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The Thecal Structure of a Marine Toxic Dinoflagellate *Gambierdiscus toxicus* gen. et sp. nov. Collected in a Ciguatera-endemic Area

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Gambierdiscus toxicus gen. et sp. nov. is described. This is a toxin producing dinoflagellate which was collected in a ciguatera-endemic area. Observations were made using both a light microscope with or without phase-contrast and a scanning electron microscope. This species is distinctive in its antero-posterior compressed body shape, with a circular narrow deep cingulum and a deep hollow sulcus. The theca consists of 33 plates: Po, 3′, 0a, 7″, 6c, 8s, 6‴, 1p, 1⁗. The plate pattern of this species is characteristic in having extremely reduced precingulars 1″ and 7″, which are situated between apical 1′ and the sulcal excavation and are clearly separate from apical 2″ and 4‴. These features and others indicate that this genus should be assigned to the Heteraulacaceae family. This species is always sessile and attaches to dead coral and seaweed, especially brown alga, *Turbinaria ornata* J. AGARDH. A large number of this species were taken around the Gambier Islands, French Polynesia, in May 1975.

Gambierdiscus toxicus gen. et sp. nov., which is a toxin producing dinoflagellate collected in a ciguatera-endemic area, is described. This species is distinctive in its antero-posteriorly compressed body with a circular narrow deep cingulum and a hollow deep sulcus. The plate pattern of the species is characteristic in having extremely reduced precingulars 1″ and 7″, which are situated between apical 1′ and sulcal excavation and are clearly apart from apical 2″ and 4‴. These features and others indicate that it is most suitable to assign this genus to the Heteraulacaceae family.

This paper deals with the thecal structure of a marine toxic dinoflagellate *Gambierdiscus toxicus* gen. et sp. nov., which was previously allocated in *Diplopsalis*[1]. This species is found around the Tahiti Islands and the Gambier Islands where ciguatera disease often occurs. YASUMOTO *et al.*[1] pointed out that this species was likely to be the causative organism of ciguatera.

Materials and Methods

Gambierdiscus toxicus gen. et sp. nov. used in this study was provided by Dr. YASUMOTO of Tohoku University. Two types of sample were studied. One was a fixed material collected around the Gambier Islands in May 1975, and the other was a living material separated around the same islands and cultured at his laboratory. Observation was made both by a light microscope with or without phase-contrast and by the scanning electron microscope JEOL JSM35 of the Ocean Research Institute, Tokyo University.

Gambierdiscus gen. nov.

Division PYRROPHYTA PASCHER 1914
Class DINOPHYCEAE FRITSCH 1929
Order PERIDINIALES HAECKEL 1894
Family HETERAULACACEAE LOEBLICH Jr. & DRUGG 1968

Diagnosis

The cell is flattened dorso-ventrally. The theca consists of 33 plates; Po, 3′, oa, 7″, 6c, 8s, 6‴, 1p, 1⁗. Plate 1″ and 7″ are much reduced in size and situated between the sulcus and apical 1′. They do not contact with apical 2′ and 4′. The sulcal posterior plate and the posterior intercalary plate are symmetrical about the dorso-ventral axis. Most parts of the sulcus are deeply concaved and contracted like a hollow.

Planta unicellularis, lenticularis, flagella duo. Theca ex 33 laminis composita: Po, 3′, 0a, 7″, 6c, 8s, 6‴, 1p, 1⁗. Laminae 1″ et 7″ magnitudine inferiores inter sulcum et apicem 1′ residentes. Laminae sulci posteriores et posterioriintercalares magnitudine fere aequales, circum axem dorso-ventralem utrimque symmetrique. Magna pars sulci profunde concava, instar cavernae.

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Discussion

As for major thecal plates, *Gambierdiscus* has no difference with *Heteraulacus* in the number of plates and in their arrangement.[3] However, the shape and size of the ventral plates of epi- and hypothecae show distinctive features of each genus. In *Gambierdiscus* apical 1′ is or ortho-shaped, and precingular 1″ and 7″ are so reduced that they are likely to be overlooked. Two ventral plates of hypotheca, sulcal posterior and posterior intercalary, are smaller in *Gambierdiscus* than in *Heteraulacus*. Until recently these two plates are interpreted as antapical plate 1‴ and 3‴, but they are obviously homologous with sulcal posterior and posterior intercalary of *Gonyaulax* and some related genus.[3,4]

Type species

***Gambierdiscus toxicus* sp. nov.**

Synonym: *Diplopsalis* sp. (YASUMOTO *et al.* 1977)

Diagnosis

The cell is a di-flagella organism and consists of lense-like uni-cell, range of length being 24–60 μm, range of transdiameter 42–140 μm. Theca consists of 33 plates; Po, 3′, 0a, 7″, 6c, 8s, 6‴, 1p, 1⁗. The apical platelet has a fishhook-shaped pore, and all thecal plates are firm and randomly porulated. Plate 1″ and 7″ are much reduced in size and situated between the sulcus and apical 1′. They do not contact with apical 2′ and 4′. The sulcal posterior plate and the posterior intercalary plate are nearly equal in size and symmetrical about the dorso-ventral axis. Cingulum is narrow and deeply excavated. Most parts of sulcus are deeply concaved and contracted like a hollow.

Planta unicellularis, lenticularis, flagella duo, 42–140 μm longa, 24–60 μm lata. Theca ex 33 laminis composita: Po, 3′, 0a, 7″, 6c, 8s, 6‴, 1p, 1⁗. Lamina apicalis ornata foraminibus parvis, his sunt similia foramina hami piscatorii. Omnes raminae thecales firmae, libidinose dispersae. Laminae 1″ et 7″ magnitudine inferiores inter sulcum et apicem 1′ residentes. Sulcus atque apex 1′ ab apicibus 2′ et 4′ separati. Laminae sulci posteriores et posteriori-intercalares magnitudine fere aequales, circum axem dorso-ventralem utrimque symmetriquae. Cingulum angustum profunde excavatum. Magna pars sulci profunde concave, instar cavernae, solum spatium minutam occupans.

Description

The body is large in width, and lenticular without any apical horn and without any antapical spine. The length is from a half to one third of the transdiameter. The epitheca and the hypotheca are beret-shaped and nearly equal in altitude. The narrow, deep and slightly ascending cingulum is bordered by a low thickened ridge, which is made of the folding of plates of pre- and postcingulars. The sulcus is very short and most parts except posterior plate are deeply concaved like a hollow.

The epitheca consists of eleven plates; Po, 3′, 7″. The apical pore platelet Po is oval to ellipsoidal with a characteristic fishhook-shaped pore, the opening of which is always orientated ventrally. The first apical 1′ is ortho-shaped. The apical 2′ is the largest of the three and looks subrectangular because the sutures with the other apicals are in a straight line.

Among the seven precingulars, plate 1″ and 7″ are remarkably constricted and situated between apical 1′ and sulcal excavation. On the 7″ the ridge extending from the cingular margin of precingulars curves forward in right angle and runs in parallel with the suture with 1″. In the same way the ridge of precingular 2″ curves along the suture

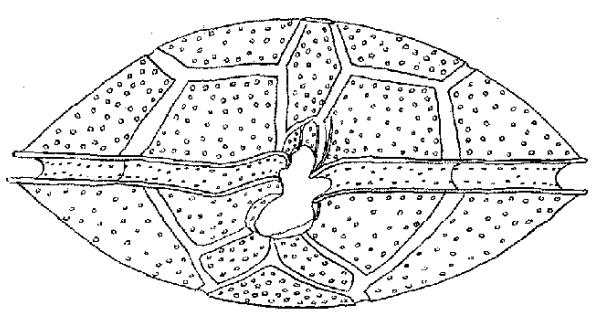

Fig. 1. Ventral view of *Gambierdiscus toxicus* gen. et sp. nov.

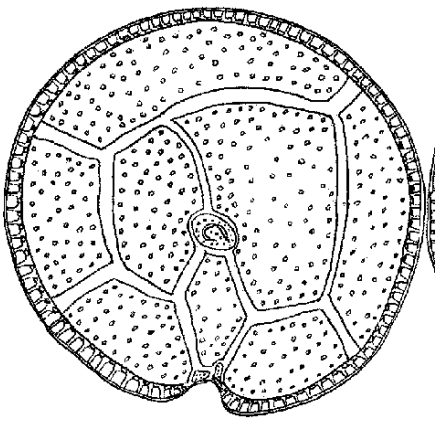

Fig. 2. Plate pattern of epitheca.

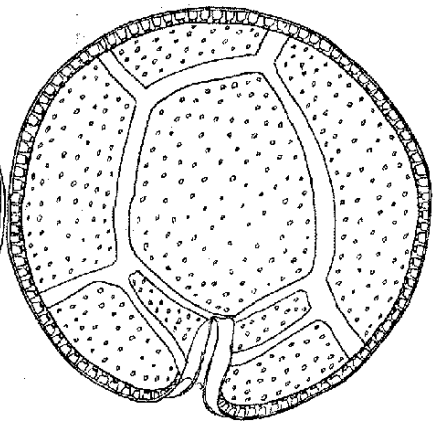

Fig. 3. Plate pattern of hypotheca.

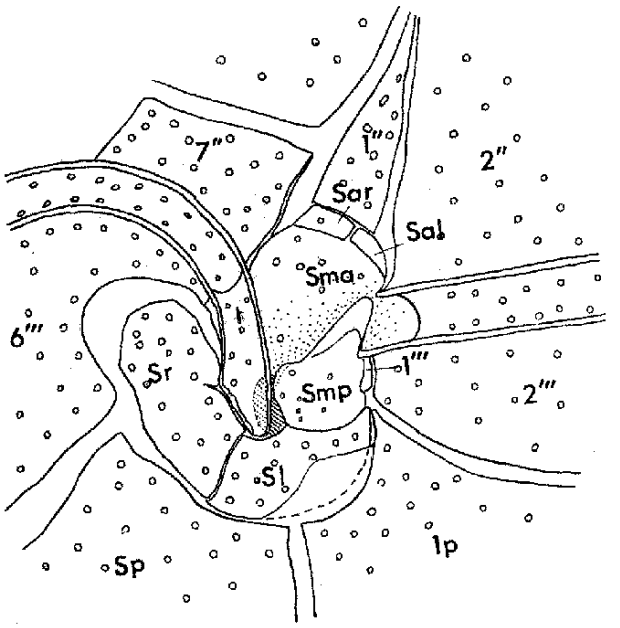

Fig. 4. Ventral view of sulcal plate pattern.

with 1''. Therefore, the lower half of the right margin of 2'' looks thickened and the 1'' is surrounded with two ridges. The side 3'' and the dorsal 4'' are two times as large as the ventral 2'', 6'' and the side 5''.

In the hypotheca, the postcingular 2''' is triangular and its right corner extrudes, curves inside, and contacts with the postcingular 1''''. This 1'''' is minute rectangular plate and situated in the sulcal left wall. The 3''', 4''', 5''' plates are large, nearly equally high and the 5''' is the widest. The left half of the lower margin of the distal postcingular 6''' winds inside so that its lower-left corner is pointed like a beak.

The posterior intercalary plate is rhomboidal to pentagonal elongated. Along the sulcal margin, a ridge, which is continued from the wind of postcingular 6''' and sulcal posterior plate, overhangs the sulcus.

The large pentagonal antapical plate 1'''', which elongates dorso-ventrally, occupies the lowest antapex.

The cingular wall consists of six plates. The borderline of each cingular plate is contaminous with the corresponding precingular plate.

The sulcus is composed of eight plates; anterior (S.a.r., S.a.l.), right (S.r.), left (S.l.), transitional (t.), posterior (S.p.), and median (S.m.a., S.m.p.). As most of these plates are extremely minute, it is very difficult to distinguish without dissection or scanning electron microscope. The S.p. plate is relatively large, five sided and most parts are out of the sulcal hollow. It develops to the right along the postcingular 6′′′. The wedge-shaped S.r. plate, which fits to the concave of the 6′′′, constitutes the right posterior wall of the sulcus. The upper half of the S.r. plate is ridged in the same manner of postcingulars. The transitional plate is boat-shaped, located at the extension of the cingulum and enters deeply into the sulcus. The left posterior wall of the sulcus is occupied by S.l. plate, which is located between the S.m.p. plate and posterior intercalary plate. The S.m.p. plate consists the sulcal left wall with adjoining posticingulum 1′′′ and its anterior margin ridges like that of postcingulars. The round S.m.a. plate is located at the bottom and its anterior margin contacts with the two minute S.a. plate (S.a.r., S.a.l.). They are subrectangular and situate between the precingular 1′′ and the S.m.a. plate.

The thecal plates are very thick, possess numerous dense pores which cave in deeply. On the hidden side of the theca, numerous hollows, the top of which carries some minute pores like a sieve are found. The suture line is winding, and along one side of it a flat zone without any pore develops. This species has neither ventral pore nor posterior attachment pore.

The cell contents are dense with numerous irregular-shaped chromatophores and oil granules. The color varies from light greenish-yellow to yellowish-brown. The nucleus is a V-shaped and

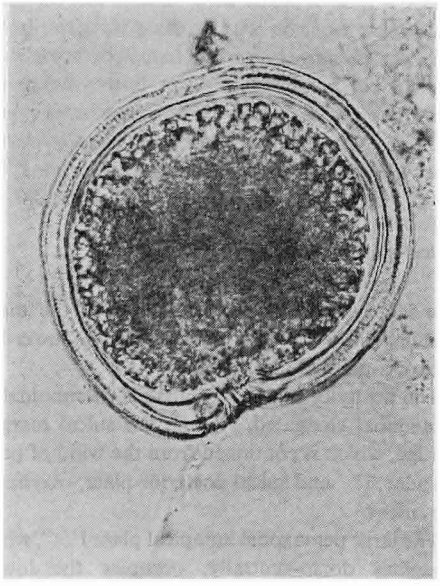

Fig. 5. Living cell.

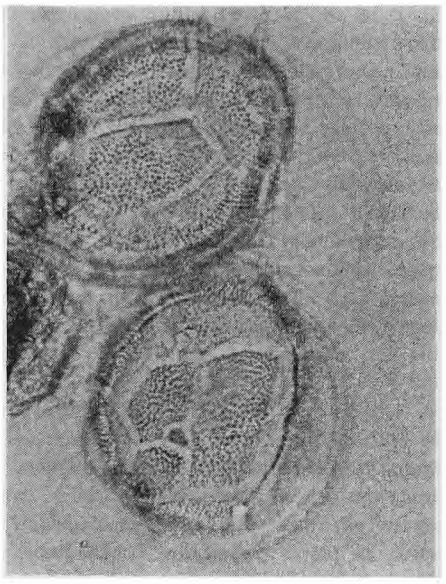

Fig. 6. Theca (phase contrast).

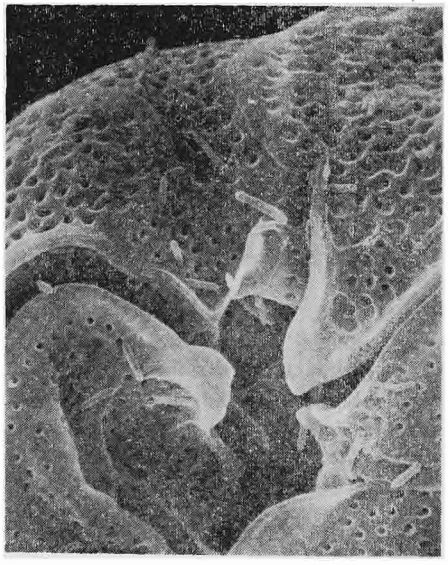

Fig. 7. Ventral view of sulcal plates (scanning electron microscope).

usually its open end orientated ventrally.

The dimensions of this species vary very greatly. The mean length is 44 μm (range 24–60 μm), the mean transdiameter is 92 μm (range 42–140 μm), and the dorsoventral diameter is 100 μm (45–150 μm). The width of the cingulum is approximately 5 μm.

Distribution

This species is collected from surface of seaweeds, especially brown alga, *Turbinaria ornata* J. AGARDH. (T. YASUMOTO personal communication). He collected at Gambier Islands, French Polynesia, in May 1975.

Discussion

This species is easily distinguished from all others of Heteraulacaceae and Gonyaulacaceae by its antero-posteriorly flattened body shape, and by its circular narrow deep cingulum and its deep hollow-like sulcus.

A fixed material collected around the Gambier Islands and a living cultured one are the same in their thecal structure, but show a slight difference in shape. The cultured cell is larger in length so that it looks more rounded in ventral view. Variations in number of thecal plates, namely four apicals or eight precingulars, often appear in fixed materials.

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