The effect of light intensity on the survival of a temperate coral *Acropora solitaryensis* under low temperature conditions

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Recent global warming has induced the northward expansion of the corals around Japan including one of the most dominant temperate species, *Acropora solitaryensis*. Numerical simulations have been conducted to project its future distribution, however the definition of the potential habitats deployed in the previous studies remain uncertain due to the lack of understanding in the coral responses to environmental stresses. The most recent research defined the potential habitat based on the average winter temperature, however corals are known to be affected by the synergistic effects of multiple environmental factors and it is insufficient to estimate the habitat solely based on one variable. For example, light intensity in particular has been considered as another key environmental factor controlling the habitat distribution and moreover, the recent research suggested the light intensity affects the vulnerability of corals to cold temperature stress. Therefore, the primary aim of the study was to investigate the effect of light intensity on the survival of *A. solitaryensis* under low temperature conditions.

An outdoor tank experiment was conducted between January-April 2019 at Shimoda Marine Research Center, University of Tsukuba. Nine colonies were exposed to each of the four treatments: ambient temperature (+0 ºC) and ambient light intensity (100%), ambient temperature (+0 ºC) and reduced light intensity (25%), elevated temperature (+2 ºC) and ambient light intensity (100%) and elevated temperature (+2 ºC) and reduced light intensity (25%). Number of samples alive, buoyancy weight and the maximum quantum efficiency of the Photosystem II (Fv/Fm) were measured every other week. The experimental result was subsequently tested for its correspondence with the current distribution around the Izu peninsula which locates around the northern limit. A striking pattern is observed around the peninsula where *A. solitaryensis* is observed on the west but absent on the southeast side. Therefore, data analysis of SST and light intensity was conducted focusing on the difference between the distribution pattern on the west and east sides of the peninsula.

The mean survival rates of the colonies under ambient temperature and reduced light intensity declined to zero when the colonies under ambient temperature and ambient light intensity were still 80% by the end of the experiment. Also, the ambient temperatures and reduced light intensity led to decreased growth rates compared to elevated temperatures and ambient light intensity respectively. This was likely a result of decreased photosynthetic rates due to low temperature and light intensity (Bessell-Browne et al., 2017; Caroselli et al., 2015), which provides a possible explanation for zero survival rates of the colonies under ambient temperature and reduced light intensity.

Based on the SST and light data analysis around the Izu peninsula, the number of days falling below 14 ºC in January between 2011-2018 were greater on the east than the west side of the peninsula. Additionally, the east side had significantly greater cloud cover than the west, which led to significantly reduced light intensity. These results suggested that the current distribution is consistent with the experimental results, and the absence of *A. solitaryensis* on the east side might be due to the simultaneous occurrence of cold temperature stress and low light intensity.

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