

## Growth-rate influences on coral geochemical proxies tested by a long-term culture experiment

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Corals are rich archives of climatic changes in tropical seas covering from the recent to distant past. The isotope and elemental compositions of coral skeletons reflect physicochemical parameters of the ambient seawater. Because the long-lived colony of hermatypic coral can live several hundred years with clear annual growth-bands, the coral skeletons have great potential to provide environmental archives. From previous calibration researches, the skeletal oxygen and carbon isotope ratios depend on factors such as the temperature, isotope ratios and light intensity of the ambient water, making coral skeletons useful for palaeoenvironmental reconstruction. Although many studies have utilized oxygen and carbon isotope ratios in corals for proxy calibration, there has been much debate over its controlling factors. In this study, we examine the magnitude of growth-rate influence on coral oxygen and carbon isotope and Sr/Ca ratios in a long-term common-garden culture experiment of *Porites australiensis* corals. The aim of this study is to evaluate the intraspecific variability of the skeletal isotope signals, the usability of the carbon isotope ratio as an environmental proxy, and accuracy of reconstructed seawater temperature.

Keywords: Coral, Climate, Oxygen isotope ratio, Sr/Ca ratio

## A coral internal model on photosynthesis and calcification processes incorporating trans-calcification mechanism

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Coral reef ecosystem has been exposed and affected to some environmental changes, such as global warming, ocean acidification, eutrophication, etc., and it has been responded to these environmental changes on community level, colony level and organism level. However, prediction of the responses of coral reef ecosystem is not easy because of complexity of coral internal processes. One of the effective approaches for understanding the responses of corals to multiple environmental changes is to develop a coral internal model and to obtain the solutions of the model by computer simulation.

In this study, a coral internal model for photosynthesis and calcification has been developed. This model is based on a conceptual model of trans-calcification by McConnaughey (1994). The model consists of three parts (ambient seawater, coelenteron and calcifying fluid), and fluxes of total alkalinity (TA) and total dissolved inorganic carbon (DIC) between each part by metabolic and physical effects are calculated, then TA and DIC are calculated to determine the photosynthesis rate, respiration rate and calcification rate, which are the functions of CO<sub>2</sub> system parameters. Simulation results of the model well reconstructed some coral internal conditions (i.e. internal pH, photosynthesis, respiration and calcification responses). The response of calcification rate against ambient aragonite saturation state was nonlinear in this model simulation, and the response agreed with the experimental responses observed in some previous studies (Gattuso et al. 1998; Marubini et al., 2008; Anthony et al., 2011; Inoue et al., 2011).

Keywords: hermatypic coral, coral internal model, photosynthesis, trans-calcification, ocean acidification

## THE RELATIONSHIP OF OCEANOGRAPHIC PARAMETERS AND CORALS CONDITION IN WAKATOBI ISLANDS

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This research aims to evaluate the relation of some oceanographic parameters to coral conditions in Wakatobi Islands. The evaluated parameters are temperature and salinity in water surface and in 30 m depth, and also chlorophyll-a concentration in surface. The correlation of those parameters with hard coral cover area is evaluated using correlation matrix. The data of hard coral cover area was acquired from COREMAP-LIPI program in 2001, 2005, 2006, 2007, and 2009, and from TNC-WWF joint-program in 2003. Parameter oceanographic data used here was obtained from NOAA-AVHRR satellite from 1990 to 2009, while chlorophyll-a data was obtained from Seawifs satellite from 2000 to 2009. Temperature and salinity data in 30 m depth and surface salinity are from Hycom model in 1992-2010.

Observation shows that surface temperature rises 1.80 degree Celcius while surface salinity rises 0.108 psu. There is negative correlation of hard coral cover with temperature and chlorophyll-a, which means that the higher the temperature or chlorophyll-a the lower the hard coral cover in that area. The change of temperature more that normal coral temperature (25 - 30 degree Celcius), makes zooxanthelae stress and makes the coral can not live. Whereas when chlorophyll-a have a high number, the sunlight will be partly blocked. The distribution of surface temperature and chlorophyll-a gives the indication of upwelling phenomenon on east monsoon session that acts as refuge for the coral to be in their normal temperature.

Keywords: hard coral cover, surface temperature, salinity, upwelling, wakatobi islands

## Behavior of coral observed by Fluorescence Monitoring System camera and application to deep sea biological research

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The purpose of this presentation is to describe the intensity of fluorescence images that we got using a coral Fluorescence Monitoring System camera and its relationship with environmental fluctuations, and feeding damage from a snail. Moreover, we describe applications to deep sea biological research of the fluorescence photographing technique. Then, in this Japan Geoscience Union Meeting 2012 (Coral Reefs: Life, the Earth and Human Beings), we present a paper about the following results.

Development of coral Fluorescence Monitoring System camera. (FMS\_Camera)

Relationship between light intensity of coral fluorescence image and environmental fluctuations.

Apparatus-photographed influence of feeding damage by a snail (*Drupella* spp.).

Application to deep sea biological research of photographing technique.

We developed a time-lapse camera that makes fluorescence photographing of coral possible using a Blue Block filter and fluorescence excitation filter. In-situ observations with the FMS Camera were accomplished in Sekisei lagoon three times. By *in-situ* experimentation, we succeeded in taking time series photographs of coral fluorescence. Regardless of night or day, we were able to produce fluorescence and normal images hourly for 26 days (620 images). The numerical information provided from an image must be correlated with environmental data. We consider the strength and weakness of light intensity to be an indicator of a coral's health. Consequently, we will first extract the light intensity from a part of the fluorescence image. Then we will compare the value with environmental data (for example, water temperature and current velocity).

Recently, we used the filter set from this apparatus and carried out photography of deep sea organisms in the laboratory. Fluorescence photographing was possible with many organisms. Consequently we considered that this photographing technique could be applied to investigation of deep sea organisms.

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Keywords: coral Fluorescence Monitoring System camera, coral fluorescence image, intensity of fluorescent image, feeding damage, deep sea organisms

## Reconstruction of marine environments around Todoroki River in Ishigaki Island using trace elements of coral skeletons

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### I. Introduction

Coral reefs form one of the most productive ecosystems in the world, providing complex and varied marine habitats that support a wide range of other organisms. However, they are being greatly stressed by recent human activities. Especially, coastal areas are subject to river discharge of polluted material from its watershed. Since corals of the genus *Porites* with annual bands assimilate trace elements in their skeletons depending on their concentrations in seawater, coral skeletons are considered as a useful indicator of estuarine environment.

### II. Samples and Methods

Coral skeletons were collected around river mouth of Todoroki River, Ishigaki Island, Okinawa. To demonstrate spatial distributions, 5 short coral cores (S1, S2, S3, S4, S5) were collected along an inshore-offshore transect line. To reconstruct time series variations, 2 long cores (L1, L2) were collected and sub-sample were collected along annual bands. 13 elements including manganese (Mn) and barium (Ba) were measured by ICP-MS (Inductively Coupled Plasma Mass Spectrometry) and 2 elements including iron (Fe) were measured by ICP-AES (ICP-Atomic Emission Spectrometry). In order to remove secondary contaminations during coral coring and/or sample storage, and to understand the state of elements, appropriate pretreatment on coral samples is required. In order to find out an appropriate pretreatment procedure, I conducted a stepwise cleaning on coral samples.

### III. Results and Discussion

It has been suggested that Ba concentration of coral skeleton can be a proxy for freshwater discharge while Mn and Fe concentrations would indicate terrestrial runoff. Variations of Ba, Mn and Fe concentrations in coral skeletons in this study have reconstructed marine environments around Todoroki River, Ishigaki Island described as below.

The results of pre-treatment experiments have suggested that dissolved Ba is incorporated into coral skeletons while Fe seems to be attached to skeletal surfaces as

particles. In addition, corals would uptake both the dissolved and particulate Mn. Time series variations of L1 core showed seasonal variations of Ba and Mn concentrations corresponding the variation of precipitation. On the other hand, Fe concentration of L1 core did not show seasonal variations, although Fe has also reported as a proxy of soil runoff as well as Mn. It can be explained by differences of uptake mechanism of each element by corals. Because corals seem to uptake Fe as particles in the study area, Fe concentration may represent not only soil runoff but also sediment resuspension. Chronological variations of Mn and Fe concentrations reconstructed by L2 core showed increasing trends from late 1980s with the maximum during 1990s, although this trend was not found in chronological records of Ba and precipitation. Subsequently, Mn and Fe concentrations decreased after 1990s. This might be attributed to red soil runoff due to land improvement projects and subsequent conservation actions.

Keywords: coral skeleton, trace elements, red soil