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NOTA

FIRST RECORD OF FREE-LIVING CILIATES (ALVEOLATA) FROM CACALOTENANGO FALL, GUERRERO, MEXICO

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ABSTRACT

Eleven morphospecies belonging to seven different genera (*Coleps*, *Vorticella*, *Halteria*, *Spirostomum*, *Loxodes*, *Cyclidium,* and *Euplotes*) of free-living ciliates were recorded for the first time in Cacalotenango fall in Guerrero state, Mexico. *Coleps hirtus* and *Vorticella microstoma* were the most abundant species in the samples.

Keywords: Freshwater, Ciliophora, *Coleps, Vorticella*

RESUMEN

Primer registro de ciliados de vida libre (Alveolata) de la cascada de Cacalotenango, Guerrero, México. Once morfoespecies de ciliados de vida libre, pertenecientes a siete géneros diferentes (*Coleps*, *Vorticella*, *Halteria*, *Spirostomum*, *Loxodes*, *Cyclidium* y *Euplotes*) son registrados por primera vez en la cascada de Cacalotenango, Guerrero, México. *Coleps hirtus* y *Vorticella microstoma* fueron las especies más abundantes en las muestras.

Palabras clave: Dulceacuícola, Ciliophora, *Coleps, Vorticella*

The ciliated protozoa are a distinct group of protists characterized by the presence of cilia derived from kinetosomes with three fibrillar associates and nuclear dimorphism (Lynn, 2008). Freshwater ciliated inhabit various water bodies, both temporal and permanent, ponds, lakes, rivers, and streams; they can be free-living, planktonic, and benthic organisms (Anderson, 2010; Mayén-Estrada, Ramírez-Ballesteros, Méndez-Sánchez, Aristeo-Hernández and Durán-Ramírez, 2019).

The ciliate species distributed in Mexico ascended to 959 and the studies of free-living ciliates have been carried out in 28 of the 32 states of the country (Aladro-Lubel, Martínez-Murillo and Mayén-Estrada, 1990; Aladro-Lubel, Mayén-Estrada and Reyes-Santos, 2006; Mayén-Estrada, Reyes-Santos and Aguilar-Aguilar, 2014). However, the records per state have been minimum. No data about free-living ciliates from Cacalotenango fall has been published. This present work aimed to survey the diversity of the species of free-living ciliates from Cacalotenango fall Guerrero state, Mexico.

The samples were collected from Cacalotenango fall (18º 33' 35.22" N, 99º 39' 48.535" W) (Fig. 1) in April and August 2019, located near Taxco city, Guerrero, Mexico. We sampled at three sites: water column, sediments, and rocky site. A total of eight water samples were manually collected by using 200 ml plastic containers. Water samples were road transported (2 to 3 hrs) to the Laboratorio de Zoología Acuática, Facultad de Ciencias, Universidad Nacional Autónoma de México, and examine no more than 6 hours after collection. Ciliates were live observed with

Fig. 1. Map showing Guerrero state and Cacalotenango fall location.

Table 1. Ciliates species found in Cacalotenango fall, Guerrero, Mexico.

Family	Genera / species
Colepidae	
	Coleps hirtus (Müller 1786) Nitzsch 1827
	Coleps sp.
Cyclidiidae	
	Cyclidium glaucoma Müller
Euplotidae	
	Euplotes eurystomus (Wrzesniowski 1870) Kahl 1892
Halteriidae	
	Halteria sp.
Litonotidae	
	Litonotus fasciola Wresniowski 1870
Loxodidae	
	Loxodes sp.
Parameciidae	
	Paramecium caudatum Ehrenberg 1833
Spirostomidae	
	Spirostomum minus Roux 1901
Vorticellidae	
	Vorticella convallaria Linnaeus 1758
	Vorticella microstoma Ehrenberg 1830

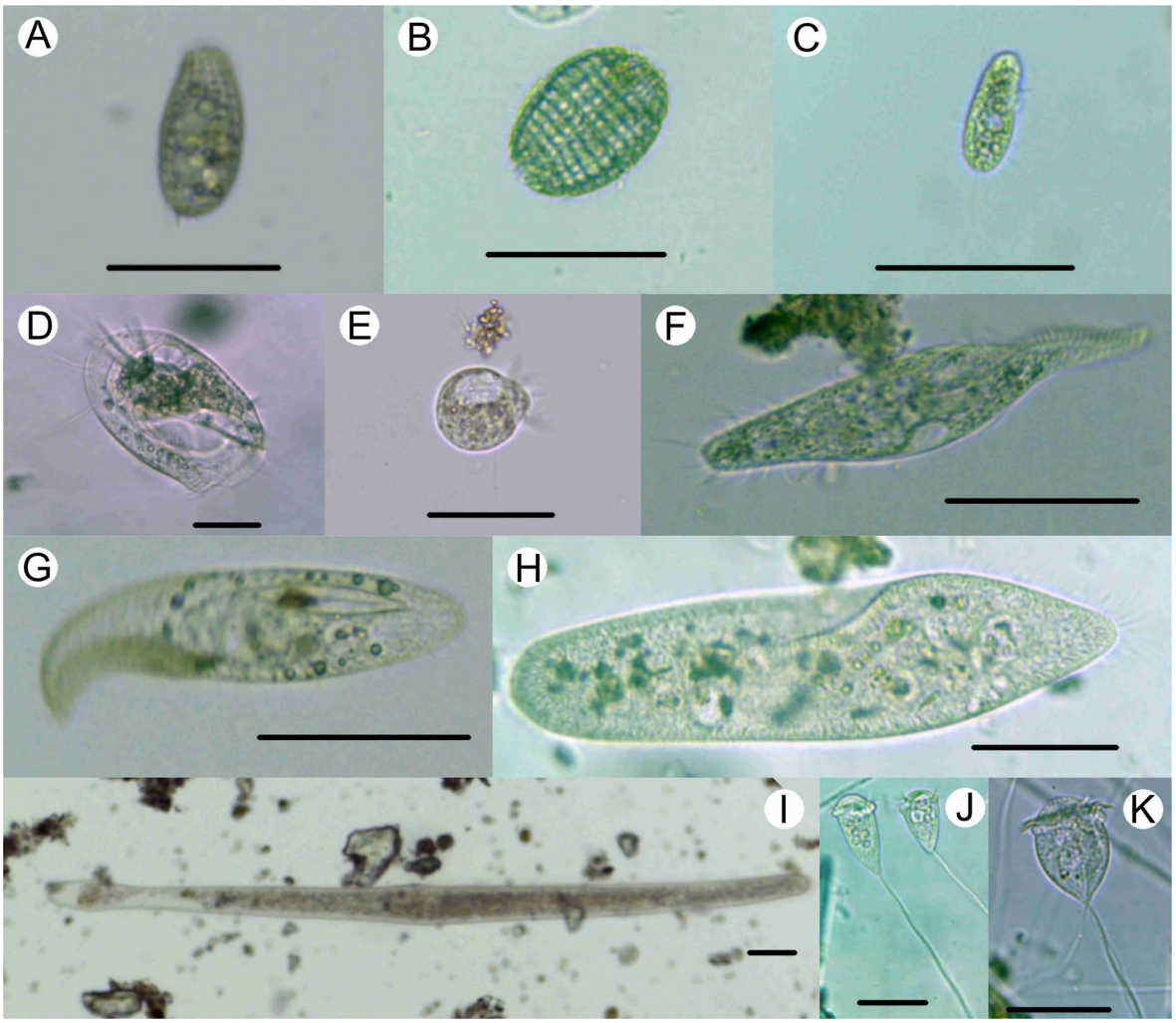

Fig. 2. Microphotographs *in vivo* of ciliates from Cacalotenango fall; scale bar 50 µm. **(A)** *Coleps hirtus*. **(B)** *Coleps* sp. **(C)** *Cyclidium glaucoma*. **(D)** *Euplotes eurystomus*. **(E)** *Halteria* sp. **(F)** *Litonotus fasciola*. **(G)** *Loxodes* sp. **(H)** *Paramecium caudatum*. **(I)** *Spirostomum minus*. **(J)** *Vorticella convallaria*. **(K)** *Vorticella microstoma*.

bright field (Leica DM500) and phase-contrast (Carl Zeiis) microscopy. Microphotographs and morphometric data were obtained using Leica DM500® photomicroscope equipment, with the Leica ICC50 HD® capture imaging system. Dry silver nitrate impregnation (Klein, 1958) and supravital staining techniques were used to reveal cytological structures (Foissner, 1991). For species identification, specialized literature was consulted (Berger and Thompson Jr, 1960; Madrazo-Garibay and López-Ochoterena, 1973; Katz *et al*., 2005; Luna-Pabello, 2006; Wang *et al*., 2019).

Since the transport conditions of the samples, there is a possibility that certain overly sensitive ciliate species have reduced their numbers, being undetectable for us. For the samples analyzed a total of 11 ciliate morphospecies were recorded from the three sites sampled from Cacalotenango fall (Fig. 2), the species belong to nine different genera (Table 1). Only three species out of the 11 were identified up to genera: *Loxodes, Halteria,* and one of the *Coleps* species, due to their uncommon presence in the samples and the lack of recorded morphometric data. Among all these morphospecies, the genera *Coleps* and *Vorticella* were the most diverse, two species of each genus were identified. Also, *Coleps hirtus* showed the highest abundance occurring in all the samples. All species have been previously recorded in other aquatic ecosystems in Mexico (López-Ochoterena and Rouré-Cané, 1970; Aladro-Lubel et al., 2006; Mayén-Estrada

et al., 2014).

This study contributes to the knowledge of microdiversity in Guerrero state, being the second one reporting free-living ciliates. Bulit and Díaz-Ávalos (2009) reported for the first time 32 morphospecies of planktonic ciliates in Chautengo lagoon, Guerrero. The morphospecies *Coleps* sp. and *Halteria* sp. were identified in both sites; Cacalotenango fall and Chautengo lagoon.

Three of the identified species: *Euplotes eurystomus*, *Paramecium caudatum,* and *C. hirtus* were found in all sampled sites, they have been considered as freshwater common species due to their capacity to tolerate changes in their habitats (Foissner, Berger, Blatterer and Kohmann, 1995; Foissner and Berger, 1996; Berger and Foissner, 2003).

The sediment sample had the major ciliate diversity, seven genera were found (*Coleps*, *Cyclidium*, *Euplotes*, *Halteria*, *Paramecium*, *Spirostomum,* and *Vorticella*). Four species occurred only in this sample, i.e. *Vorticella convallaria*, *Vorticella microstoma*, *Halteria* sp., and *Spirostomum minus.* Among these species, *V. microstoma* was the most abundant. The genus *Vorticella* is adapted to sessility, attaching to the organic matter in freshwater (Bushe, McCutcheon, Clamp and Sun, 2011; Lynn, 2016), characteristic of the site sampled. Some authors suggest that *Spirostomum* spp. and *P. caudatum* are sensitive to some heavy metals (Madoni, 2000; Lynn, 2008), a recent study detected concentrations of heavy metals in Cacalotenango river (Méndez-Ramírez and Armienta-Hernández, 2012). The sample was also composed of diatoms, microalgae, flagellates, testate amoebas, bacteria, and other protozoa serving as food source (Bick, 1972; Finlay and Fenchel, 1986; Finlay and Esteban, 1998; Simek, Jürgens, Nedoma, Comerma and Armengol, 2000).

All the identified organisms have a wide or cosmopolitan distribution, *C. hirtus, Cyclidium glaucoma, P. caudatum, S. minus,* and *V. microstoma* have been recorded in the five continents (Fokin, 2010; Boscaro *et al*., 2014; Fenchel, Finlay and Esteban, 2019), *E. eurystomus* and *V. convallaria* up to four continents (Foissner, Berger, Blatterer and Kohmann, 1991, 1992; Méndez-Sánchez et al., 2018). Ciliate diversity in many habitats is due to their high tolerance or adaptability to wide ranges of physical-chemical environmental conditions (Aladro-Lubel *et al.,* 1990).

The Cacalotenango fall provided the conditions for the colonization of 11 free-living ciliate morphospecies. Despite the multiple ciliate records found all over Mexico, there are still missing areas to be studied. It is necessary to develop more studies to stand out the importance of these organisms and Mexico diversity. In this sense, this study represents an additional piece of information contributing to the inventory of free-living ciliates in the region.

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