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# Growth of staghorn coral *Acropora aspera* (Dana) (Scleractinia: Acropridae) in relation to environmental factors at Kavaratti atoll (Lakshadweep Islands), India

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Skeletal extension and calcification were measured over 2 years in branches of the staghorn coral *Acropora aspera* from a shallow-water site. Correlations were made between growth parameters and environmental variables monitored over the same period. Calcification varied significantly (9.4-17.4 mg. $28d^{-1}$) than skeletal extension (3.1-4.7 mm. $28d^{-1}$) and unlike extension, it varied significantly between seasons with lowest values during southwest monsoon (June-September). Seasonal reduction in calcification was probably associated with the reduced availability of light due to increased cloud cover and sediments in water. Extension, however, seemed to be under the direct influence of currents and sediments. The effect of environmental factors seemed more critical to calcification.

Quantitative studies of growth of corals at Lakshadweep is limited to a single report[1], dealing with skeletal extension of *Acropora formosa* (Dana) in relataion to environmental factors at Kavaratti atoll. However, skeletal extension alone would not give a clear picture on the influence of environmental factors on growth of corals as skeletal growth can be characterized by two parameters; increase in length along one or more growth axis (skeletal extension) and increase in weight (calcium carbonate accretion or calcification)[2-5]. These two growth parameters do not necessarily vary in the same way at the same time[6-8] and they may be infuenced by different set of environmental factors[2,5]. Very few workers[5,9] have considered both these growth parameters together to describe the effect of environmental factors on coral growth. The communication reports the results of growth studies conducted over 2 years on *Acropora aspera* (Dana) from a shallow-water site at Kavaratti atoll, and calcification (weight of calcium carbonate accreted) in relation to water temperature, salinity, current velocity, suspended matter sdimentation and light conditions.

The study was conducted at the southern portion of the Kavaratti lagoon[1], at a depth of 2m at high water and 30m away from the shore. One large colony (2m diameter) of *A. aspera* was used for the study. All measurements were made between March 1988 and December 1989. The distal 5-8 cm of 10-15 straight growing, unbranched apical tips of the species were stained for 5-6 h *in situ*, using Alizarin-Red S[10]. One month later the stained branches were cut and cleaned in 2% sodium hypochlorate for 30 min to remove the living tissue, rinsed in fresh water and then air dried. New set of branches were stained every month. The interval between staining and collection was 28-30 days (except August 1988, 34 days; April, 26 days and October 1989, 32 days). All the values were normalized to a rate per 28 day. Skeletal extension to the nearest 0.1 mm, was measured using a dissecting microscope and an ocular micrometre[5]. To determine the rate of calcification, the white skeleton (new growth) beyond the stained portion was cut out and weighed to the nearest 0.1 mg[5]. Mean and standard deviation (n = 10-15) in extension and calcification rates were then calculated for each month. Data on monthly mean values of environmental variables were gathered from a concurrent study[1] in the same site.

The monthly values of skeletal extension did not vary significantly, while that of calcification exhibited significant seasonal variation (Fig.1). The lowest values of both the growth parameters occurred in June and July during southwest monsoon (June-Sept). High values of extension occurred in April-May and November-December. The annual variation in extension (mm. $28d^{-1}$), was $3.1 \pm 1$ - $4.7 \pm 0.1$, with seasonal average values of $4.2 \pm 2$, $3.6 \pm 0.4$ and $4.1 \pm 0.3$ respectively for premonsoon (Feb.-May), southwest monsoon (June-Sept.) and northeast monsoon (Oct.-Jan.). The annual extension was 3.8 cm (1988) and 4.9 cm (1989). High calcification values also occurred in April-May and November-December. The annual calcification (mm.$28d^{-1}$) varied between $9.4 \pm 1$ and $17.4 \pm 2$ with seasonal averages of $15.9 \pm 0.3$, $13.2 \pm 2.2$ and $15.6 \pm 1$ respectively for premonsoon, southwest monsoon and northeast monsoon.

Except salinity, all other environmental variables exhibited seasonal variation with respect to

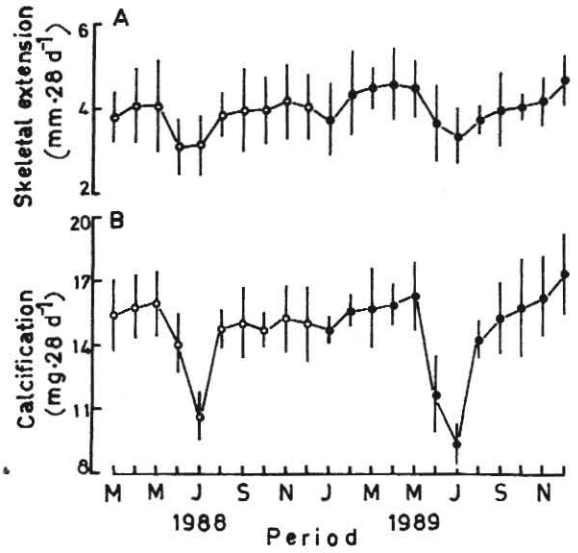


Fig. 1—Monthly rates of skeletal extension (A) and calcification (B) of branches of *A. aspera* (means and standard deviations are calculated for n = 10-15)

southwest monsoon[1]. To determine the relationship between growth parameters and environmental variables, their correlation was tested (n = 2). The results did not show any significant relation between growth parameters and temperature and between skeletal extension and salinity. Highly significant inverse relations ($P \leqslant 0.01$) existed between skeletal extension and current velocity ($r = -0.722$); suspended matter($r = -0.649$) sedimentation ($r = -0.750$). Calcification exhibited direct relation ($P \leqslant 0.05$) with salinity ($r = 0.404$) and highly significant inverse relations ($P \leqslant 0.01$) with current velocity ($r = -0.735$), suspended matter ($r = -0.627$) and sedimentation ($r = -0.714$) were found..

The two parameters of skeletal growth, extension and calcification, measured monthly did not show the same variations between seasons. Unlike extension, calcification exhibited seasonal variations with lowest values during southwest monsoon. Extension and calcification need not show the variation with seasons[2,5] and are often out of pace with one another[6-8], because the two growth parameters may be under different environmental controls[2,5]. This seemed true in the present study also as the two growth parameters exhibited difference in their response to seasonally varying environmental variations. Since temperature and salinity varied over a minimum range, a marked effect on account of this on growth is not likely. However, calcification exhibited direct relation ($P \leqslant 0.05$) with salinity, while the relation between extension and salinity was not significant.

Calcification inversely related ($P \leqslant 0.01$) with currents, suspended matter and sedimentation and rate of calcification was lowest during southwest monsoon period, when the level of these parameters were highest. Currents create turbulence and sedimentation. Sediments settling on body cause energy loss to corals in their sediment rejection process[11] and disturbance to feeding[12], which would affect calcification. However, investigations[5,8,13] suggest that light intensity and sunlight hours are the most important factors influencing rate of calcification in corals. The reduction in light due to increased cloud cover and rainfall in the study area during southwest monsoon[1] would thus be a major cause to reduced calcification. High level of sediments in water in this season would further reduce the available light[14] and contribute to reduction in calcification.

The absence of a marked variation and seasonality in skeletal extension in this study shows that environmental factors have less influence on extension. Neverthless, extension showed lowest values in June-July during southwest monsoon and inversely correlated ($P \leqslant 0.01$) with currents, suspended matter and sedimentation. As skeletal extension is not light dependant[2] and seasonal changes in light has little direct effect on extension[5], this response may be the direct result of currents and high levels of sediment in water, which are already implicated in the reduction of skeletal extension in Acroporid corals[9,14-16]. It seemed that the variation in calcification is strongly associated with light and to a lesser extent with sediments in water, while skeletal extension may be directly affected by currents and sediments and the effect of these environmental factors on growth appeared more critical to calcification.

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