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The growth rate of coral *Porites lutea* relating to the El Niño phenomena at Tunda Island, Banten Bay, Indonesia

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Abstract

Reefs are benthic biotas that have an important role in marine ecosystems, where its growth is strongly influenced by environmental conditions. A massive coral has capacity to records environmental condition. This can be traced through the process of deposit calcium carbonate ($CaCO_3$). Deposited coral skeletons of species *Porites lutea* are able to provide information in determining the rate of corals growth that is seen in its annual band. Sampling technic of corals was carried out by using pneumatic drill and then the coral samples were analyzed using X-rays to gain its directions, ages and growth rates. The research results showed that growth rate of corals *P. lutea* at the north station (windward) was in a range of 0.6-2.3 cm/year and its average growth rate was 1.20 cm/year. The coral growth at southern station (leeward) was in range of 0.5-1.9 cm/year and its average growth rate was 1.11 cm/year. There is not significant correlation at windward (R^2 = 0.1922) and leeward (R^2 = 0.201) between *P. lutea* growth rate with sea surface temperature. However, there is a decreasing trend of coral growth from 1982 to 2014. There are three lowest peak were observed during El Niño event in 1983, 1993, 1998 with the growth rate respectively are 0.9 cm/year, 0.7 cm/year, and 0.5 cm/year.

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1. Introduction

The skeleton of classified corals order *Scleractinia* is made of calcium bioaccumulation produced by corals. Massive corals are able to grow and bind calcium carbonate on the small tissue layers of their colonies 'outer surface [1]. The existing massive coral has a significant role as habitats for many types of reef organisms, and serve as spawning, nursery, feeding and shelter grounds. Coral has linier accretion growth pattern (wide, height, and length) within a certain time. In general, coral skeleton formation was interpreted as the increase of weight of coral skeleton deriving from calcium carbonate in the form aragonite crystal and calcite [2]. The finding density of carbonates was equivalent to its annual growth [3]. Annual band of the coral skeleton structures can provide important information about environmental conditions such as temperature, pollution, earthquake and others, which influence coral growth rates [4].

Observation using X-rays can easily determine the coral reefs linear growth rate particularly hard corals such as *Porites* shown in coral skeleton [5]. The skeleton structures on large-sized coral colonies were able to give information about annual density variation observed by using X-rays [3]. The thickness of sliced coral skeletons for X-rays analysis depends on the X-rays' ability in interpreting the samples [6]. Reef formation of hard corals such as *Porites* has the advantage that it can determine the past corals growth by examining and studying theirs annual (growth) bands [7].

The coral genus of *Porites*, *Pavona*, or *Montastraea* are often used in climate change studies because of they possess large colonies along with different annual bands that were different from other massive corals, and furthermore they are able to grow for several hundred years [8]. Several studies about coral growth rates that were conducted in Indonesia, especially in Karimun Jawa and Bangkalan, obtained a growth rate for coral *Porites* within a range of about 5.38-17 mm/year, aged between 4-8 years old, and different colony growth [9]. Massive corals produces calcium carbonate ($CaCO_3$) and provide an advantage of absorbing global warming as much as 7-15% [10].

Sea surface temperature plays an important role in the growth of corals [11]. The increase of sea surface temperature can cause coral bleaching [12]. The higher or lower sea surface temperatures would inhibit the growth process of *P. lutea* because the corals would lose their symbiotic algae (*zooxanthallae*) which cannot tolerate extreme temperature changes [13]. The aim of this research is to analyze the effect of sea surface temperature on the *P. lutea* growth rates in the windward and leeward areas Tunda Island.

2. Methods

The research was conducted from August to October 2014 at Tunda Island, Karang Anyer, Serang, Banten Province (Fig. 1) and also at the Center of Applied Isotopes and Radiation Laboratory, National Nuclear Energy Agency Jakarta, Indonesian. Sampling in this study was conducted at both locations, the windward and leeward. The collection of coring coral samples were done by using a pneumatic drill. The stainless steel drill bit was connected to a scuba diving equipment as the drill driver. Its size was 5 cm in diameter and 50 cm length and could be extended by adding a joint in order to collect a sample within three meter deep [14].

The coring coral sample were sliced into 2 mm plates. Plated samples were analyzed by using radiographic X-ray Rift Rigaku Generator Radioflex RF-300 EGM2 130 with 1 second radiation and 1 meter long distance. Then, they were washed in a dark room to get positive films which were then converted into digital formats using positive film scanner (Epson V 600) from each coral samples. Furthermore the annual bands of X-rays from 1981-2014 years with processed were analyzed by applying Coral XDS software to determine directions, ages, growth rates and coral luminance [15]. Sea surface temperature data were obtained from satellite images published by ERDDAP (Easier Access to Scientific Data) which then it was analyzed using Ocean Data View 4 (ODV 4) Software. The correlation of coral growth rate with SST analyzed by Statistical Product and Service Solution 17 (SPSS 17).

3. Results

P. lutea is a good species for schlerochronology study to see the long record of environmental change, because the morphological shape changes are rarely found in corals based on its previous growths [19]. The growth rate of

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