Effect of temperature on two reef-building corals *Pocillopora damicornis* and *P. verrucosa* in the Red Sea

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Abstract

The effects of temperature on two reef building corals *Pocillopora damicornis* and *P. verrucosa* inhabiting the Obhur Creek, a small embayment on the western, Red Sea coast of Saudi Arabia, was studied from December 2009 to November 2010. The overall annual range of seawater temperature in Obhur Creek was between 24.5°C and 33°C. Zooxanthellae abundance and diversity showed seasonal variations: the number of zooxanthellae in *P. damicornis* was slightly higher than in *P. verrucosa*, and the abundance of zooxanthellae of both species was low in summer and high during winter. The respiration rate of *P. verrucosa* did not vary between summer and winter, suggesting compensatory acclimation. In contrast, the respiratory rate in *P. damicornis* was lower in winter than in summer. During the

winter season the metabolic rate was higher in both species owing to the optimum seawater temperature (30°C). As a result of the abundance of zooxanthellae and the optimum seawater temperature, the growth rates of the skeletons of the two coral species were higher in winter and lower in summer. In general, the results showed that *P. verrucosa* is more flexible with respect to temperature than *P. damicornis*. The difference in zooxanthellae thermal tolerances at 35°C may be due to the algal genotypes between the two species, resulting in *P. damicornis* becoming bleached as the rate of metabolism exceeds the rate of photosynthesis with increasing temperature.

1. Introduction

Environmental factors such as global warming, ozone depletion, increase in coral diseases (Hallock 2001, Nguyen 2009) and natural events such as hurricanes, earthquakes, predator outbreaks and periods of high temperature (Nguyen 2009) may threaten the health and existence of coral reefs. Coral reefs are among the ecosystems most endangered by climate change and associated effects as corals live near their upper thermal limits and are sensitive to modest increases in background seasonal seawater temperatures (Kleypas et al. 2001, McClanahan et al. 2007).

Stony corals of the order Scleractinia have a symbiotic relationship with the zooxanthellae species *Symbiodinium microadriaticum* that lives within their endoderm layer, providing up to 90% of assimilated carbon to corals as food (Al-Sofyani 1991, Davies 1991, Papina et al. 2003) and enhancing the growth of coral (Goreau 1959). Upon exposure of coral to abnormal environmental conditions such as variations in physical and chemical parameters as well as anthropogenic threats, the spectacular symbiotic relationship between them breaks down, with the zooxanthellae being expelled from the coral tissues, a phenomenon called coral bleaching (Calvin & Muscatine 1997, Downs et al. 2002, Coles & Brown 2003). Shallow coral species have more resistant clade A and B zooxanthellae than the less resistant, deeper coral species, which have clade C zooxanthellae (Rowan et al. 1997), while clade D zooxanthellae have been reported to be the most heat resistant (Baker et al. 2004, Fabricius et al. 2004).

Many reports link coral bleaching to high sea surface temperature (Dunne & Brown 2001), solar radiation (Hoegh-Guldberg 1999, Fitt et al. 2001) and differences in the zooxanthellae clades (Brown et al. 2002, Lewis & Coffroth 2004). Field studies have indicated that some species of corals offer greater resistance to bleaching when subjected to unusual environmental factors, compared to other vulnerable species. Some studies