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Calcification, photosynthesis and mucus production of the coral Pocillopora verrucosa along the nutrient and temperature gradient of the Red Sea

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The Red Sea is characterized by a large latitudinal gradient, most important an increase in nutrients and in temperature (21-33°C) from N to S, featuring challenging conditions during summer in the S. The metabolism of the widely distributed coral species Pocillopora verrucosa was investigated in situ along the gradient in summer and in winter to evaluate its acclimatization mechanisms to these variable and partly extreme environmental conditions. Calcification rates revealed clear seasonal pattern with more than 2-fold increased rates in the Northern reefs during summer and more than 1.5-fold increased rates in the Southern reefs during winter. This pattern strongly relates with temperature, where maximum calcification rates occurred at ∼29°C independent of latitude and nutrients in the water. Furthermore, diel calcification rates decreased with light intensity during summer in the S, indicating energy allocation towards stress mitigation, possibly caused by co-occurring high SST and high light intensity. Photosynthesis, as the main energy supply, followed the gradient stronger during winter with a 3-fold increase from N to S and was generally higher in winter than in summer, except at the most Northern site. Hence, energy consuming calcification could only partly be related to photosynthesis with a higher correlation during winter than in summer. Mucus release increased >5-fold from N to S during winter and summer, while mucus release was generally higher during summer. This indicates that a substantial amount of energy in Southern corals was allocated towards protection from sedimentation in nutrient enriched waters and possibly towards the protection from heat-related stressors, e.g. enhanced bacterial pressure. These acclimatization mechanisms of P. verrucosa to varying temperature and nutrient regimes explain its success and wide physiological niche in the Red Sea, although conditions may be rather marginal for coral growth in some areas.