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RESEARCH NOTE

First record of the dinoflagellate *Oxytoxum caudatum* (Peridinales: Oxytoxaceae) in the Gulf of California

Primer registro del dinoflagelado *Oxytoxum caudatum* (Peridinales: Oxytoxaceae) en el Golfo de California

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Abstract. As part of a continuing microalgae monitoring program, phytoplankton samples were collected from 19 August 2014 to 25 February 2015 at a fixed sampling site in the southern part of the Bahía de La Paz, Mexico. The armored dinoflagellate *Oxytoxum caudatum* was observed mainly in net samples of phytoplankton. Study of live specimens did not show great variation in cell size or shape. Cells were 24-38 µm long and 12-16 µm wide (n= 30). This is the first record of *O. caudatum* in the Gulf of California.

Key words: Dinoflagellates, *Oxytoxum caudatum*, Bahía de La Paz, Gulf of California

INTRODUCTION

Dinoflagellates are one of the most important components in marine phytoplankton. These plankton are unicellular protists that exhibit great diversity of both shape and size. Roughly, half of the species in the group are photosynthetic (Gaines & Elbrächter 1987); the other half is exclusively heterotrophic. Dinoflagellates are described as armored or unarmored, according to the type of cell covering (theca or amphiesma), which always consists of several layers of membranes. The armored group has a number of cellulosic plates, and the unarmored group lacks plates (Vlamiš & Katibou 2014). About 605, principally free-living, dinoflagellate species and infraspecific taxa from 91 genera have been reported along the Pacific coast of Mexico (Okolodkov & Gárate-Lizárraga 2006). However, this list has expanded as new dinoflagellate records are published (Gárate-Lizárraga 2008, 2009, 2013, 2014; Gárate-Lizárraga *et al.* 2009, 2014; Esqueda-Lara & Hernández-Becerril 2010, Meave del Castillo *et al.* 2012, Maciel-Baltazar & Hernández-Becerril 2013). The leading genera are *Protoperidinium* (111 species), *Ceratium* (63) *Dinophysis* (41), *Gonyaulax* (25) and *Oxytoxum* (22). The most obvious characteristic feature of members of the latter is the position of the girdle, which normally divides the cell into a small epitheca and a larger hypotheca (Dodge & Sanders 1985). Cells of the genus *Oxytoxum* are characterized as elongated with pointed apices that are clavate to fusiform. This report describes the first record of *Oxytoxum caudatum* in the Gulf of California.

MATERIALS AND METHODS

As part of an ongoing toxic and noxious microalgae monitoring program, phytoplankton bottle samples were collected monthly at one fixed sampling station in the Bahía de La Paz (Station 1, 24°21'N, 110°31'W) from August 2014 through February 2015. The sampling station is located above the shallow basin at the southernmost end of the bay (see Gárate-Lizárraga 2014). Phytoplankton samples were collected in plastic flasks, fixed with Lugol's solution, and later preserved with 4% formalin. Surface and vertical tows at 15 m depth were made with a 20 µm mesh phytoplankton net. Sea surface temperature was measured with a bucket thermometer (Kahlsico International, El Cajon, CA, USA). Examination and identification of *O. caudatum* was done under a Carl Zeiss® phase-contrast microscope. An Olympus® CH2 compound microscope was used to measure the cells and a digital Konus® camera (8.1 MP) recorded the images.

RESULTS AND DISCUSSION

In this work 58 specimens of *O. caudatum* were identified and measured from 13 phytoplankton net samples. *O. caudatum* was not found in bottle samples, therefore, no quantitative data are shown. Temperatures recorded at the same time as the collections ranged from 22 to 31°C (Table 1).

Table 1. Sampling dates, specimens of *Oxytoxum caudata*, and temperature in 13 samplings from the southern Bahía de La Paz, August 2014 through February 2015 / Fecha de los muestreos, especímenes de *Oxytoxum caudata* y temperatura en 13 muestreos realizados al sur de la Bahía de La Paz, en agosto 2014 hasta febrero 2015

Sampling dates	Specimens of <i>O. caudata</i>	Temperature (°C)
19/08/2014	3	31.0
20/08/2014	4	31.0
29/09/2014	5	29.5
30/09/2014	7	29.5
22/10/2014	5	28.0
23/10/2014	4	27.5
19/11/2014	4	26.0
20/11/2014	5	26.0
16/12/2014	3	24.5
17/12/2014	5	24.0
15/01/2015	3	22.0
16/01/2015	5	22.0
25/02/2015	5	23.0

***OXYTOXUM CAUDATUM* SCHILLER, 1937 (Figs. 1A-F)**

Synonym (s): *O. nanum* Halldal, 1953, p. 56, fig. 20

References: Schiller, 1937, p. 454, fig. 504; Wood, 1963, p. 44, fig. 160; Dodge & Saunders, 1985, p. 113-114, figs. 31-34; Ochoa & Gómez, 1997, p. 56, fig. 2; Gómez *et al.*, 2008, p. 28, figs. 31-34.

Dimensions: Cells are 24-38 μm long (30.10 ± 4.23) and 12-16 μm wide (14.70 ± 1.21).

Brief description: Our specimens fit the description of *O. caudatum* in terms of cell shape and size (see references above). Cells have a sub-orbicular body with obtusely angled apex and subacute, slightly spined antapex. Cells have straight or slightly convex sides. Epithea is low and conical and looks like a small button-like structure, with small apical spine (Figs. 1A-F); hypotheca is wider than epithea, tapering to acute antapex. The contour of the hypotheca of *O. caudatum* is slightly shouldered. The theca is extremely fragile, has a smooth surface, and no plates have been seen, as yet (Dodge & Saunders 1985). Specimens of *O. caudatum* seem to have an elongated plate-shaped chloroplast (Figs. 1A-D). The nucleus is in the upper part of the hypocone (Figs. 1A-B).

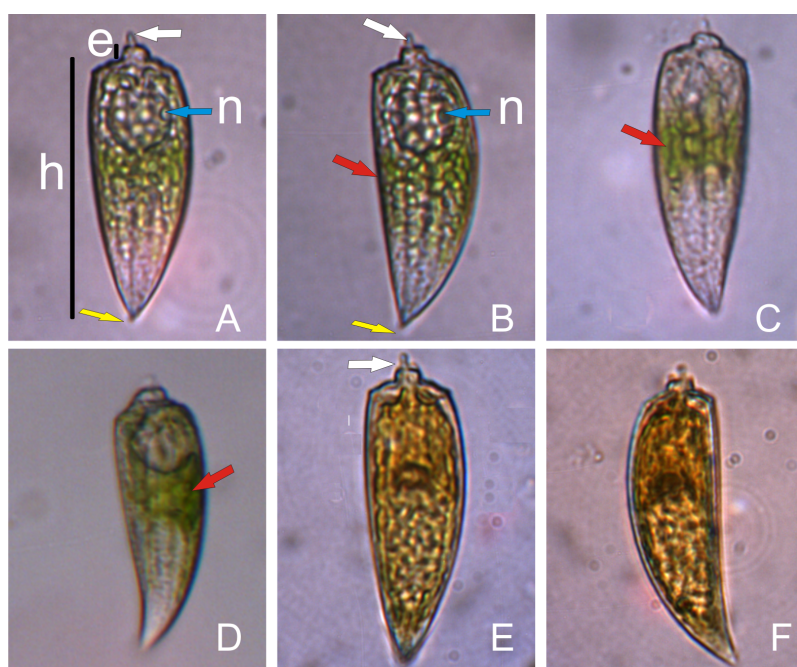


Figure 1. A-F) Light microphotographs of several specimens of *Oxytoxum caudatum* from the Bahía de La Paz. (A) Specimen of *O. caudatum* showing the epithea (e), the hypotheca (h) and the nucleus (n) is indicated with a blue arrow; White arrows indicate the apical spine (A, B and E); Yellow arrows indicate the antapical spine (A and B); Orange arrows indicate the chloroplast (B, C and D); Specimens in lateral view (D and F); Cells of *Oxytoxum caudatum* fixed in Lugol's solution (E and F) / A-F) Microfotografías de luz de algunos especímenes de *Oxytoxum caudatum* de Bahía de La Paz. (A) Especimen de *O. caudatum* mostrando la epiteca (e), la hipoteca (h) y el núcleo (n) es señalado con una flecha azul; Las flechas blancas indican la espina apical (A, B y E); Las flecha amarillas indican la espina antapical (A y B); Las flechas naranjas indican el cloroplasto (B, C y D); Especímenes en vista lateral (D y F); Células de *Oxytoxum caudatum* fijadas con solución de Lugol (E y F)

O. caudatum is closely related to *O. curvatum* (Kofoid) Kofoid 1911. Major differences between them are: Unlike the former, *O. curvatum* has a ventral side, markedly concave in lateral view (see Schiller 1937, Gómez *et al.* 2008) and without a central pimple at the apex, characteristic of *O. caudatum* (see Dodge & Saunders, 1985: p. 112); the small apical spine is clearly visible in our specimens and absent in *O. curvatum*. No antapical spine is reported in the original description of *O. curvatum* (Kofoid 1907, Kofoid & Michener 1911). The nucleus is located in the upper part of the hypocone of *O. caudatum* and in the lower part of the hypocone in *O. curvatum*. All of these morphological differences between these species led us to identify our specimens as *O. caudatum*.

Regional distribution: Recorded twice along the Pacific coast of Mexico; first at El Faro, Michoacán (Okolodkov & Gárate-Lizárraga 2006), and recently in Bahía de Acapulco (Meave del Castillo *et al.* 2012). The distribution of *O. caudatum* is now extended with this finding in the Gulf of California. Records of this species occur only in coastal waters from the Pacific coast of Mexico. *O. curvatum* was reported once in Puerto el Sauzal in the northern part of Baja California (Hernández-Becerril 1986), but not in the Gulf of California.

General distribution: This species has been recorded in the Adriatic Sea (Schiller 1937), in Galway Bay (Ireland) (Dodge & Saunders 1985), the Mediterranean Sea (Vilièra *et al.* 2002, Gómez 2003), the Caribbean Sea (Wood 1968), the Gulf of Mexico (Licea *et al.* 2004), along the Eastern Tropical coast of Australia (Wood 1963), the Japan Sea (Konovalova 2000), in the North Pacific Gyre (Venrick 1982), equatorial southeast Pacific (Iriarte & Fryxell 1995, Liu *et al.* 1996, Ochoa & Gómez 1997), and in the open southeastern Pacific Ocean (Gómez *et al.* 2008). Okolodkov *et al.* (2007) consider *O. caudatum* as non-indigenous plankton along the Mexican coast or an introduced species for other areas. The presence of this species in Bahía de La Paz supports this hypothesis because phytoplankton studies have been performed since the late 1970s and was not previously recorded (Gilmartin & Revelante 1978, Signoret & Santoyo 1980). The presence of *O. caudatum* for seven months indicates that hydrographic conditions in the Bahía de La Paz were favorable for this species.

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