

Gynogonadinium aequatoriale gen. et sp. nov., a New Dinoflagellate from the Open Western Equatorial Pacific

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A new genus and species of marine dinoflagellate from the open western equatorial Pacific Ocean, *Gynogonadinium aequatoriale* gen. et nov. sp., is described from light and scanning electron micrographs. This laterally compressed unarmoured taxon had a triangular cell body in lateral view with two different elongate extensions. The end of the apical extension was spherical with a groove that arises from the epicone in the ventral side of the cell. The antapical extension was longer. The dorsal part of the cingulum showed undulated lists in each margin. The nucleus was ellipsoidal and perpendicularly crossed the cingulum. Dimensions of cells were 90-110 μm long and 43-55 μm wide in lateral view at the level of the cingulum. *Gynogonadinium* is placed in the order Gymnodiniales, family uncertain.

Key Words: apical groove, Dinophyceae, equatorial Pacific Ocean, *Gynogonadinium aequatoriale*, taxonomy

INTRODUCTION

Taxonomic studies of unarmoured dinoflagellates from open waters of tropical oceans are few in number. The Western Pacific Warm Pool (western equatorial Pacific Ocean) is a poorly studied region of the world's oceans for phytoplankton taxonomy. From samples collected in that region under influence of the phenomenon of El Niño in 2003, several specimens of a distinctive unarmoured dinoflagellate, which could not be ascribed to any known genus, were found. Despite the scarce specimens available and delicacy, by using the Takayama's method (Takayama 1985) was successfully obtained SEM pictures. This dinoflagellate with a distinctive shape and unique morphological characters is here described.

MATERIALS AND METHODS

A cruise was carried out on board *R/V Mirai* (15-28 January 2003) along the Equator from 160°E to 160°W. Samples were collected from 9 stations at 14 depths between 0 and 200 m depth. Samples were collected using Niskin bottles, preserved with acidified Lugol's

solution and stored at 5°C. Subsamples (400 mL) were allowed to settle in glass sedimentation cylinders. The top 350 mL of each sample was siphoned off progressively over 5 days using a length of small-bore tubing. The remaining 50 mL was settled in composite sedimentation chambers. Light microscopy observations were made as described in Gómez *et al.* (2004). For scanning electron microscopy (SEM), specimens were isolated with a capillary from sedimentation chambers and adhered to poly-L-lysine-coated cover-slip. Fixed cells attached to the cover-slip were rinsed twice in distilled water for 5 min each. Cells were then dehydrated through an ethanol series, dried in a critical point drier (HCP-2, Hitachi, Tokyo, Japan), and coated with Au-Pd (Takayama 1985). Observations were made using a SEM (S-800, Hitachi, Tokyo, Japan).

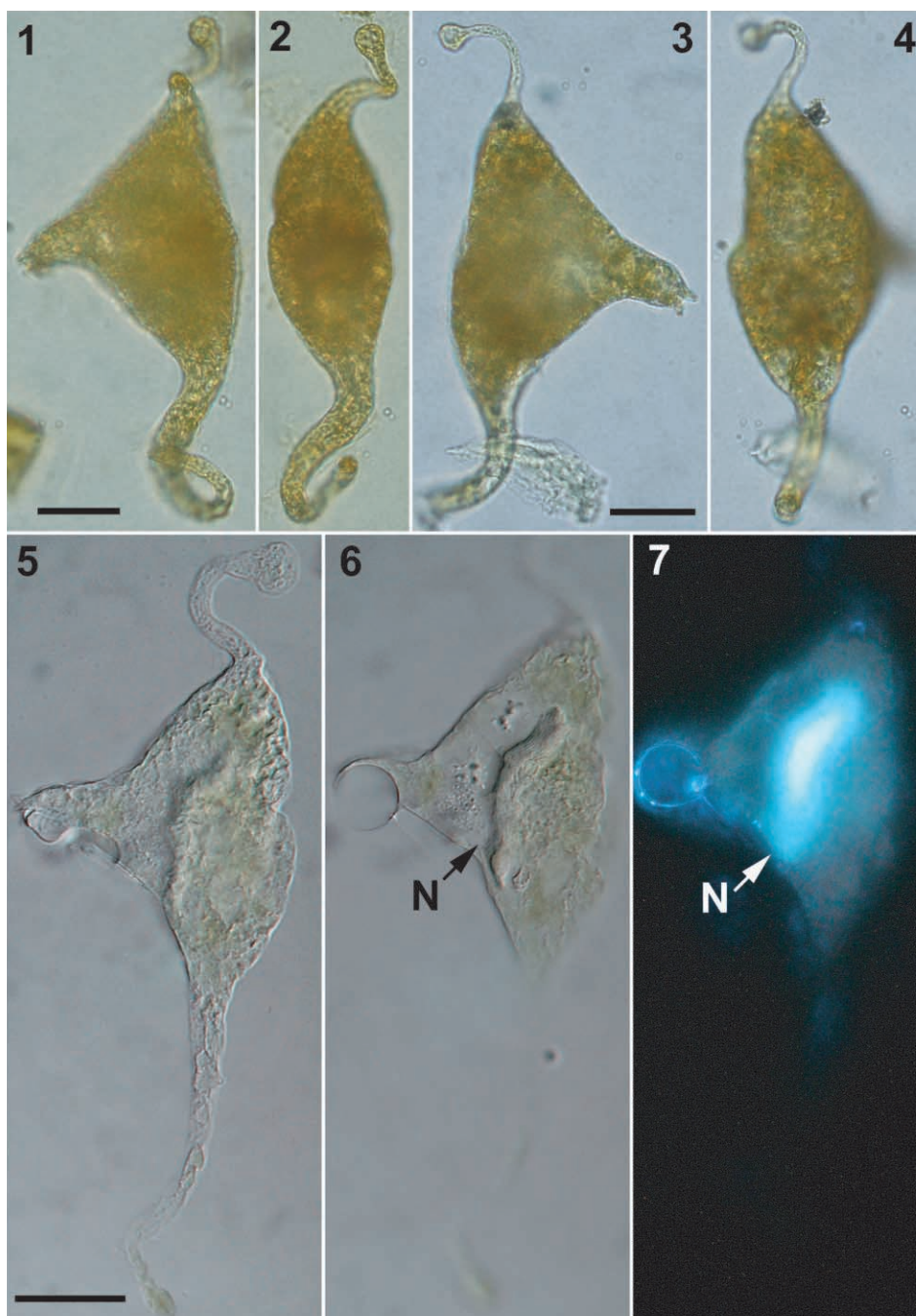
RESULTS AND DISCUSSION

Gynogonadinium aequatoriale gen. et sp. nov.

Figs 1-15

Diagnosis: *Cellulae lateriter compressae cum corpore cellulae perdepreste anguste triangulare, diviso a cingulo mediano. Sulcus locatus in latus longissimum corporis cellulae. Duo extensiones curvatae elongatae orientes e extremis regionis ventralis. Extensio apicalis extensione anteapicali brevior. Extremum extensionis apicalis sphaericum et circumcinctum*

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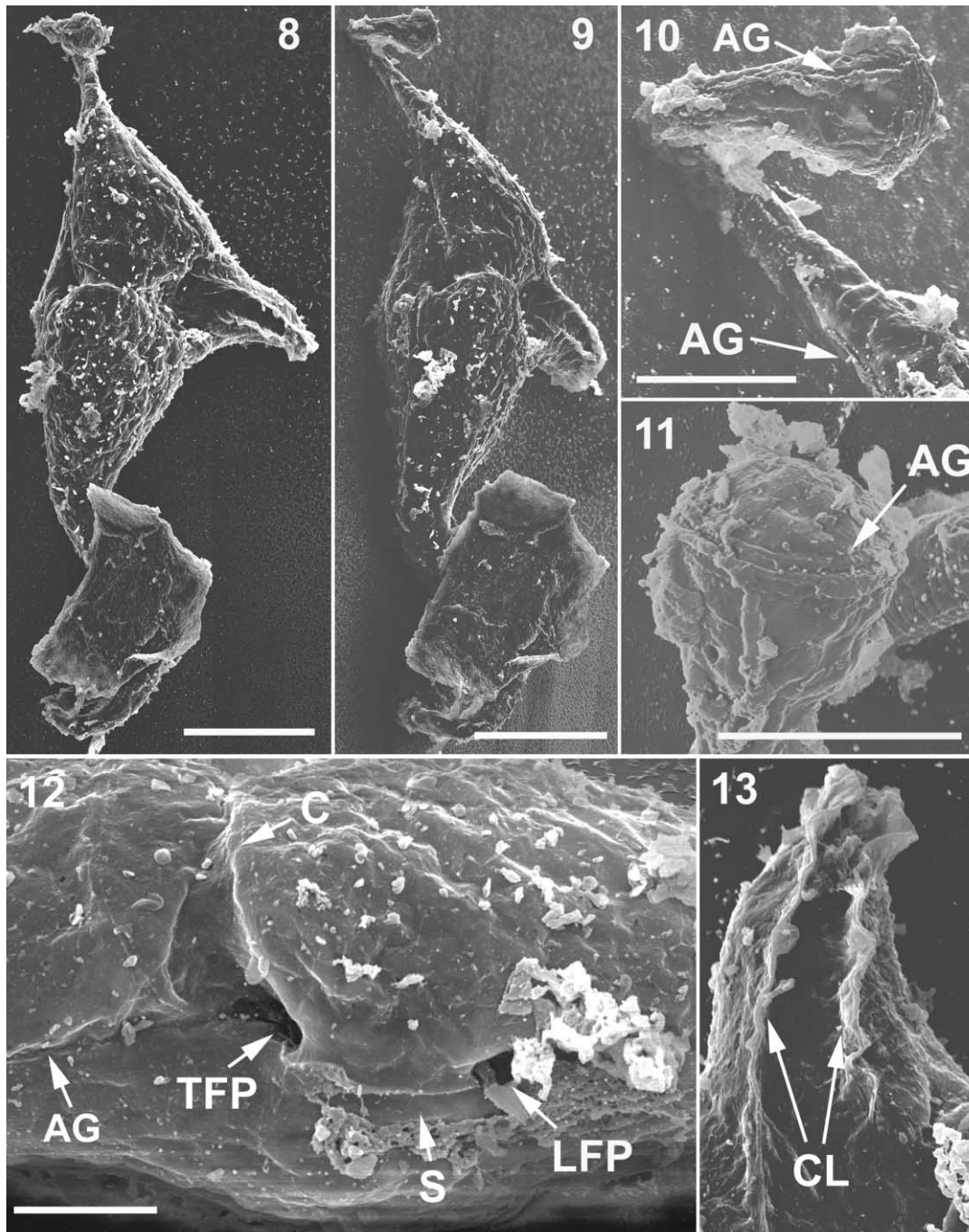


Figs 1-7. Photomicrographs of *Gynogonadinium aequatoriale*, bright-field optics. **Figs 1-2.** Right lateral and ventral view of one specimen (also Figs 8-13). **Figs 3-4.** Another specimen in left lateral and ventral view. **Figs 5-6.** Nomarski differential interference contrast (DIC) micrographs of another specimen (see nucleus in Fig. 6). **Fig. 7.** Epifluorescence photomicrograph of the same specimen stained with DAPI (4,6-diamidino-2-phenylindole) showing the nucleus glowing brightly under UV excitation. N = nucleus. Scale bars: 20 μm .

ab canalicule. Pars dorsalis cinguli cum lateribus cristatis in utramque marginem. Nucleus ellipsoideus, curvatus et perpendicularis ad cingulum. Cellulae 90-110 μm longae et 43-55 μm latae prope cingulum.

Cells are laterally compressed with a depressed triangular cell body divided by a median cingulum. The sulcus was located in the longer side of the cell body. Two

curved elongate extensions arose from the extremes of the ventral region. The apical extension was shorter than the antapical one. The end of the apical extension was spherical and surrounded by a groove. The dorsal part of the cingulum showed undulated lists in each margin. The nucleus was ellipsoidal, curved and perpendicularly crossed the cingulum. Cells are 90-110 μm in length and



Figs 8-13. *Gynogonadinium aequatoriale*, scanning electron micrographs (also Figs 1-2). **Figs 8-9.** Left lateral and ventro-left lateral view, respectively. **Figs 10-11.** Detail of the apical extension. The arrows indicate the apical groove. **Fig. 12.** Detail of the cingulum-sulcus area. See the flagellar pores. **Fig. 13.** Detail of the cingulum in the dorsal part of the cell. AG = apical groove; C = cingulum; CL = cingular list; LFP = longitudinal flagellum pore; S = sulcus; TFP = transverse flagellum pore. Figs 8-9, Scale bars: 20 μ m. Figs 10-12, Scale bars: 5 μ m.

43-55 μ m in width at the level of the cingulum.

Holotype: Fig. 8 collected by F. Gómez.

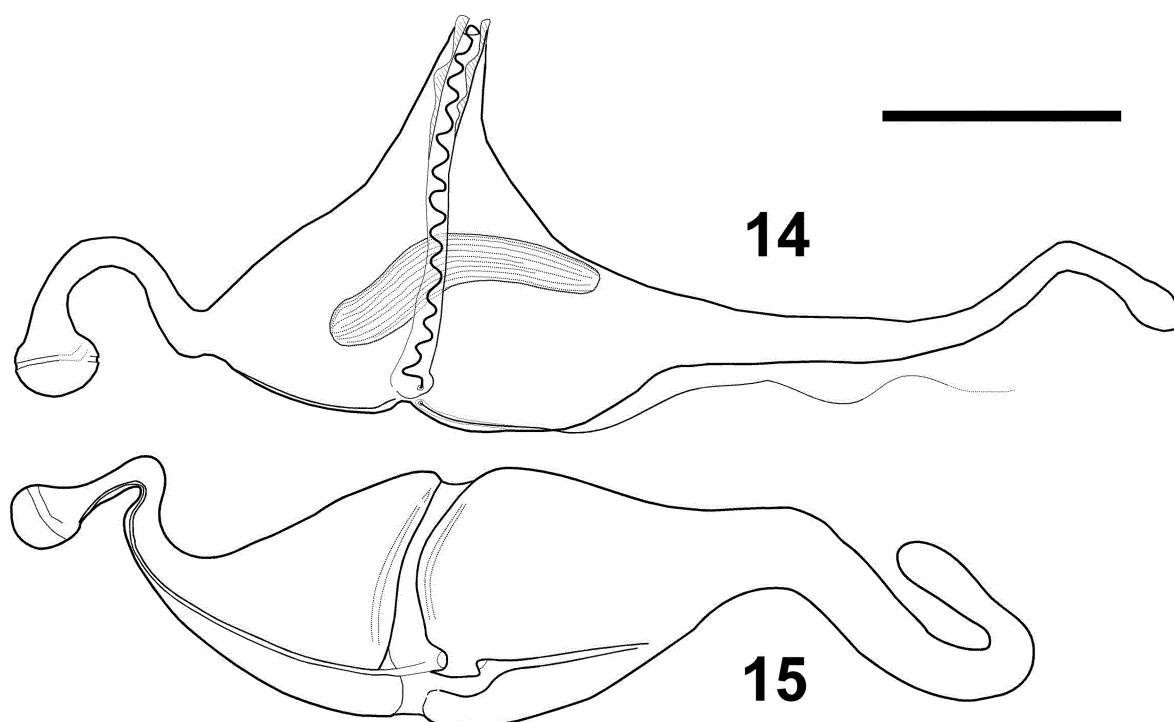
Isotype: Figs 3-7.

Type locality: Western equatorial Pacific Ocean (0°, 160°E), 15 m depth.

Etymology: *Gyn-*, *Gyno-* (from Greek: female, woman);

Gonad-, *Gonado-* (from Latin: ovary or testis based on Greek: *gonos*: "seed"): referring the contour of the cell that resembles the female gonad. *Aequator* (from Latin: equator): referring to the type locality.

Morphology: Based on light microscopy, the outline of the cell body in lateral view was triangular with two



Figs 14-15. *Gynogonadinium aequatoriale*, line drawings. **Fig. 14.** Left lateral and **Fig. 15.** ventral view, respectively. Scale bars: 20 μm .

elongate extensions. The median cingulum was slightly deflected antapically on the dorsal side. The outline of the cell resembled the female gonad (Figs 1, 3). One flexible, elongated apical extension arose from the ventral side of the cell body. The end of the apical extension was spherical with $\sim 5 \mu\text{m}$ in diameter (Figs 1-4). The antapical extension, also arising from the ventral side of the cell body, was longer than the apical extension. The ending of the antapical extension was roughly spatulate in shape (Fig. 5). The nucleus was visible under differential interference contrast optics (Fig. 6) and, when stained with DAPI (4,6-diamidino-2-phenylindole), glowed brightly under UV excitation (Fig. 7). In lateral view, the nucleus had an elongate ellipsoidal shape, perpendicularly crossing the median cingulum. The part of the nucleus located in the epicone was curved towards the ventral side (Figs 5-7). The brownish pigmentation suggested the presence of peridinine. No chloroplasts were observed. Unfortunately from Lugol-preserved specimens cannot be tested the presence of the chlorophyll-*a* by epifluorescence microscopy.

One of the specimens was successfully prepared for SEM (Figs 8-13). SEM allowed observing the sulcus, two flagellar pores (Fig. 12) and a groove from the epicone to the extreme of the apical extension (Figs 10, 11). The groove surrounded the spherical-shaped end of the apical extension (Fig. 11). The margins of the cingulum in

the dorsal side showed undulated lists, anterior and posterior (Fig. 13). The specimens ranged from 90-110 μm long and 43-55 μm wide at the cingulum level (Table 1).

Habitat: Seven specimens were collected from five consecutive sampling stations along 2,200 km in the equator from 160°E to 180° between 15 and 110 m depth. This study was a part of twelve cruises carried out in the open Pacific between 41°N and 34°S. The records of *Gynogonadinium aequatoriale* were restricted to the westernmost edge of the Equatorial Pacific Ocean (Table 1).

Species comparison: *Gynogonadinium* is laterally compressed taxon and consequently the ventral side is difficult to observe under light microscopy. If the ventral position is forced (Figs 2, 4), the outline of this taxon could resemble *Gyrodinium falcatum* Kofoed *et* Swezy (= *Pselodinium vaubanii* Sournia) (Kofoed 1931; Konovalova 2003). However, *Gynogonadinium* has a cell body of triangular contour in lateral view (Figs 14-15) whereas *Gyrodinium falcatum* has an ellipsoidal shape in both lateral and dorso-ventral views. Other distinctive morphological characters such as the undulated cingular lists and the extensions are unique in *Gynogonadinium*. The cingular lists have been described in armoured dinoflagellates (Almazán-Becerril and Hernández-Becerril 2002; Vershinin and Morton 2005), but rarely in unarmoured dinoflagellates. Balech (1976, p. 11) illustrated cingular lists in *Gymnodinium cf. diploconus* Schütt. The apical

Table 1. *Gynogonadinium aequatoriale*: stations, depth, geographic coordinates (latitude, longitude), date and dimensions: W, width at the level of the cingulum in lateral view; L, total length of each record

Station	Depth (m)	Latitude	Longitude	Date	W (μm)	L (μm)	Figures
6	-15	0°	160°E	15 Jan 2003	48	110	1-2, 8-13
6	-30	0°	160°E	15 Jan 2003	45	95	5-7
7	-30	0°	165°E	17 Jan 2003	52	105	-
8	-110	0°	170°E	18 Jan 2003	43	90	-
9	-15	0°	175°E	20 Jan 2003	55	110	-
9	-40	0°	175°E	20 Jan 2003	53	110	3-4
10	-40	0°	180°	21 Jan 2003	50	105	-

groove as found in *Gynogonadinium* is a morphological character of some gymnodiniaceans (Takayama 1985). I hesitate to assign this species to any currently known family, and until further research, *Gynogonadinium* is placed in the order Gymnodiniales, family uncertain.

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