First records of *Gambierdiscus excentricus* and *Ostreopsis lenticularis* in the Cape Verde Archipelago (Macaronesia, Central Eastern Atlanctic)

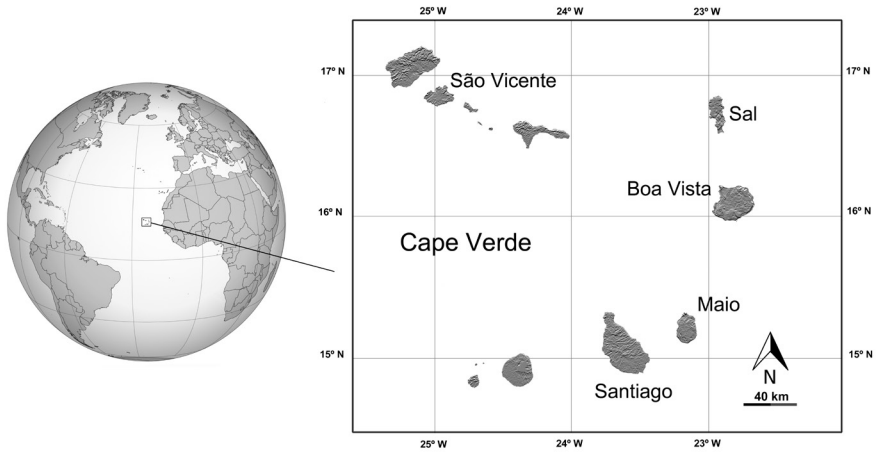

Fig. 1. Map of Cape Verde archipelago (Macaronesia Region).

Harmful algal blooms (HAB) species frequently recorded in tropical latitudes are apparently increasing their distribution in temperate areas [1]. This expansion is linked both to naturally occurring changes, such as global warming, as well as anthropogenic causes such as ship ballast water transport, nutrient loading, marine habitat deterioration and expanding aquaculture [2]. These changes are allowing the establishment of HAB species in areas where they were previously unknown. In some areas, this has been well studied, whereas in others the only evidence of the presence of these species is the harmful impact they have had on marine organisms, the environment and human health.

Macaronesia is a name used to designate several archipelagos of volcanic origin in the Atlantic off the south west coast of Europe and north west of Africa; the Azores and Madeira (Portugal), the Canary Islands (Spain) and Cape Verde. There are no reports on the occurrence of ciguatoxins (CTXs) and maiotoxins (MTXs)-producing dinoflagellates in Cape Verde.

Currently, the only information available on microalgae in the Cape Verde Islands was published by Silva in 1956 from material collected in Boa Vista Island in 1948 [3]. Silva's study included the first report of a presumed *Gambierdiscus* species named as *Goniodoma* sp. Fraga and Rodríguez described a new benthic dinoflagellate species, *Gambierdiscus silvae*, in the Canary Islands and suggested that probably corresponded to Silva's original description of *Gonodioma* sp. [4].

The objectives of the project MIMAR (MAC/4.6d/066), funded by the European Union included the monitoring, control and mitigation of the observed changes in the marine ecosystems from Macaronesia. Within the framework of this project, different islands have been sampled within the Cape Verde Archipelago and since 2017 an exhaustive inventory of microalgae species with particular interest on potentially harmful species is being carried out. Sampling has been performed in 32 coastal sites on five Islands: São Vicente, Sal, Maio, Santiago and Boa Vista (Fig.1). Sampling sites included a variety of intertidal and subtidal marine habitats ranging from 1 to 40 meters depth. Habitats included sandy and rocky substrates, macroalgal beds and coral beds (Fig. 2). Benthic microalgae species, both from macroalgae and from artificial substrates were sampled by snorkelling and by SCUBA diving. Water temperature during the sampling period ranged from 24 to 27 °C. Cells were examined with scanning electron microscopy (SEM) (JEOL JSM-6380 LV) and with light microscopy/fluorescence microscopy (LEICA DM6000 B). Cells were stained with fluorescent stain calcofluor for the examination of their plate tabulation. A total of 140 microalgae species were identified. Diatoms were the most numerous group with 108 species. *Gambierdiscus excentricus* Fraga, *Ostreopsis lenticularis* Y. Fukuyo and *Ostreopsis* cf. *ovata* Y. Fukuyo were identified amongst the dinoflagellates.

Gambierdiscus excentricus had an anteroposteriorly compressed lenticular shape. Measurement ranges

Fig. 2. Macroalgae and corals habitat at Baia das Gatas, São Vicente.

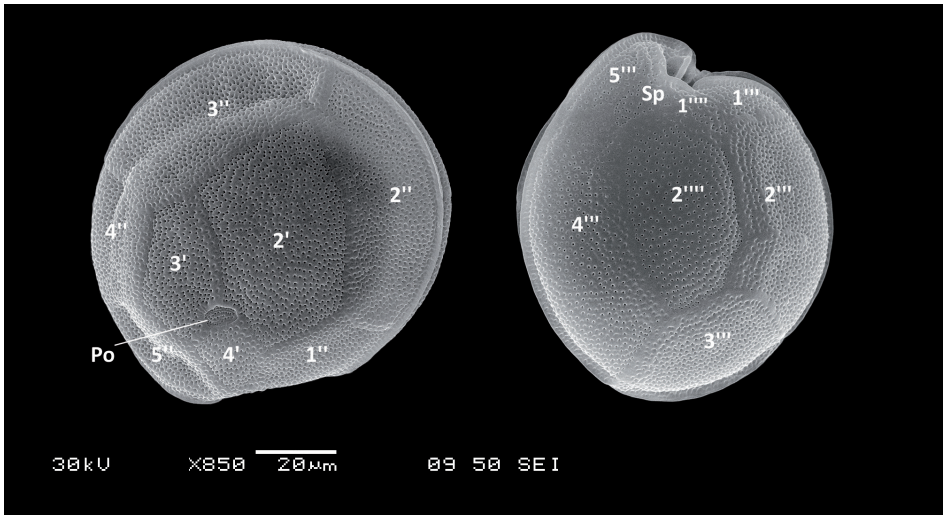

Fig. 3. Gambierdiscus excentricus. Scanning electron micrographs, apical and ventral views

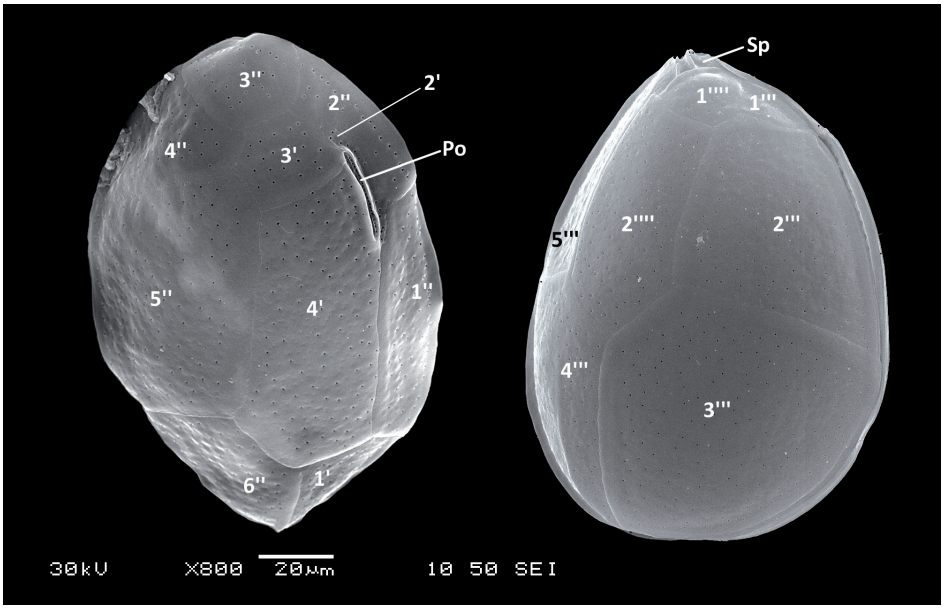

Fig. 4. Ostreopsis lenticularis. Scanning electron micrographs, apical and ventral views

were: depth (D) 84-110 µm, width (W) 70-105 µm, and length 35-40 µm. The thecal plate formula was: Po 4' 6'' 6c ?s 5'' 1p 2''''. Thecal plates were smooth with fine round to oval pores. Apical pore plate Po was oval with a fishhook-shaped slit and was ventrally displaced. First apical plate, 1', was very small. Ratio between plates 2'/3' and 2'/4' suture lengths ranged from 2 to -2.5. Plates 1' and 6'' were very small and facing the posterior part of the cell due to the torsion of the flagellar area which formed a hollow. From this hollow, two flagella emerged, the longitudinal one being perpendicularly projected. The Sp was in the hypotheca, out of the sulcus. The 2'''' plate was about twice as long as wide (Fig. 3).

Ostreopsis lenticularis Y. Fukuyo cells were broadly oval in apical and antapical views, lenticular-shaped, biconvex, and flattened, with the cingulum straight in lateral view. Measurements ranges were: depth (D) 60-105 µm, width (W) 53-74 µm and the DV/W ratio 1.13-1.42 (mean 1.27). The thecal plate formula was: Po 4' 6'' 6c 4?s 5''' 2''''. The apical pore plate Po was long and narrow, slightly curved with the outline of the cell. The fourth apical plate (4') was elongated and hexagonal, located mostly on the left side of the cell. The second apical plate (2') was narrow and elongated, and located below the APC, extending dorsally to the Po plate, and reaching about the mid-position of the 3' plate. Plates 5'' were pentagonal and reached half of the DW axis (Fig. 4). The thecal surface was smooth and plates presented numerous pores of two types (Fig. 5). Large pores and small pores visible with the light microscope with epifluorescence and with SEM. Analyses of the LSU rDNA D1-D3 corroborated previous identifications of *Gambierdiscus* and *Ostreopsis* species. The analyses of samples from 32 sampling sites showed that *O. lenticularis* was widely distributed in Sal, Sao Vicente and Boa Vista but was not observed in Maio and Santiago. *Ostreopsis lenticularis* cell densities ranged from 50 per sample to 1 x 10^6 cells per 100 cm^{-2}. *G. excentricus* was distributed in all the islands visited except for Maio. *Gambierdiscus excentricus* concentrations ranged from a few cells per sample to 150 cells per 100 cm^{-2}.

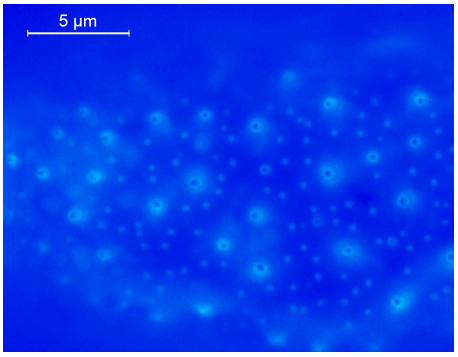

Fig. 5. Ostreopsis lenticularis. Epifluorescence micrograph showing detail of the thecal surface with two kinds of thecal pores.

Potentially toxic species of the genera *Gambierdiscus* and *Ostreopsis* are reported for the first time in the Cape Verde Islands. The presence of these species would explain the ciguatera cases that have been previously documented for this archipelago.

Acknowledgements

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References

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