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Comparison between Caribbean and eastern Pacific coral reefs

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Resumen: El Caribe y el Pacífico Oriental están separados por una distancia corta en el tiempo y en el espacio, pero sus arrecifes coralinos son muy diferentes. Estas diferencias van más allá que sus características actuales, también difieren en su desarrollo Cuaternario. El crecimiento arrecifal en el Pacífico Oriental era escaso o limitado durante el Pleistoceno y Holoceno temprano debido a condiciones ambientales adversas. Además, eran más frágiles y expuestos a más bioerosión que los arrecifes del Caribe. La posibilidad de preservación de los arrecifes coralinos del Pacífico Oriental es comparativamente baja.

Key words: reef comparison, Caribbean, eastern Pacific, Quaternary.

The temporal and spatial distance separating the Caribbean and the eastern Pacific is short, as little as 50 km (Leschine 1981) and around 3.5 million years (Coates *et al.* 1992). This separation has resulted in very different oceanographic settings and coral reefs on both sides of the Central American isthmus (Glynn 1982). In this paper I extend Glynn's comparisons to include historical development of the reefs and more recent contrasting data from both sides.

Coral reef development in the Caribbean has been relatively constant during the whole of the Quaternary period, and fossil uplifted and submerged reefs are common in the region (Dodge *et al.* 1983, Macintyre 1988, Macintyre *et al.* 1991). In the eastern Pacific, uplifted reefs of Pleistocene or early Holocene age are not found (per. obs., based on field work and interviews with geologists that work in the area), there are no reports of submerged reefs, and there is only one example of an uplifted late Holocene reef (Urvina Bay, Galapagos: Colgan and Malmquist 1987), and of fossil corals (Sea of Cortez, Mexico: Squires 1959).

The absence of fossil reefs on the Pacific coast of the Americas may be due to several factors. It seems probable that no reef developed during the Pleistocene, because of extreme changes in temperature, cooling due to intensified upwelling (Hays *et al.* 1989) and warming due to development of El Niño events (Colgan 1990). It was also a period of large shifts in sea level in a region with narrow continental shelves (Cortés 1986). During the late Holocene, reefs started to grow in the eastern Pacific in protected areas (Gulf of Chiriquí, Panamá: Glynn and Macintyre 1977; Golfo Dulce, Costa Rica: Cortés 1990a), but not in areas exposed to temperature extremes, where growth started less than 2,000 years ago (Caño and Cocos Islands, Costa Rica: Guzmán 1986, Macintyre *et al.* 1992; Galápagos Islands, Ecuador: Macintyre *et al.* 1992).

Additionally, recent research has shown that El Niño may kill whole reefs in the eastern Pacific (Glynn 1990) and that post-disturbance events may partialy obliterate the reefs (Colgan 1990, Glynn and Colgan 1992, Guzmán and Cortés 1992). Futhermore, studies on siltation-stressed reefs in Golfo Dulce on the Pacific coast of Costa Rica, indicate that even after the corals have been killed, internal bioerosion by lithophagid bivalves continues (Cortés 1990b). Finally, monitoring of eastern Pacifc reefs since the 1982-83 El Niño shows that recovery is slow (Glynn 1990, per. obs.).

The sluggish recovery of eastern Pacific reefs is exemplified by reefs killed over 350 years ago on the north Pacific coast of Costa Rica (Glynn *et al.* 1983) that have shown no signs of recovery.

Extensive death of coral communities due to some disturbance event, such as hurricanes (Woodley *et al.* 1981), post-event mortality due to predation (Knowlton *et al.* 1990) and slow recovery (Hughes 1992), have been observed in the Caribbean, but there are no reports of completely eroded reef frameworks. In addition, recovery of Caribbean reefs may be faster than eastern Pacific reefs because of more benign environmental conditions and/or more source populations supplying recruits in the Caribbean.

Several observations indicate that the possibility of preservation of eastern Pacific reefs is lower than for Caribbean reefs. Eastern Pacific reefs are smaller and more dispersed than their Caribbean counterparts (Glynn 1982). The inner structure of eastern Pacific reefs consists of loosely interlocking branching corals and/or unattached massive corals. Moreover, little or no submarine cementation is evident and crustose coralline algal pavements are weakly developed (Glynn and Macintyre 1977, Cortés 1990a). Also, bioerosion is probably higher in the eastern Pacific than in the Caribbean (Highsmith 1980). Caribbean reefs typically have a high degree of submarine cementation, abundant populations of crustose coralline algae, and massive reef structures (Goreau and Goreau 1973, Macintyre and Glynn 1976). Most eastern Pacific reef frameworks would probably break up and collapse during strong earthquakes. This does not seem to occur in the Caribbean. During a 7.5 earthquake on the Caribbean coast of Costa Rica, only a small section of a reef front collapsed, while the rest of the reef and all the other reef structures on the coast endured the movement (Cortés *et al.* 1992).

In conclusion, the differences between Caribbean and eastern Pacific coral reefs go beyond their present day characteristics (Glynn 1982). They also differ in their Quaternary development; most eastern Pacific coral reefs are late starters (growth began less than 2,000 years ago), and significant accretion is restricted to a few localities. In contrast, most shallow-water modern Caribbean reefs started to grow over 6,000 years ago and relict submerged reefs document reef development throughout the Holocene transgression.

The absence of Quaternary fossil coral reefs in the eastern Pacific may be due to sparce or limited growth during the Pleistocene and early Holocene because of adverse environmental conditions. Also, because eastern Pacific coral reefs are more fragile than their Caribbean counterparts, the probability of them being preserved in the fossil record is relatively low.

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