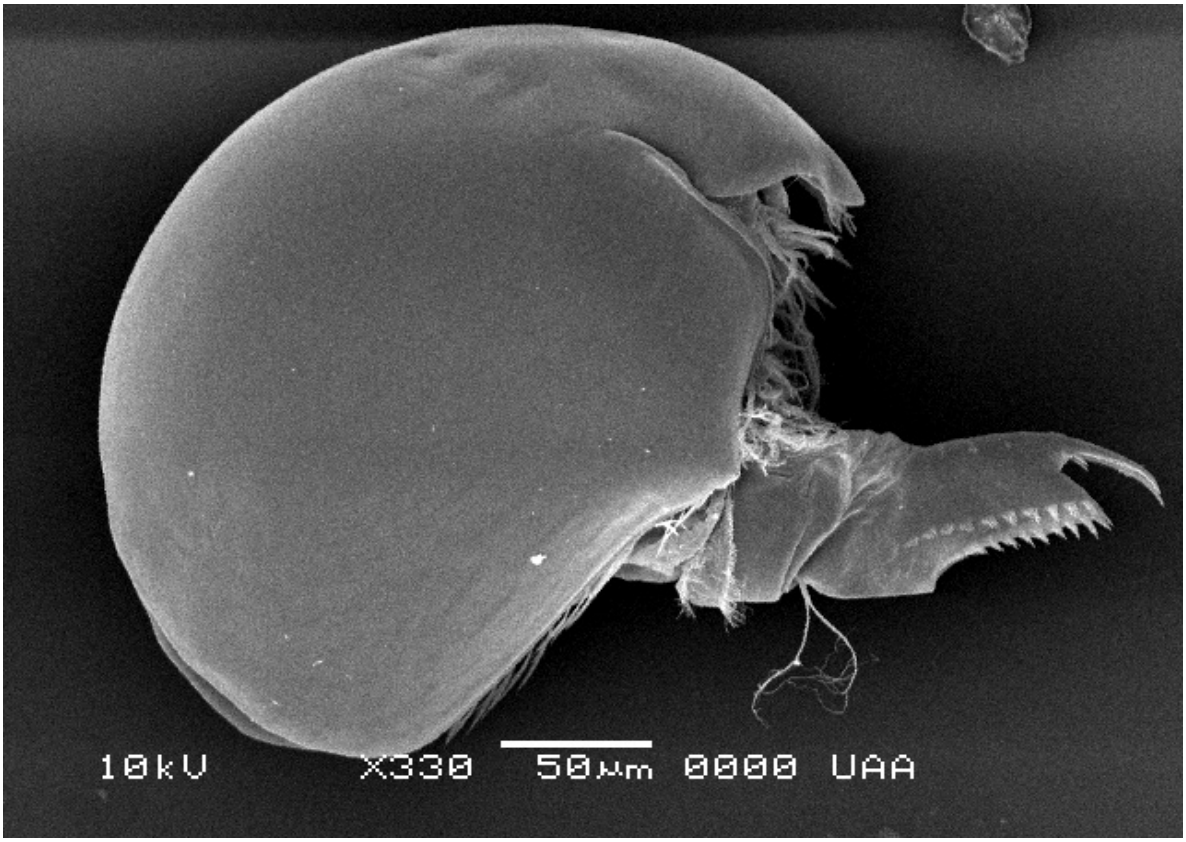

Figure 75: ***Alona guttata.*** Cladoceran or water flea that filters particles from the pond where it lives. Important member of the state's microfauna. Collected at El Jocoqui dam. San José de Gracia, Ags.

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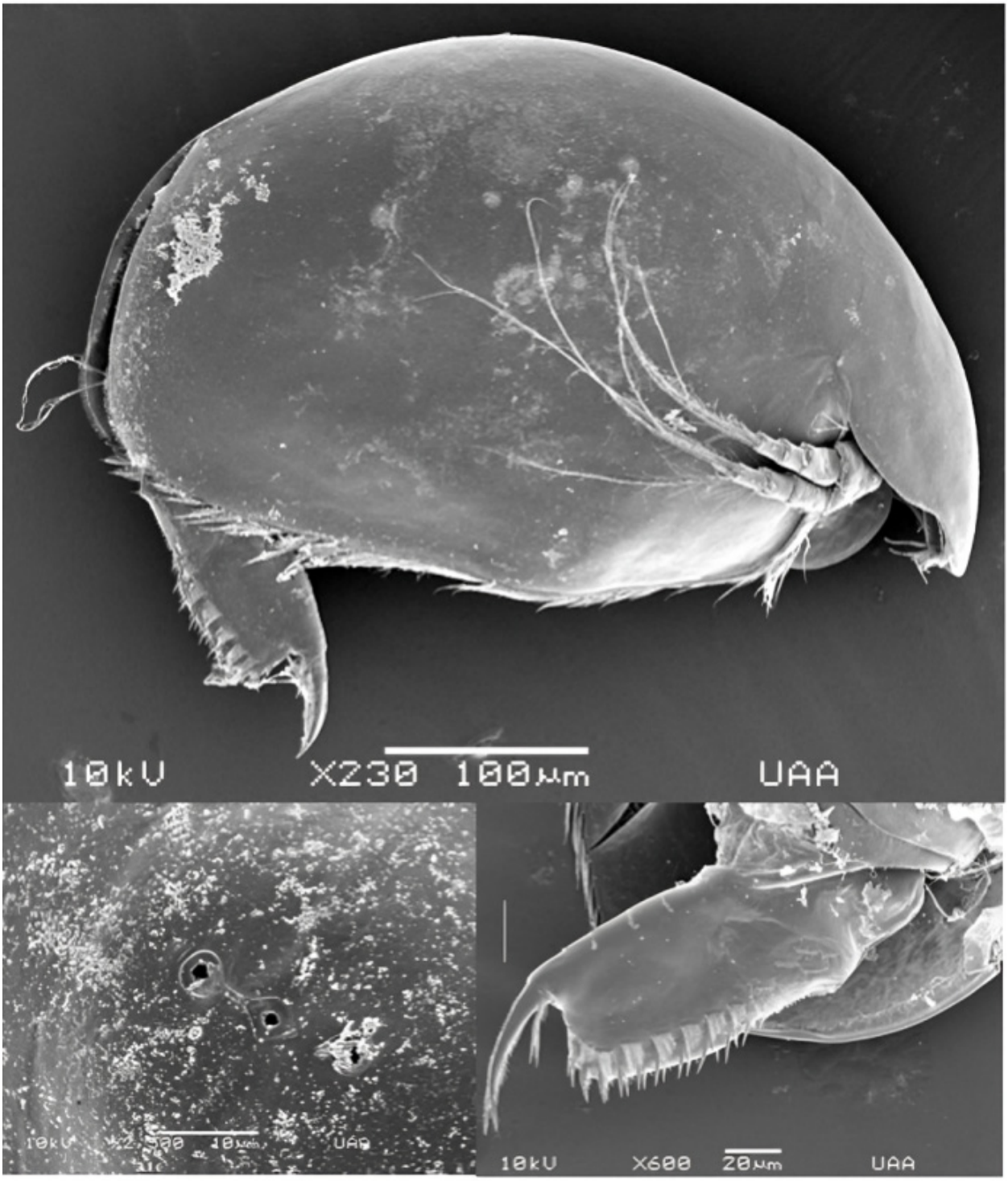

Figure 76: ***Alona aguascalientensis.*** Small cladoceran that inhabits the bodies of water of the state. This species is new to science. It is part of the food chain, as it is a filtering organism, which also serves as food for predators that inhabit small ponds in the state. Collected in a pond on the side of the Villa Hidalgo-Aguascalientes highway, Ags. 4 September 1990.

Author: Marcelo Silva Briano & Araceli Adabache Ortiz

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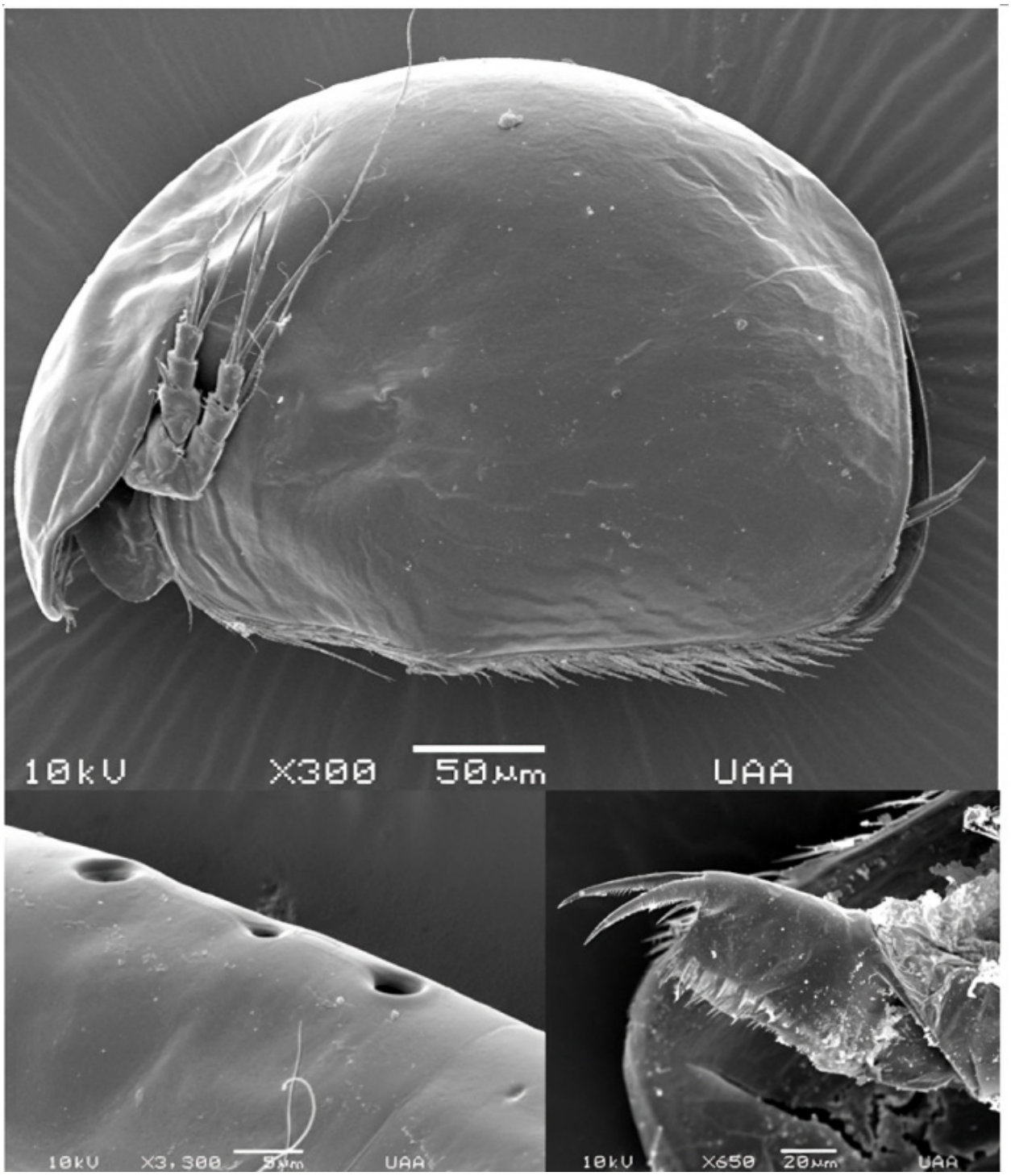

Figure 77: ***Alona anamariae.*** Small cladoceran that inhabits the bodies of water of the state. This species is new to science. It is part of the food chain, as it is a filtering organism, which also serves as food for predators that inhabit small ponds in the state. Collected at La Araña dam. Sierra Fría, San José de Gracia, Ags. 29 September 1993.

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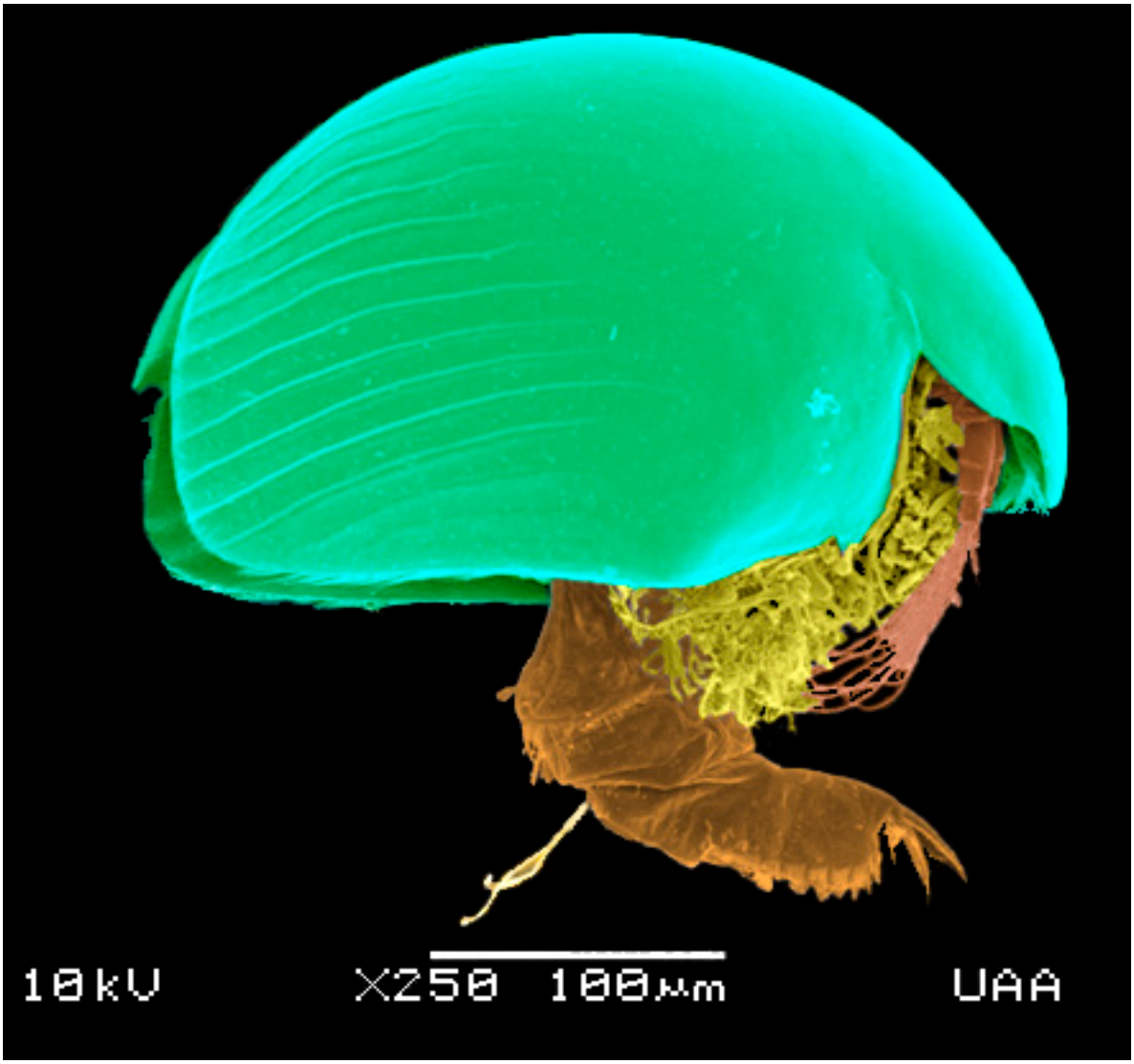

Figure 78: ***Coronatella circumfimbriata.*** Cladoceran or water flea that lives in ponds filtering organic matter. It is a relatively rare cladocero that has been found in only a few localities. Collected in a pond in the town of Gracias a Dios. Jesús María, Ags.

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Figure 79: ***Chydorus sphaericus.*** Cladoceran or water flea, which inhabits the ponds and dams of the state. It is a small filter-feeder that feeds on particles from the medium. Left, complete specimen in lateral view with its reticulated valva. Right, specimen in ventral view showing the rostrum, first and second pair of antennae. Collected in pond at Mesa El Roble. Calvillo, Ags. 2000.

Author: Araceli Adabache Ortiz & Marcelo Silva Briano

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Figure 80: ***Chydorus sphaericus.*** Small cladoceran that inhabits the ponds and dams of the state. It is a filterer of particles and micro algae found in the water bodies of the state. Collected in a pond next to the town of La Congoja. San José de Gracia, Ags. September 20, 2020.

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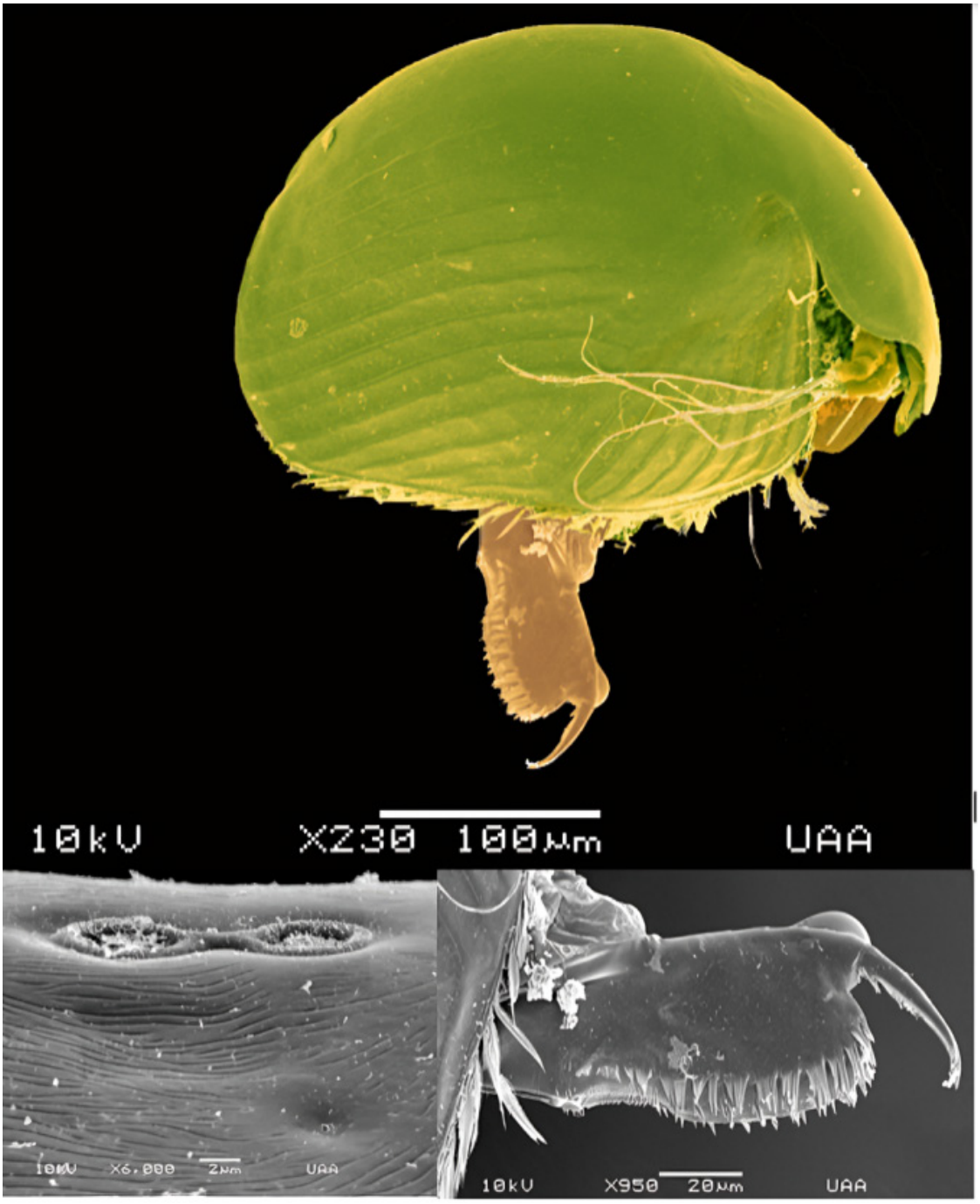

Figure 81: ***Karualona penuelasi.*** Female showing the two cephalic pores characteristic of the genus (left) and the postabdomen (right). It is a water flea that was only found in one locality. Species new to science. Collected at Peñuelas dam, Ags.

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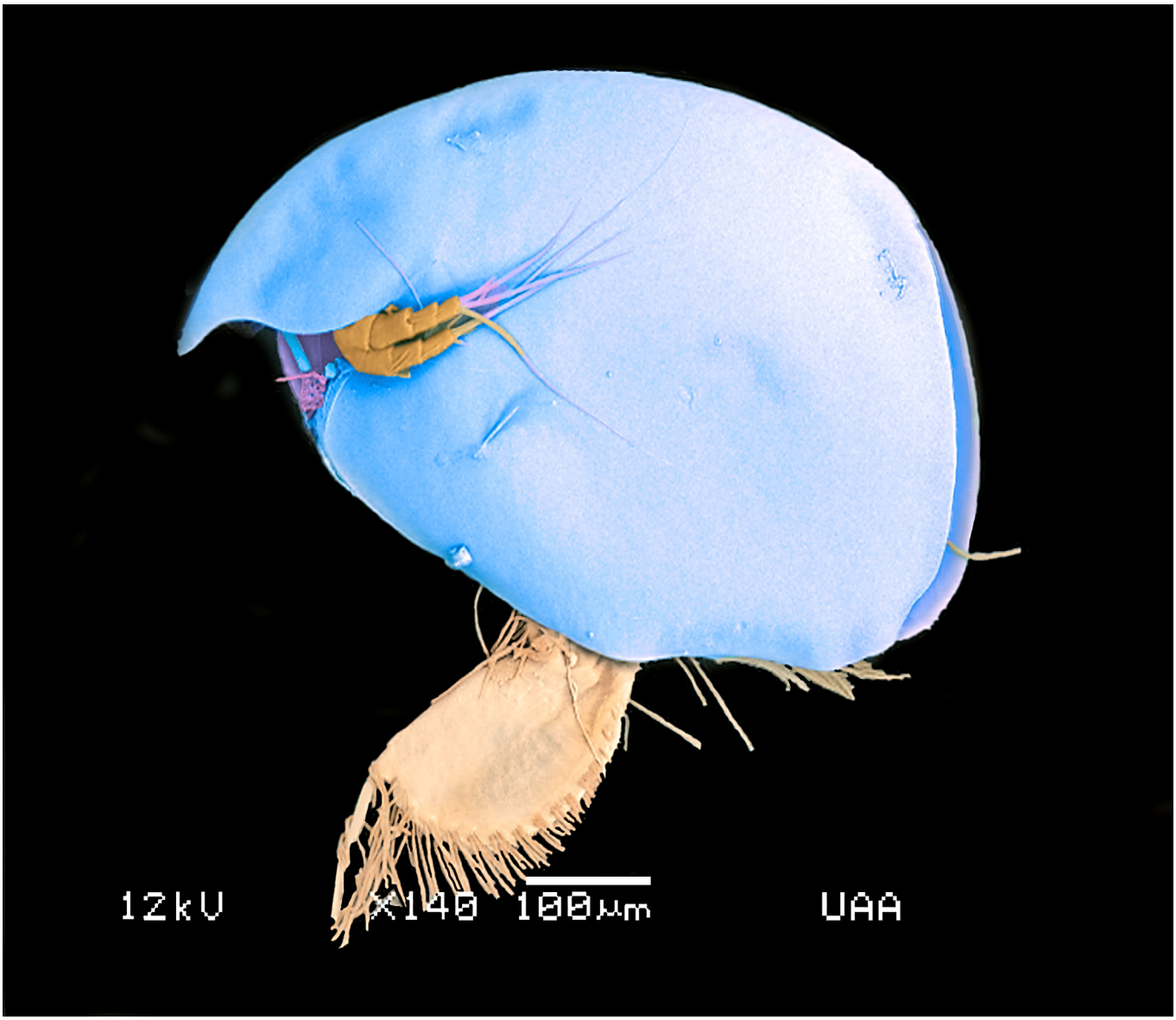

Figure 82: *Leydigia* sp. A Cladocero (water flea), which lives in the temporary ponds of the state of Aguascalientes as part of the zooplankton that inhabits the small ponds and dams of the state. Collected at Santa Elena dam, Ags.

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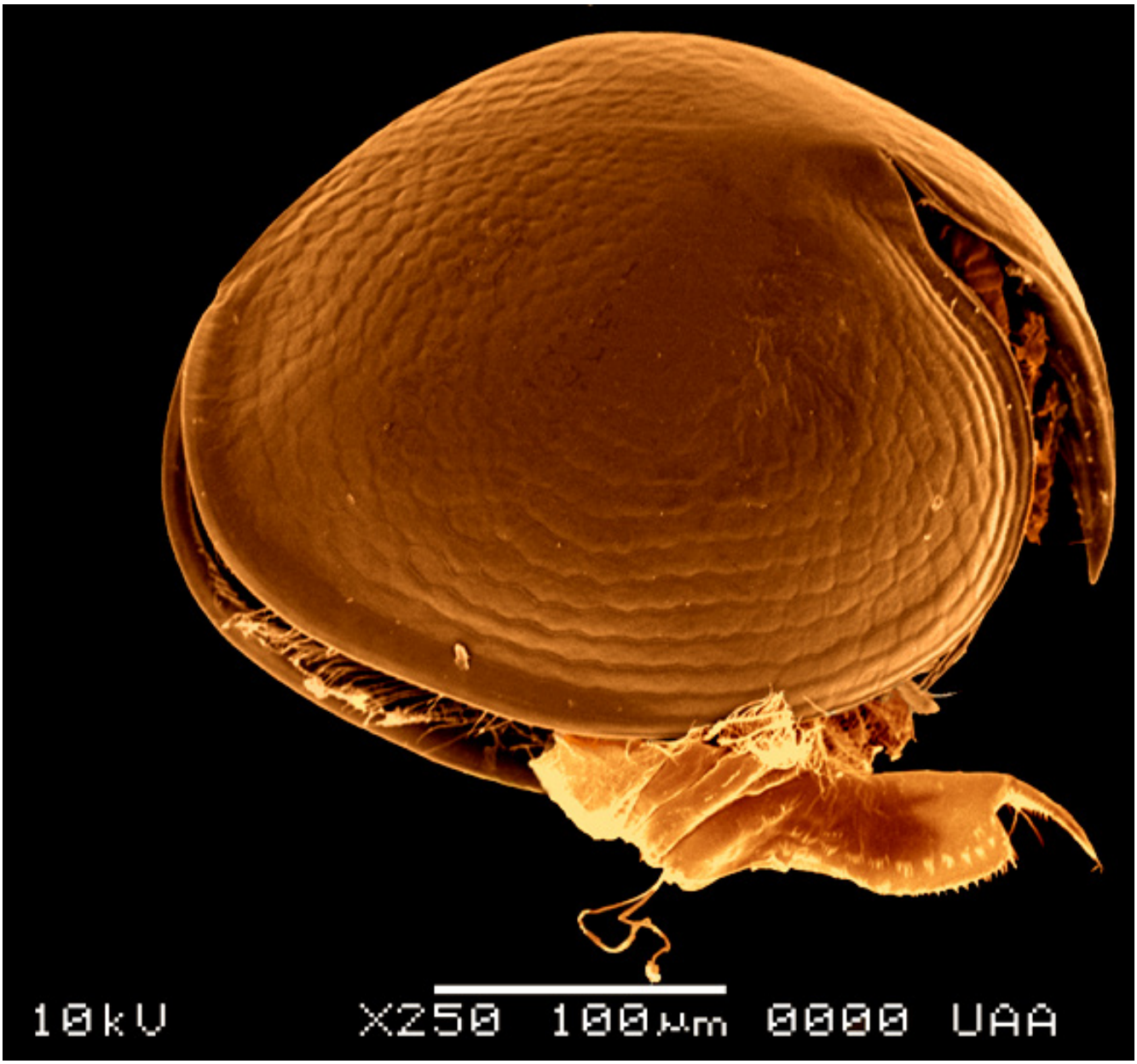

Figure 83: ***Pseudochydorus margaritalfonsorun*****.** Cladoceran or particle-filtering water flea. This is a new species for Aguascalientes and Mexico. Collected in dam, at one side of the town of Sandovales, El Llano, Ags. 1990. The name was given in honor of our friends and colleagues, Margarita Palacio Núñez and Alfonso Salado Rodríguez.

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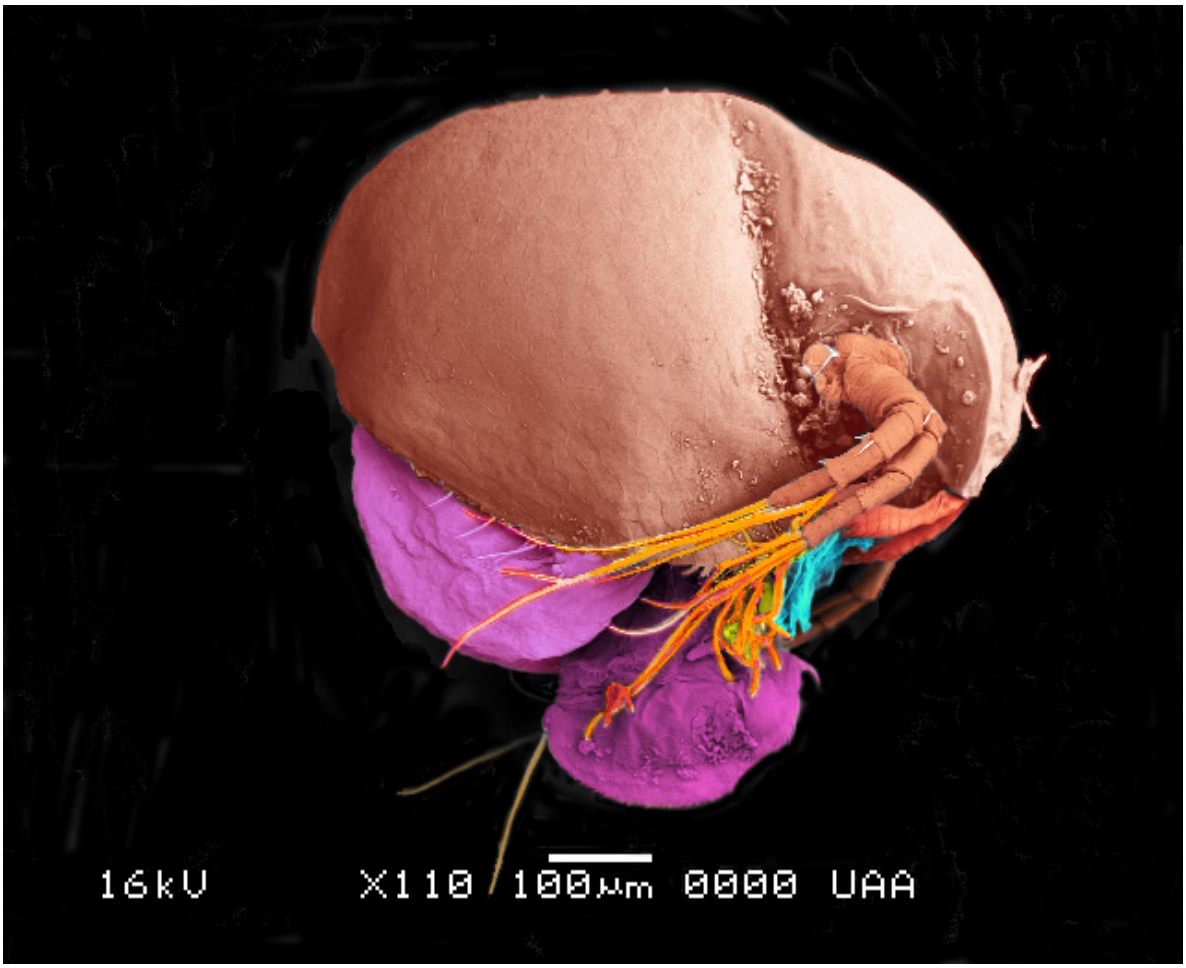

Figure 84: ***Macrothrix agsensis.*** Cladoceran that lives as part of the zooplankton filtering food particles and serving as food for the members that are above in the food chain. This species is new to Mexican science. Collected in El Jagüey or Salto del Burro dam. Aguascalientes.

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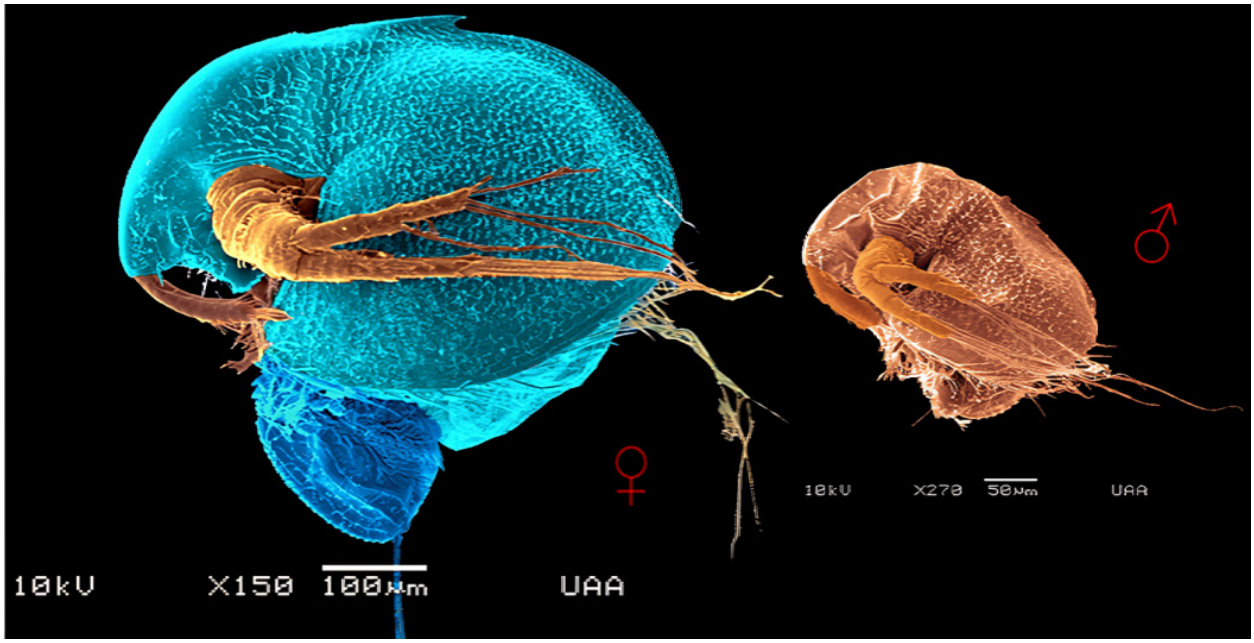

Figure 85: ***Macrothrix mexicanus.*** Species new to science, endemic to the state of Aguascalientes and Mexico. Member of the zooplankton of water bodies and part of the food chain. Collected at El Llavero dam, Ags (now extinct).

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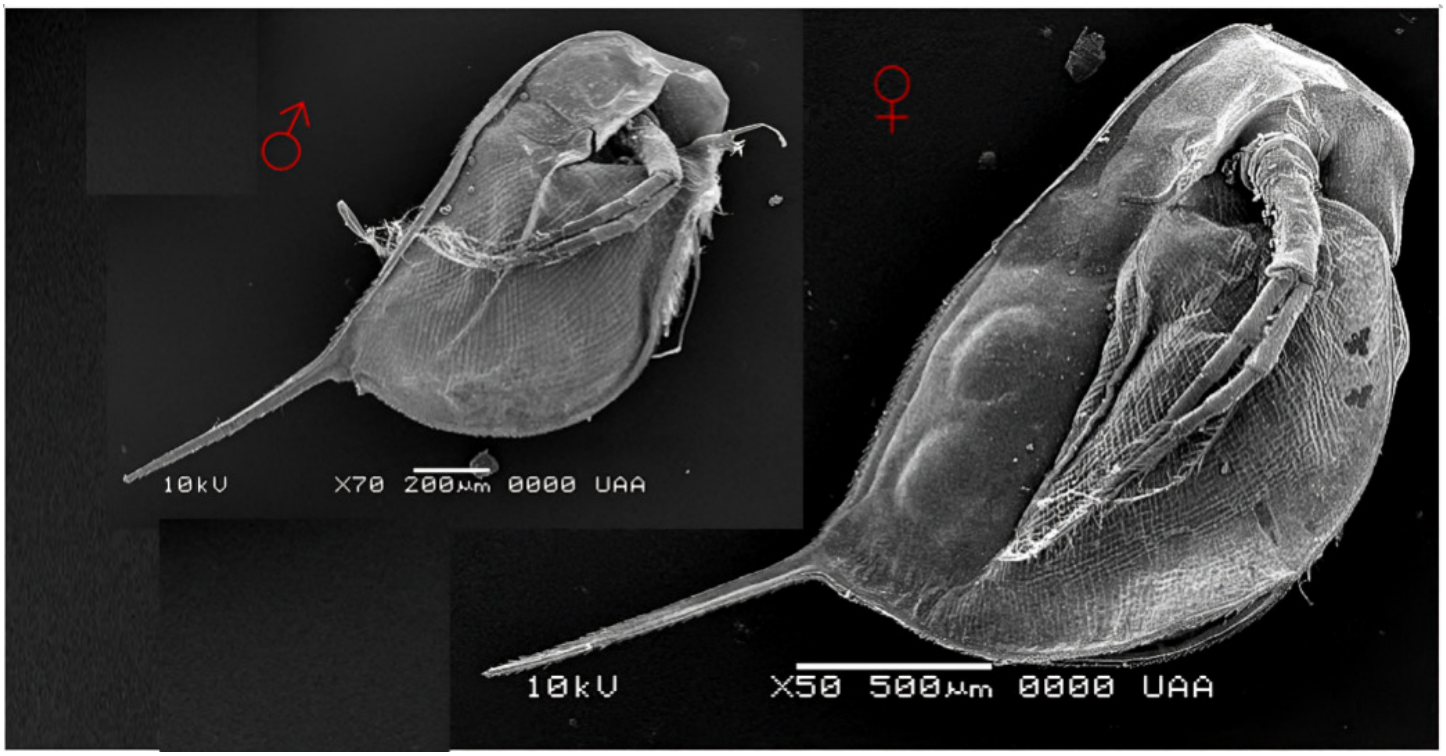

Figure 86: ***Daphnia C. exilis*****.** Cladoceran or water flea, which inhabits the ponds and dams of the state. It is a filter-feeder that feeds on particles and microalgae in the medium. Left, adult male, generally smaller than the female. Right, female showing ephippium with two eggs from male fertilization. Collected on pond at Allende street No. 39. Cosío, Ags. 2002.

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Figure 87: ***Daphnia Ctenodaphnia exilis* & *Daphnia Daphnia pulex*.** Two small crustaceans whose function is to filter particles from the environment, as well as microalgae. They inhabit the water bodies of the state, including Zacatecas. Collected in the states of Aguascalientes and Zacatecas.

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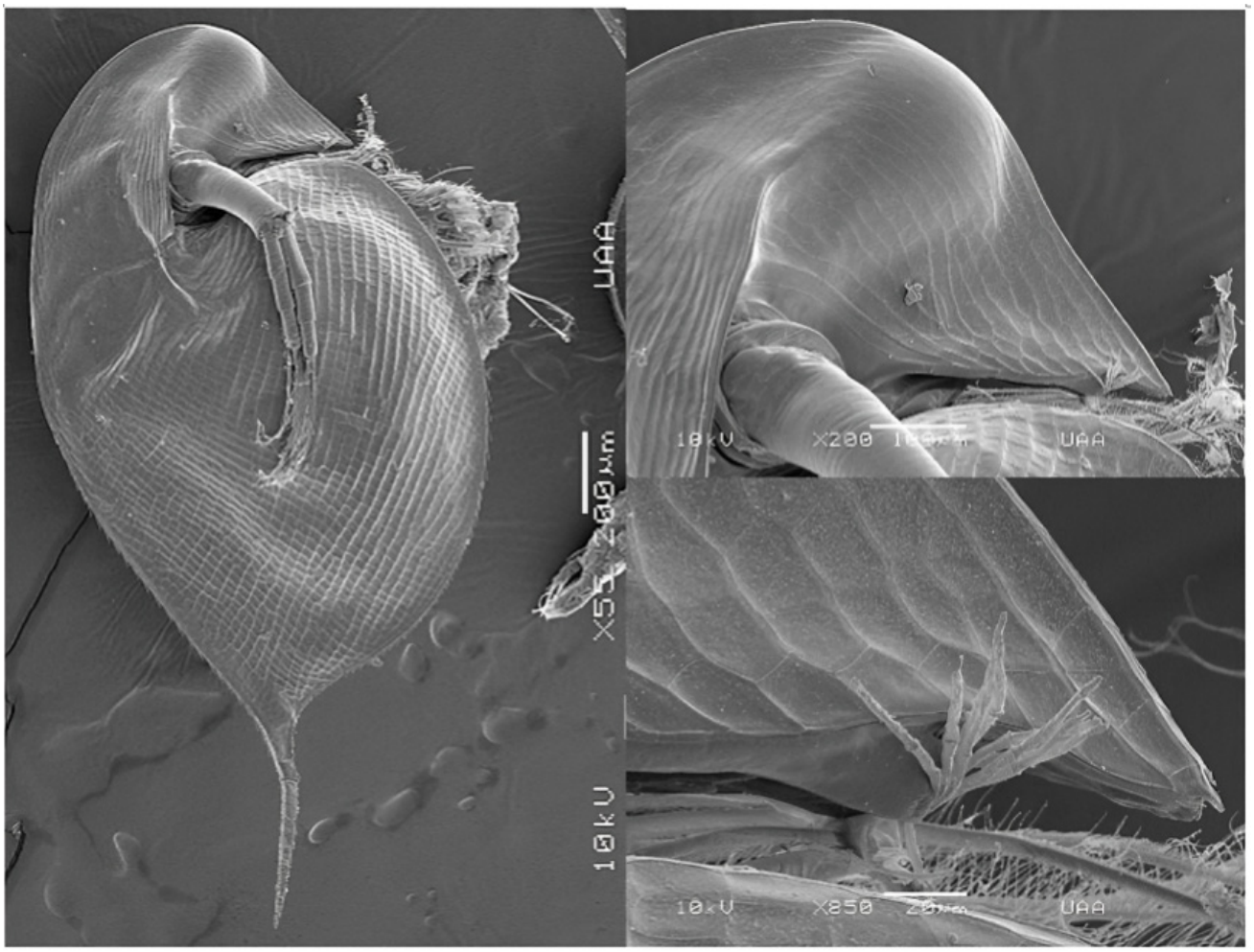

Figure 88: ***Daphnia D. pulex*****.** Small crustacean or water flea, inhabitant of the water bodies of Aguascalientes. It is part of the food chain as a primary consumer and at the same time prey for secondary consumers. Collected at Los Alamitos dam. Calvillo, Ags.

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Figure 89: ***Daphnia D. pulex*****.** Small crustacean or water flea. Small cladoceran clustacean that lives in the small ponds of the state. On one side of this cladocero a Cyclopoid copepod of the genus ***Acanthocyclops*** **sp.** collected in Parque Rodolfo Landeros Gallegos pond, Ags. 20 August 2021.

Author: Ana Ekaterina Retes Pruneda
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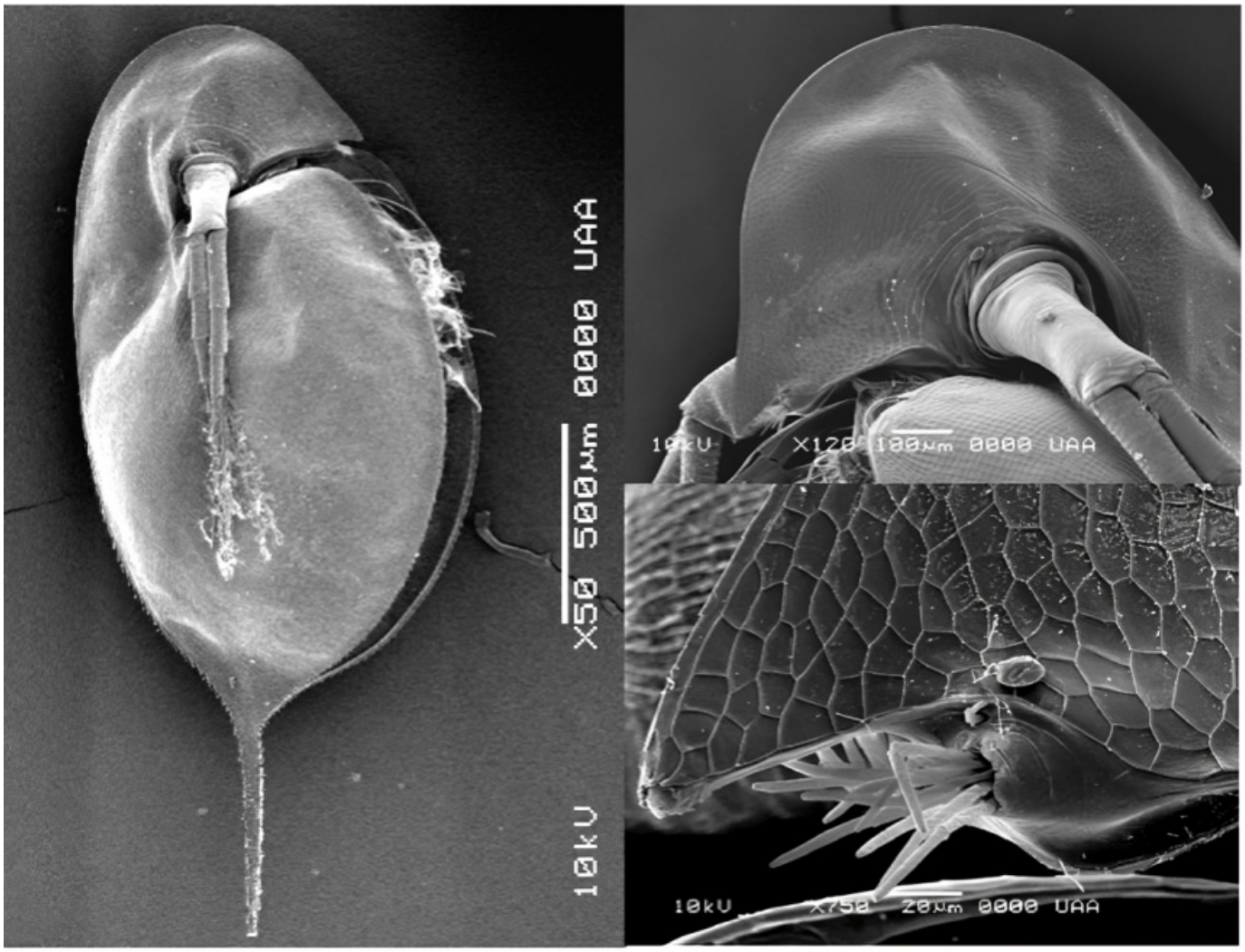

Figure 90: ***Daphnia Daphnia pileata*****.** Cladoceran crustacean or water flea that lives in the ponds and bodies of water in the state. Unlike the species collected in Bordo 1, Rancho San Jacobo, Jesús María, Ags., which shows a very large head, the image presented does not show this growth. Collected in Las Camas pond. San José de Gracia, Ags.

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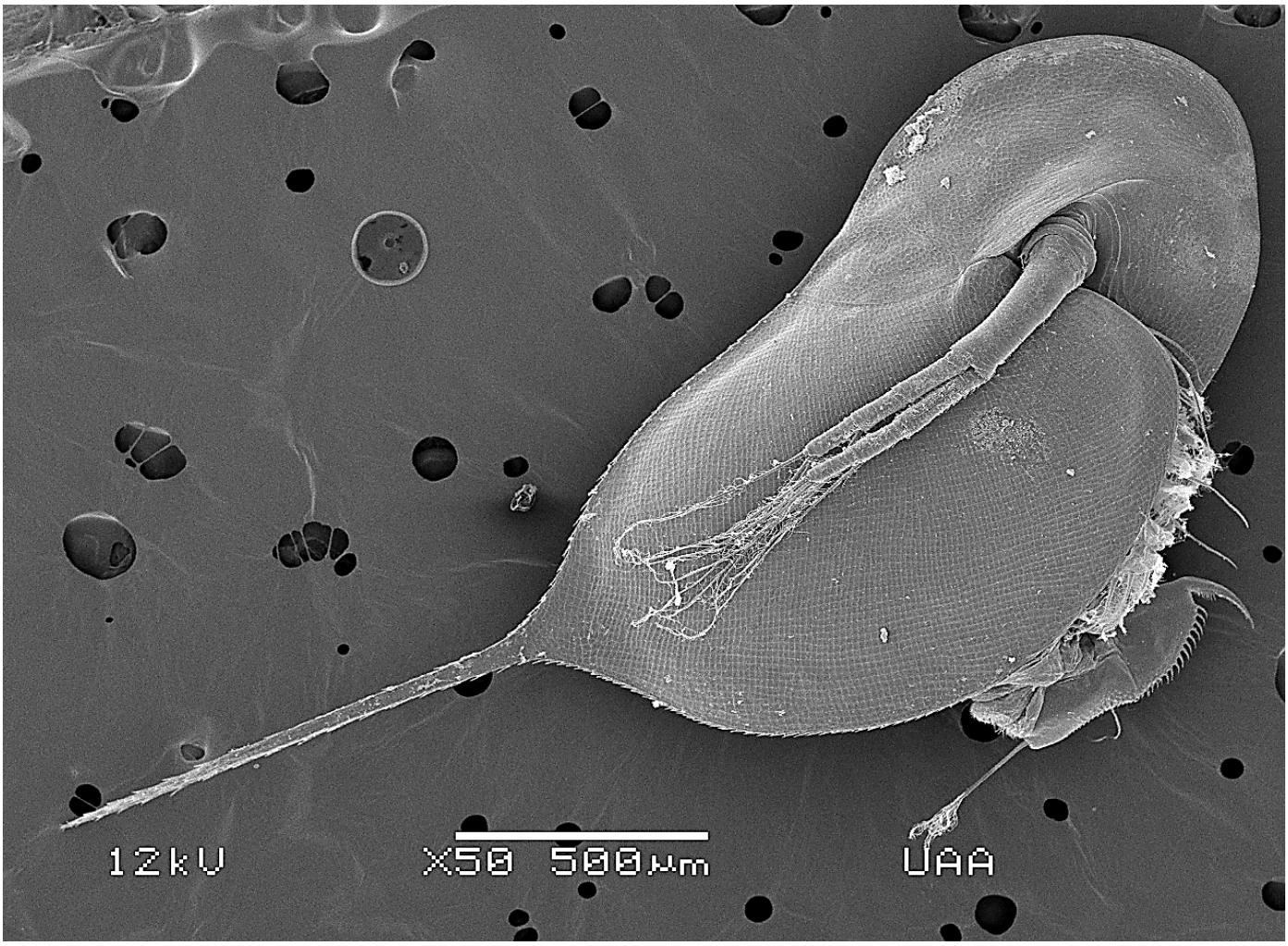

Figure 91: ***Daphnia pileata*****.** Cladoceran crustacean or water flea that inhabits the ponds and dams of the state, constituting part of the food chain, whose role is to feed the small predators present in aquatic ecosystems. Collected in pond on the way to Peña Blanca Dam. Calvillo, Ags.

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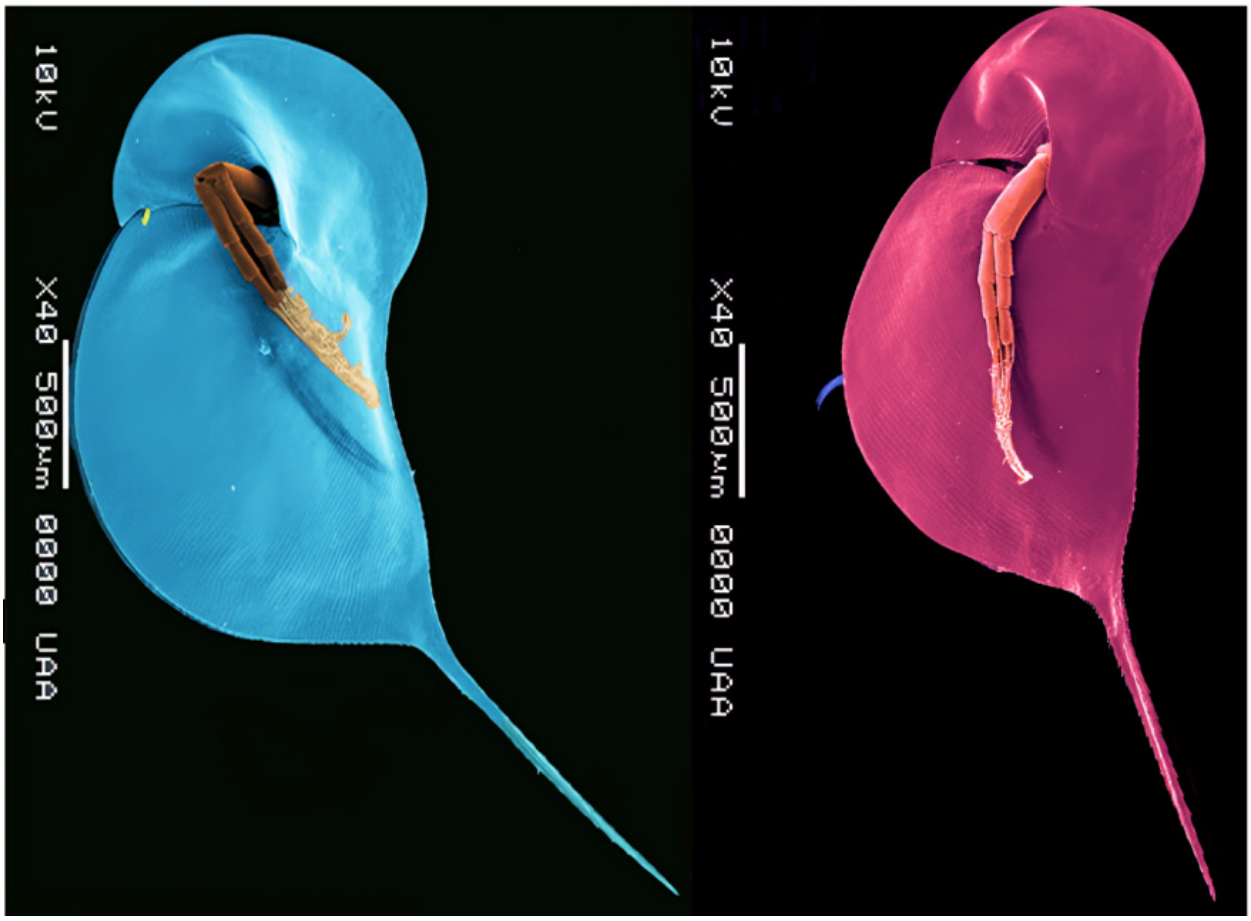

Figure 92: ***Daphnia D. pileata*****.** Cladocero or water flea, which shows a huge head, this species filters the particles with which they feed. Collected in pond 1, in San Jacobo ranch. Jesús María, Ags.

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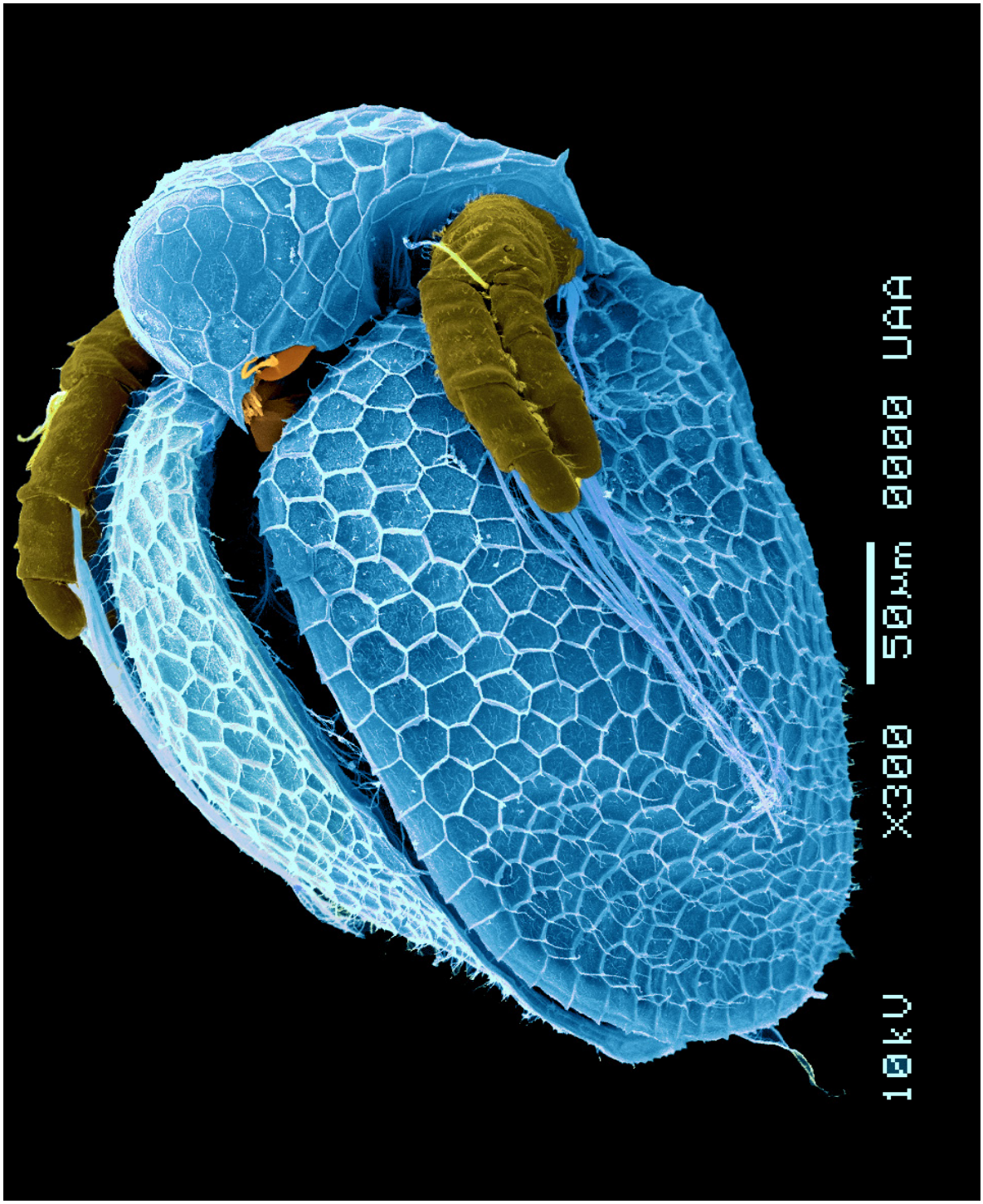

Figure 93: ***Ceriodaphnia cornuta*****.** Cladoceran or water flea, which presents a reticulation that makes it look spectacular. Filter-feeding inhabitant of the water bodies of the state. Collected at Los Huijolotes dam, Ags.

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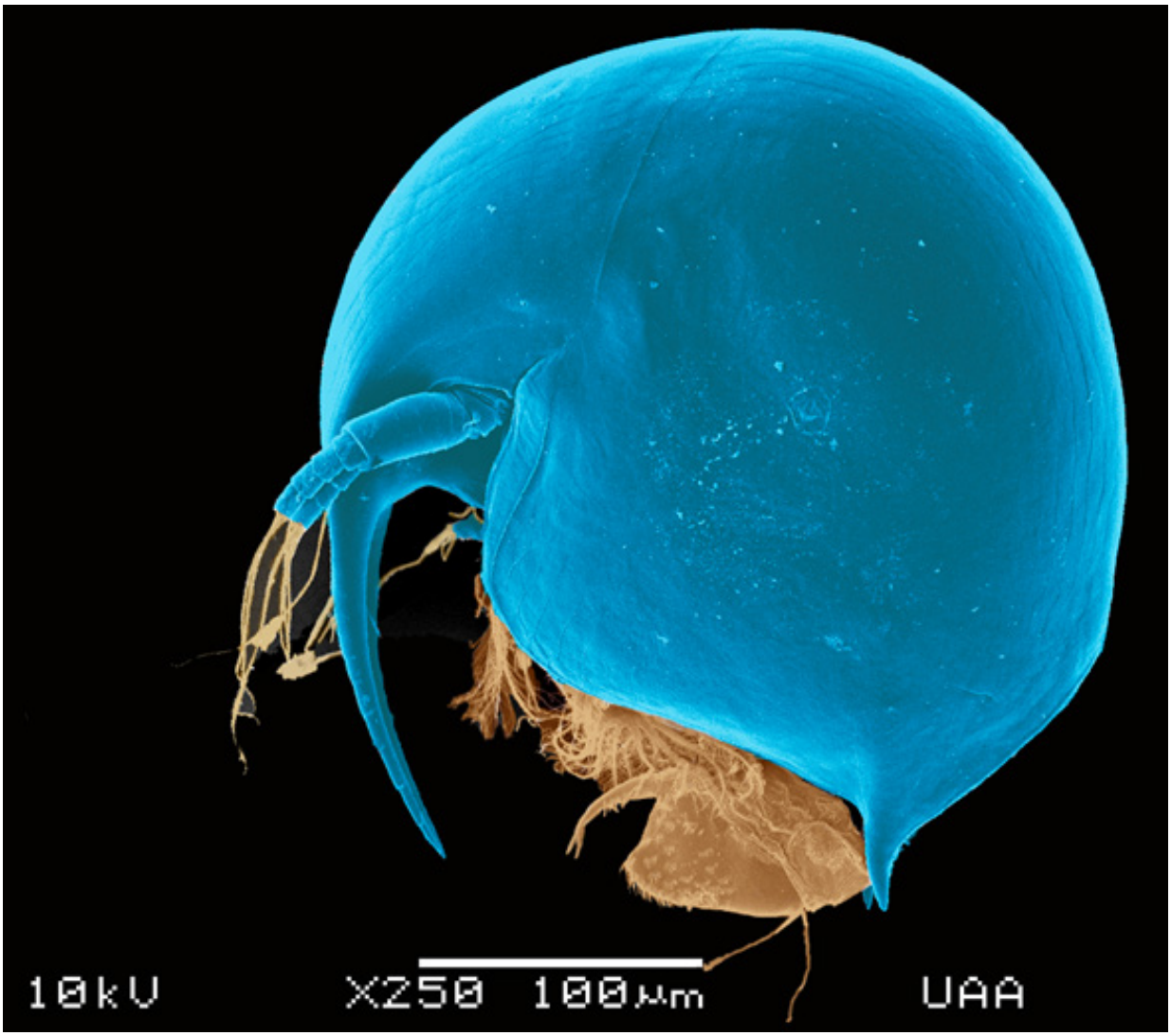

Figure 94: *Bosmina* sp. Cladoceran or water flea, which lives by filtering the food particles it ingests. Small crustacean that inhabits the ponds of Aguascalientes. Collected at El Sauz pond. Calvillo, Ags.

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Figure 95: ***Moina micrura*****.** Cladoceran or water flea that lives in bodies of water. It reproduces so much that it serves as food for the fish that inhabit the pond. Attached to the right side of its shell is a rotifer **(*Brachionus rubens*),** which sometimes invade in large groups ***Moina micrura*** or other species of the same genus. Collected at El Cedazo dam, Ags.

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Figure 96: ***Moina micrura*****.** Microcrustacean or water flea that lives as part of the zooplankton, filtering food particles and serving as food for the members that are higher up in the food chain, such as fish. Collected at El Cedazo dam, Ags.

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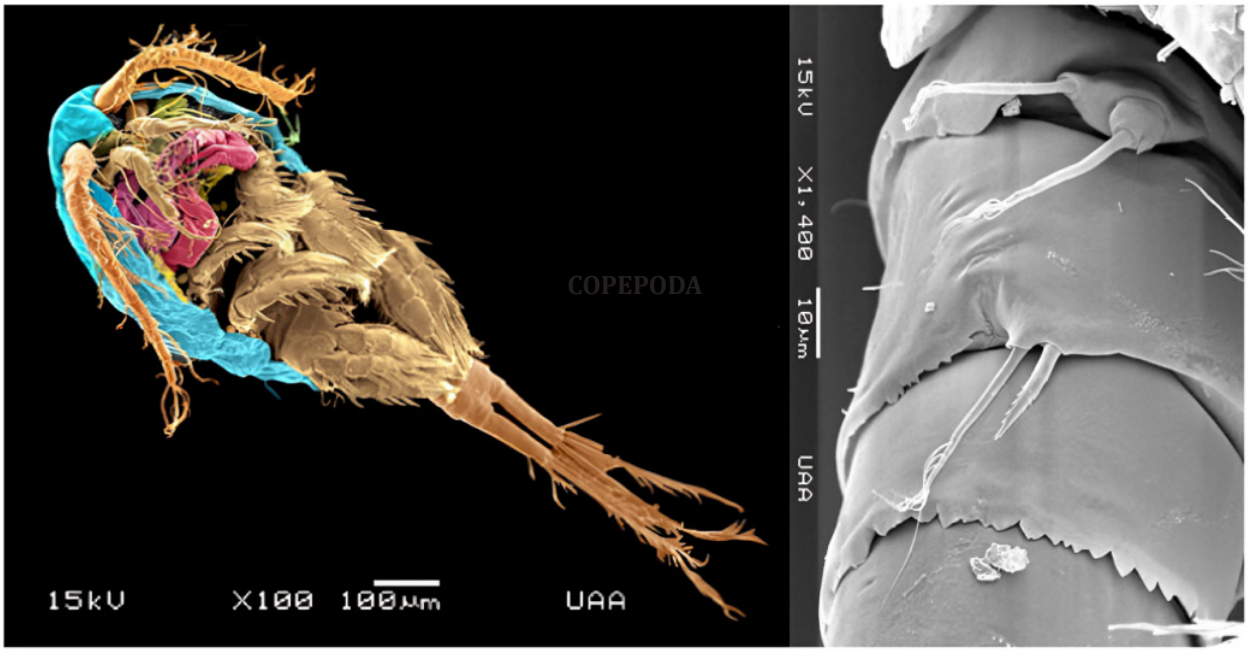

Figure 97: ***Acanthocyclops marceloi*****.** Small crustacean called copepod, which lives by swimming and stalking its prey, which it captures with its jaws. It is part of the food chain and is an integral part of the state's ponds. The left image shows the animal in ventral view. The right image shows a detail of the fifth and sixth pair of legs. Collected at Arroyo Seco dam. Jesús María, Ags. 25 September 2017.

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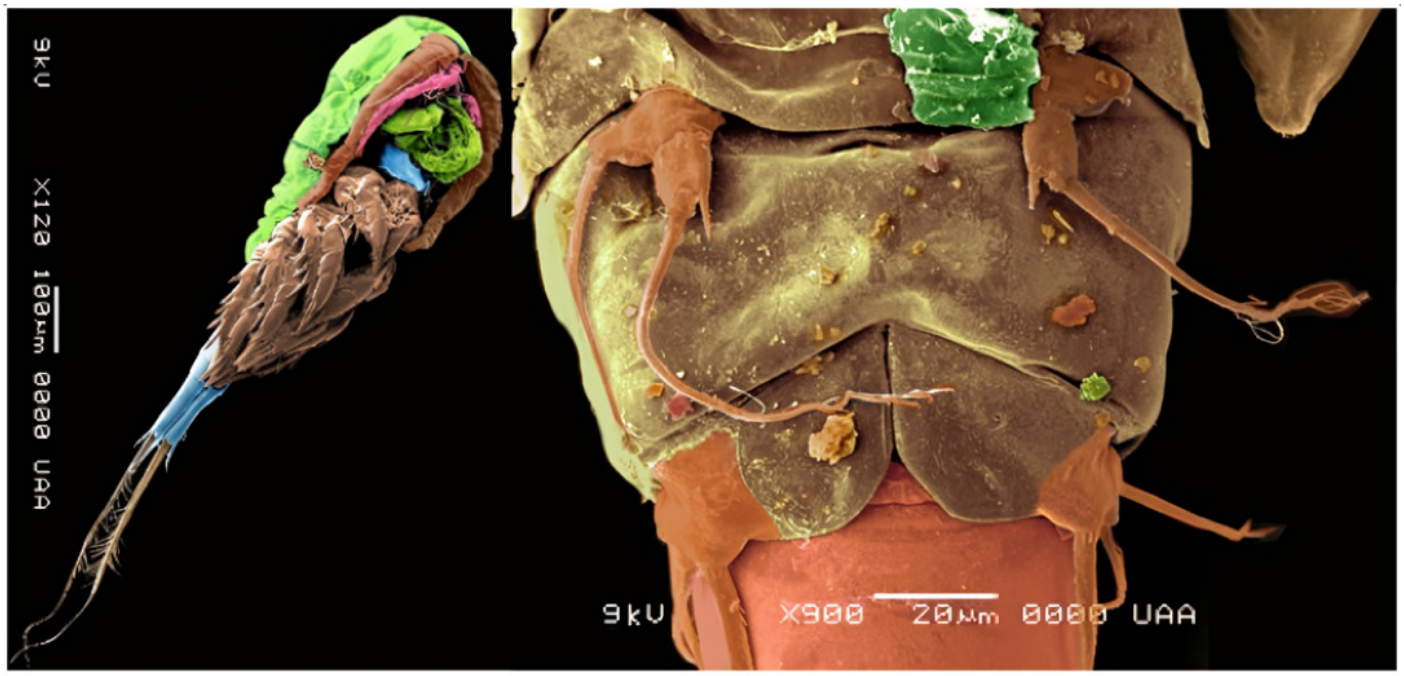

Figure 98: ***Acanthocyclops dodsoni.*** Small copepod, which lives by swimming and stalking its prey, which it captures with its jaws. It is part of the food chain and is an integral part of the state's ponds. Left image shows the organism in lateral view showing the 4 pairs of brown legs and the right image shows the fifth pair with the same color. Collected at Presidente Calles dam. San José de Gracia, Ags.

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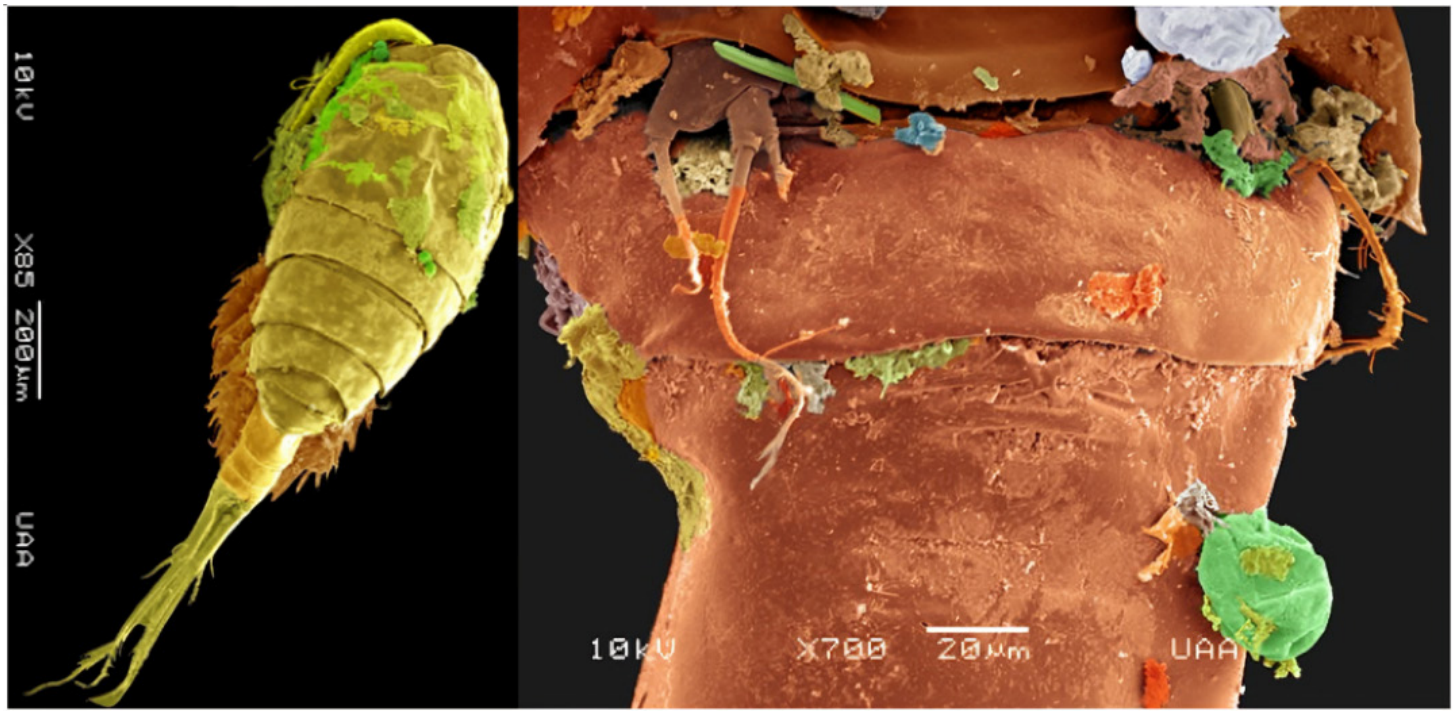

Figure 99: ***Acanthocyclops caesariatus*****.** Small copepod, which lives by swimming and stalking its prey, which it captures with its jaws. It is part of the food chain and is an integral part of the state's ponds. The left image shows the entire animal in dorsal view. The right image shows the left leg in brown-orange color. Collected at El Llavero dam, Ags. 24 September 2012.

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Figure 100: ***Acanthocyclops robustus*****.** Small copepod living in small temporary ponds and dams in the state. Left image shows a close-up of the invasion of one side of the head and antenna of the copepod by ciliates of the genus ***Epistylis*** **sp.** The right image shows a panoramic view of the invasion. Collected in the pond of Parque Rodolfo Landeros Gallegos, Ags.

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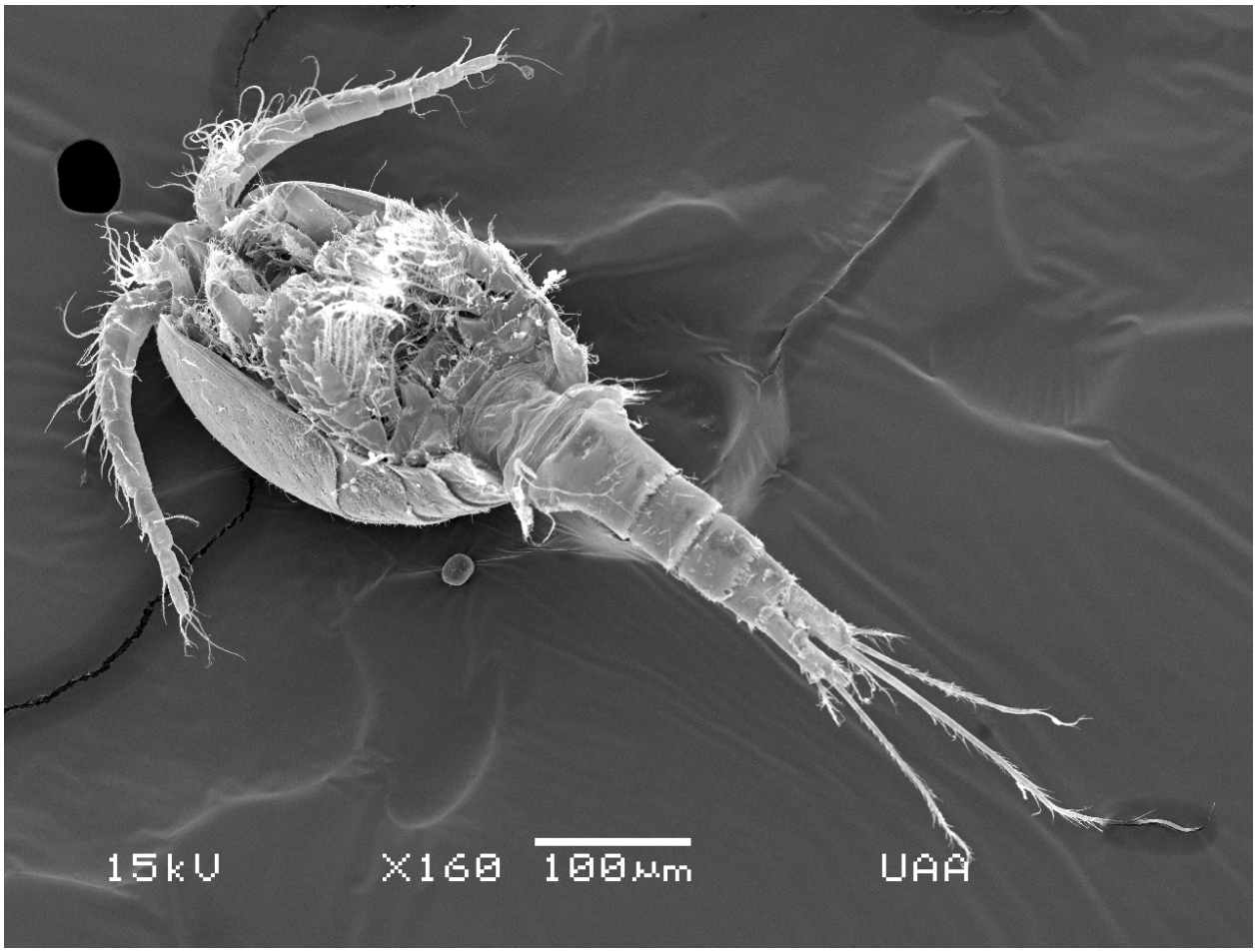

Figure 101: ***Eucyclops*** **sp. A** small crustacean that lives as a small forager, some species of these small crustaceans are rapacious. That is, they are like eagles that roam the sky looking for prey. So, the copepod hunts by searching the pond for prey, the same happens with the genus ***Acanthocyclops*****.** Collected at Malpaso pond. Calvillo, Ags.

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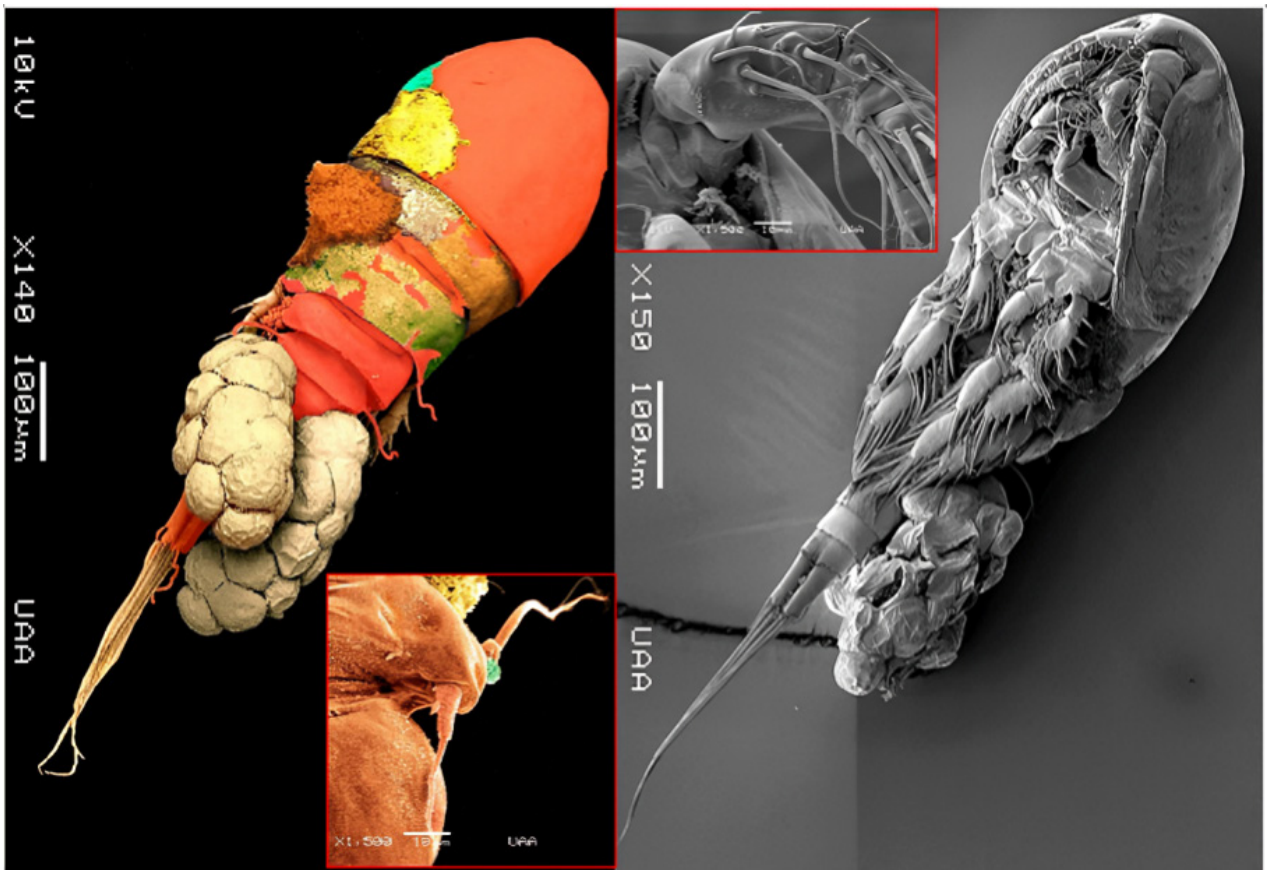

Figure 102: ***Microcyclops ceibanensis*****.** Small copepod, which lives by swimming and capturing its food. It is part of the food chain and is an integral part of the state's ponds. Left image, female in dorsal view showing two egg-sac. Bottom center image, the fifth leg of this species, which is a characteristic of this species. Right image, female in ventral view showing the legs and egg-sac. Top center image shows the close-up of the second antenna. Collected in pond at INIFAB Experimental Field. Pabellón de Arteaga, Ags.

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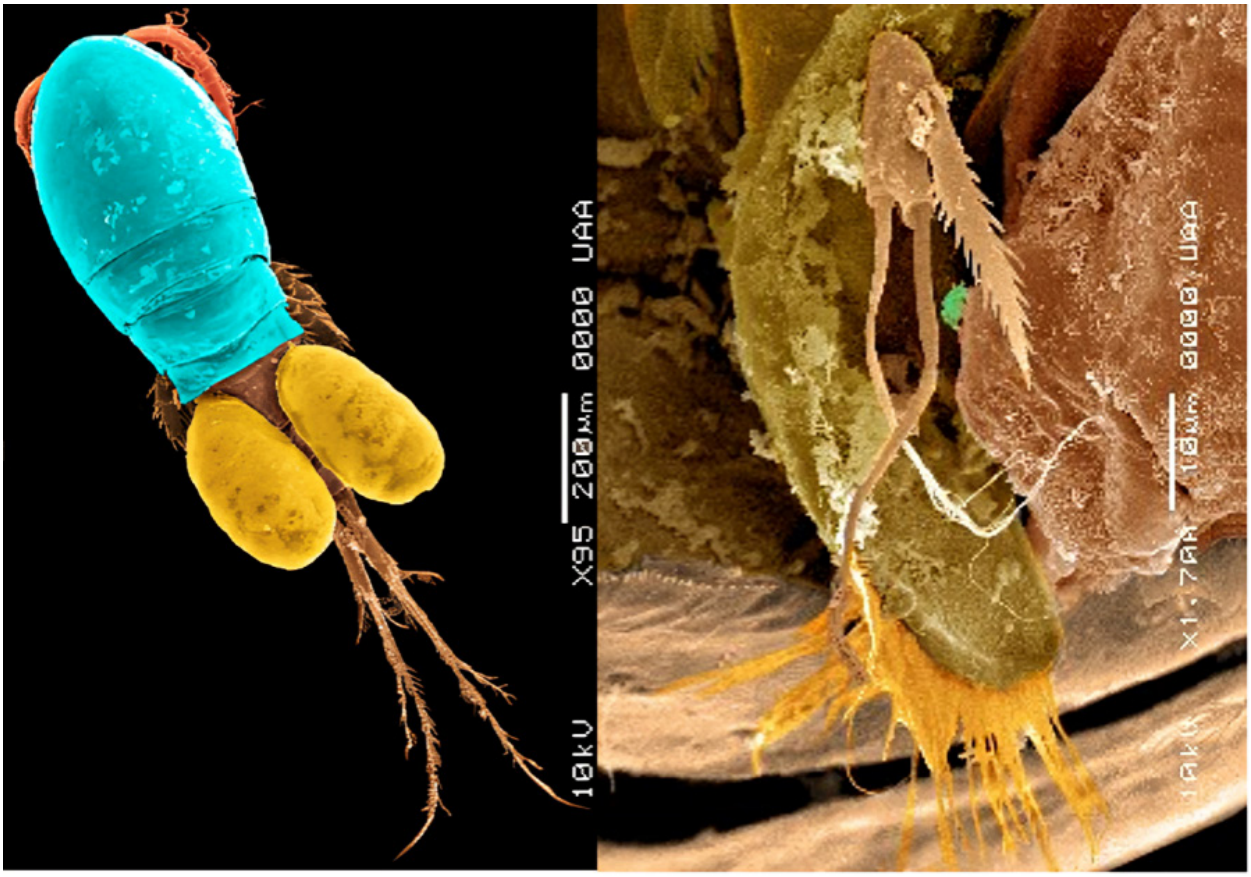

Figure 103: ***Eucyclops speratus*****.** Small copepod crustacean, which lives by swimming and capturing its food. Part of the food chain, it is an integral part of the state's ponds. Left image, female in dorsal view showing the egg sac. Right image, detail of the fifth pair of legs. Collected in a pond in the town of Túnel de Poterillos. Rincón de Romos, Ags. 24 September 2012.

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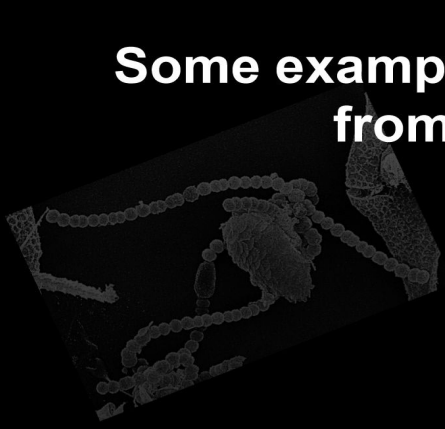
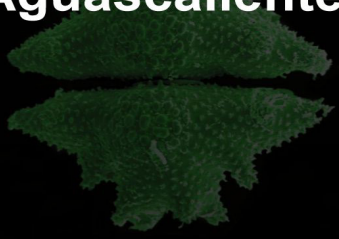
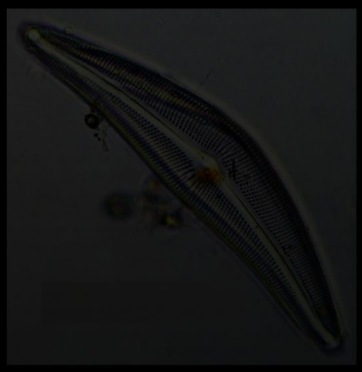
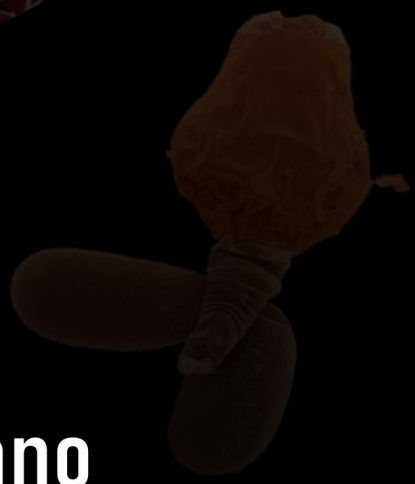
Some examples of Algae, Protists and Invertebrates from Aguascalientes State, México





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