

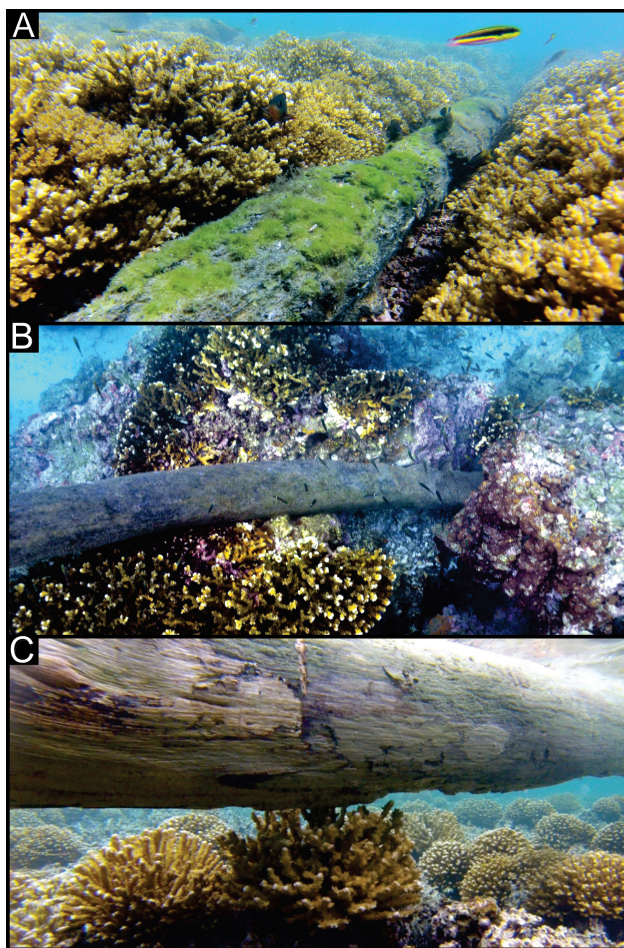
Drift logs are effective agents of physical coral fragmentation in a tropical eastern Pacific coral reef

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Coral reefs of the tropical eastern Pacific (TEP) exhibit high coral cover, but low coral diversity. These reefs are usually dominated by the genus *Pocillopora*, with branching colonies that are highly susceptible to breakage. Fragments of *Pocillopora* are often scattered over the reef bottom even in areas free of human disturbance. A major biological cause of coral natural fragmentation is the feeding activity of certain fish species, like pufferfishes (Tetraodontidae), which feed directly on the corals (Palacios et al. 2014), while triggerfishes (Balistidae) break coral colonies looking for invertebrates dwelling within them (Glynn et al. 1972). Because survival of *Pocillopora* fragments can be high (CG Muñoz, Universidad del Valle, unpubl data), coral asexual reproduction by fragmentation is likely important in these reefs (Highsmith 1982).

The continental landscape adjacent to Gorgona Island, Colombia, is densely covered by rainforests (Chocó/Darién/W. Ecuador—biodiversity hotspot; Myers et al. 2000), where logging is a poorly regulated, but widespread

profitable activity performed by local people. Logs are carried through waterways by small boats pulling many logs tied together with ropes. As a result, logs are frequently lost during transport. Additionally, landslides are common in forests along coastal hills and carry large quantities of vegetation to the sea, including entire large trees. In consequence, logs and other floating plant debris frequently drift at sea before stranding on beaches. Drift logs have drawn some attention, mostly regarding their function as floating structures for long-distance dispersal of marine organisms (Jokiel 1990). Although drift logs "battering" of intertidal communities has received some attention (Dayton 1971), the potential effects on coral reefs have not yet been addressed. Based on direct observations, here we describe the effects of physical impact by drift logs on a TEP coral reef.

La Azufrada reef is a 9.4-ha, shallow coral reef located on the leeward side of Gorgona Island. Extensive areas of the reef flat are located at shallow water depths of approximately 0.5 m during low tide, and subaerially exposed during occasional extreme low tides. We have observed that drift logs can affect this reef in two ways: (1) logs sink and get trapped between corals, which break continually as waves rock the logs back and forth; and (2) logs break corals when they bump against the substrate as logs hover over the reef.

To assess the importance of drift logs as agents of coral fragmentation at La Azufrada reef, in June 2013 we estimated the abundance and dimensions of submerged logs on the reef and of logs stranded on the adjacent beach (which has an extension of approximately 5 ha during low tide). We found 11 submerged logs measuring a mean of 4.0 (SD 2.6) m in length and 0.4 (SD 0.2) m in diameter, all of which were surrounded by broken colonies and numerous coral fragments providing examples of the first type of effect (A, B). Additionally, we found 57 stranded logs on the beach measuring 5.6 (SD 5.4) m in length and 0.3 (SD 0.3) m in diameter, the largest ones (27 and 24 m long; approximately 1 m diameter) had roots and branches. Both types of logs (submerged and stranded) were present during the 10 d of the study, and no additional logs arrived during this period. We hypothesize that logs stranded on the beach had a destructive impact on the reef as a function of the tide level at the time of arrival, their size, and presence of roots and branches (which would maximize their potential for coral fragmentation). Later, in October 2013, one encounter with a large log (13.6×0.3 m) drifting over a distance of about 200 m on the reef for 45 min clearly illustrated the second type of effect, when this single log collided with corals at low tide (<0.5 m depth) and under weak wind conditions (C). This log hit and broke at least 13 *Pocillopora* colonies, generating 71 fragments [5.4 (SD 2.6) fragments colony⁻¹ at a rate of 1.6 fragments min⁻¹] between 4 and 12 cm in length. Approximately 60% of the fragments remained on the original colonies and thus could potentially reattach to them. The remaining fragments reached the adjacent bottom, potentially forming new colonies as observed for some species in the TEP (Richmond 1987, Baums et al. 2014). Given the survival advantages of coral fragments conferred by their much larger size in comparison with juvenile colonies derived from recently recruited larvae (Highsmith 1982), these fragments may play an important role in the local coral population replenishment. This assumption is supported by the findings that recruitment by sexually-produced larvae is generally low throughout the TEP region (Richmond 1987, López-Pérez et al. 2007, Lozano-Cortés and Zapata 2014). Thus, logs drifting over reefs may be important physical agents of coral asexual reproduction in similar areas where reefs are shallow, branching corals are common, and where rainforests co-occur with coral reefs (e.g., Coral Triangle).

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