



# FLORIDA SEA GRANT COLLEGE

## A B S T R A C T

TITLE: ECOLOGY, GENETIC VARIABILITY AND PHYSIOLOGY OF THE CIGUATERA-CAUSING DINOFLAGELLATE GAMBIERDISCUS TOXICUS ADACHI AND FUKUYO

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Ecological, genetic and physiological studies of the ciguatera-causing dinoflagellate, Gambierdiscus toxicus, were conducted over a four year period. Ecological studies indicate that G. toxicus is dispersed via drift algae, e.g. Sargassum natans. Cultures of drift cells were toxic, documenting that a semi-pelagic mode of transfer is possible in the ciguatera food chain. In a substrate specificity study (Bomber, 1985) G. toxicus preferred Heterosiphonia gibbesii (Rhodophyta) to 13 other algae examined. G. toxicus may prefer algae with mid-range ash weights and those that have high surface area. Heterosiphonia gibbesii supplies an important growth factor to G. toxicus as the growth rate of G. toxicus and the concentration of an aqueous extract of H. gibbesii were positively correlated. Several experiments were conducted with extracts and the data indicate that the extract functions as a chelator. Consequently, macroalgal metabolites probably contribute to producing a chemically balanced environment for G. toxicus in the "thallsphere". However, the algal extract did not enhance toxicity.

G. toxicus dominated the epiphytic community on the macroalgae. This ability may be due to bioactive compounds present in the organic matter that G. Toxicus exudes (up to  $2.6 \text{ mg l}^{-1}$ ). At this concentration the aqueous extract fraction of this exudate the growth rate of the littoral diatom Nitzschia longissima by 60%. The results of this test were repeatable and extract concentration and growth rate were negatively correlated,  $r = -0.98$  ( $P < 0.01$ ), indicating the method can be used as a bioassay for G. toxicus toxins. An aqueous cell extract of G. toxicus also inhibited N. longissima as well as the epiphytic diatom, Amphora costata. These studies also reveal that the inhibitory compound exuded by G. toxicus is much more potent to diatom than its endogenous toxins.

In additional laboratory experiments, temperatures above 29 degrees C and below 26 degrees C limited the division rate of G. toxicus, although growth was possible from 19.5 degrees C to 34 degrees C. Optimum growth occurred at 32 O/00 salinity. Fastest division rates in light quality experiments were achieved under blue violet to blue light (435 nm and 465 nm) with gamma slopes (light limited growth rate increases) of 0.52 and 0.42 respectively. Growth under fluorescent light was reduced above  $1.4 \times 10^{16}$  quanta  $\text{cm}^{-2} \text{sec}^{-1}$  (about 11% of full sunlight). Under optimum combinations of the aforementioned parameters growth rates above 0.5 division  $\text{day}^{-1}$  could be sustained and led to unusually high yields in large scale cultures of up to 360 mg (dry cell weight)  $\text{l}^{-1}$ . Cultures grown at 27 degrees C were more toxic than those at 21 degrees C ( $3,515 \pm 500$  cells  $\text{MU}^{-1}$  vs.  $16,536 \pm 2,400$  cells  $\text{MU}^{-1}$ , s.d.). Cultures were also more toxic under high irradiance than when light limited ( $1,587 \pm 230$  cells  $\text{MU}^{-1}$  vs.  $3,515 \pm 500$  cells  $\text{MU}^{-1}$ , s.d.). The seasonality, temperature, light, salinity and toxicity data help explain why ciguatera is a larger problem in the Caribbean (no seasonality, optimum conditions) than in Florida (seasonality, fluctuating conditions).

The genetic variability of rafting and benthic clones collected from Martinique to Bermuda was assessed via acclimated reproduction rate and toxicity comparisons. These studies have identified at least three races of G. toxicus, and indicate that clones from Bermuda probably interbreed with the moderately toxic ( $> 1,000$  cells  $\text{MU}^{-1}$ ) populations from Florida and the Bahamas, but the more toxic ( $< 1,000$  cells  $\text{MU}^{-1}$ ) Caribbean strains are isolated from Floridian and Bahamian strains. These data also help explain why ciguatera is a larger problem in the Caribbean than in Florida.

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