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Hitoshi Izumi, Hiroyuki Nakahara and Isamu Umezaki: Nitrogen fixing blue-green algae at a coral reef

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Hitoshi Iizumi, Otsuchi Marine Research Center, Ocean Research Institute, University of Tokyo, Akahama, Otsuchi, Iwate, 028–11 Japan
Hiroyuki Nakahara, Fishery Research Station, Faculty of Agriculture, Kyoto University, Maizuru, Kyoto, 625 Japan (Present address: Laboratory of Fishery Resources, Department of Tropical Agriculture, Graduate School of Agriculture, Kyoto University, Kyoto, 606 Japan)
Isamu Umezaki, Laboratory of Fishery Resources, Department of Tropical Agriculture, Graduate School of Agriculture, Kyoto University, Kyoto, 606 Japan

Nitrogen fixation is a likely major source of nitrogen at tropical marine ecosystems which show high productivity at ambient low concentrations of nitrogenous nutrients. Previous investigations revealed that some blue-green algae (cyanobacteria) actively fix dinitrogen at coral reefs (Mague and Holm-Hansen 1975, Wiebe *et al.* 1975, Potts and Whitton 1977, Potts 1980). It is observed that mats or turfs of blue-green algae cover a wide area of exposed surfaces such as coral debris or sediments. Organic production by these blue-green algae seems to be important for other organisms which cannnot fix nitrogen.

At a tropical coral reef of Ponape (7°N 158°15′E), several turfs were collected from various parts of the reef and investigated for their nitrogen fixing ability.

Algal turfs were collected by divers. Each sample was rinsed with seawater and divided into two portions, one of which was fixed by formaldehyde for later microscopic observation. The other portion was used for nitrogen fixation assay by an acetylene reduction technique. Samples were put separately in incubation chambers (volume: 80 or 230 m*l*) together with HA Millipore filtered seawater (50 or 100 m*l*). Acetylene was injected to give the final concentration of ca. 20%, and the rest being air. Incubation was conducted in an outdoor flowing seawater bath (temperature: 28–30°C) under natural light conditions. At intervals, gas was sampled from the headspace of the chamber and acetylene and ethylene concentrations were analyzed with a flame ionization gas chromatograph equipped with a 3 mm × 2 m column containing Chromosorb 104. Total nitrogen content of the sample used for acetylene reduction assay was measured by a CHN analyzer after drying at 80°C.

Single species of blue-green alga was found to form most of the turf communities collected from different parts of the reef. Many of them reduced acetylene (Table 1), irrespective of whether blue-green algae had heterocysts (*Dichothrix fucicola* and *Hormothamnion entermorphoides*) or not. The one which did not show active acetylene reduction was a turf of *Lyngbya majuscula* (Dillw.) Harvey mixed with *Microchaete vitiensis* Askenasy, *Lyngbya nordgardhii* Wille and *Nodularia sphaerocarpa* (Born. et Flah.) Elenkin. Out of six communities of blue-green algae which reduced acetylene, four were new to the record of the activity in the field; *Dichothrix fucicola, Symploca hydnoides, Hydrocoleum cantharidosmum* and *H. lyngbyaceum*. The highest rate was obtained by a community of a heterocystous alga, *Dichothrix fucicola* mixed with a small amount of *Spirulina subsalsa* Oersted. It is not certain whether the activity was solely due to *D. fucicola* or not. Though nitrogen fixing bacteria other than blue-green algae attaching to the turfs could not be excluded, acetylene reducing activity was likely due to the blue-green algae which were the main constituent of the turf communities.

Acetylene reduction rates were comparable

Table 1. Acetylene reduction of blue-green algae communities at a coral reef.

Sample No.	Dominant species	nmol C_2H_2 $mgN^{-1}hr^{-1}$	
		Day*	Night*
#1	*Dichothrix fucicola* (KUETZ.) BORN. et FLAH. with *Spirulina subsalsa* OERSTED	220	30
#2	*Symploca hydnoides* KUETZ.	30	0
#3	*Hormothamnion entermorphoides* GRUNOW	90	0
#4	*Hydrocoleum lyngbyaceum* KUETZ.	100	190
#5	*Hydrocoleum cantharidosmum* (MONT.) GOMOT.	50	0
#6	*Hydrocoleum cantharidosmum* (MONT.) GOMOT.	110	0

* Acetylene reduction was measured under natural light conditions. Rates in the day and at night were measured during 0715-2030 and 2030-0715, respectively.

to those recorded for other blue-green algae at tropical reefs (0.53–220 nmol C_2H_2 mgN^{-1} hr^{-1}, MAGUE and HOLM-HANSEN 1975; 4–.18 nmol C_2H_2 $mgN^{-1}hr^{-1}$, POTTS and WHITTON 1977). It is not possible from our data to estimate ecological significance of nitrogen fixation at the study site. However, considering the coverage of turfs or mats of blue-green algae on various surfaces at the reef, it is suggested that the turf-forming blue-green algae play an important role in nutrient budget.

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飯泉　仁[1]・中原紘之[2]・梅崎　勇[3]：珊瑚礁における窒素固定藍藻

ミクロネシア共和国ポナペ島の珊瑚礁で採集したマットを形成する藍藻について，その窒素固定活性（アセチレン還元活性）を測定した。活性は 30–220 nmol C_2H_2 $mgN^{-1}hr^{-1}$ の範囲であった。野外で採取された試料について、窒素固定能を持つことが初めて確認された藍藻が 4 種見つかった。([1]028–11 岩手県上閉伊郡大槌町赤浜 2–106–1，東京大学海洋研究所大槌臨海研究センター；[2]625 京都府舞鶴市長浜，京都大学農学部付属水産実験所，現在　京都大学大学院農学研究科熱帯農学専攻；[3]606 京都市左京区北白川追分町，京都大学大学院農学研究科熱帯農学専攻)