

Cloud Sponge, *Aphrocallistes vastus* (Porifera: Hexactinellida), Fragment Healing and Reattachment

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In May 2012, fragments of Cloud Sponge, *Aphrocallistes vastus*, that had been cut by fishing line were deposited in an array of boulders on the seabed near the parent sponge on the southwest shore of Hutt Island in Howe Sound near Vancouver, British Columbia. Open breaks in the transplanted fragments and parent sponge healed within 12 months. The fragments reattached to rock within 24 months. Previous observers of similar events reported no healing and death of damaged sponges. However, previous observations occurred during warm El Niño periods, which may be associated with higher stress leading to unsuccessful healing. In contrast, my current observations took place in cooler La Niña conditions, which may have promoted greater resilience and better healing.

Key Words: Cloud Sponge; *Aphrocallistes vastus*; tissue damage; healing; La Niña; El Niño

Introduction

Hexactinellid or glass sponges include the reef-forming dictyonine Cloud Sponge (*Aphrocallistes vastus*) and the non-reef-forming lyssasine Boot Sponge (*Rhabdocalyptus dawsoni*). Dictyonine hexactinellid sponges, including the Cloud Sponge, have been documented in British Columbia in the form of reefs (Conway *et al.* 1991) and sometimes show damage from fishing gear (Cook *et al.* 2008). These reefs are unique to British Columbia (Krautter *et al.* 2001).

Prior work during years that encompassed an El Niño climate phase (1991–1993) described slow growth rates in Boot Sponges (Leys and Lauzon 1998). Slightly faster growth of Boot Sponges was reported for 1990–1991 in Howe Sound, before the 1991–1992 El Niño phase (Marliave 1992). In addition, slow growth and extreme susceptibility to destruction by mechanical damage have been reported anecdotally for British

Columbia Cloud Sponges after the 2002–2003 El Niño period (Austin 2003). Freese *et al.* (1999) found that 67% of erect sponges (including glass sponges) were damaged by trawl fishing.

The capacity for tissue healing by sponges in situ on the seabed is an important issue in fisheries conservation. Here, I expand knowledge of Cloud Sponge healing and reattachment by describing fragments cut by fishing gear and their subsequent recovery during the cooler conditions associated with the 2010–2012 La Niña events.

Methods

On 24 April 2012, a dive team and I initially observed fishing gear damage to Cloud Sponges along the southwest shore of Hutt Island (49°24.34'N, 123°22.96'W) in Howe Sound, near Vancouver, British Columbia, at a depth of 16 m (Figure 1A). We observed sponge frag-

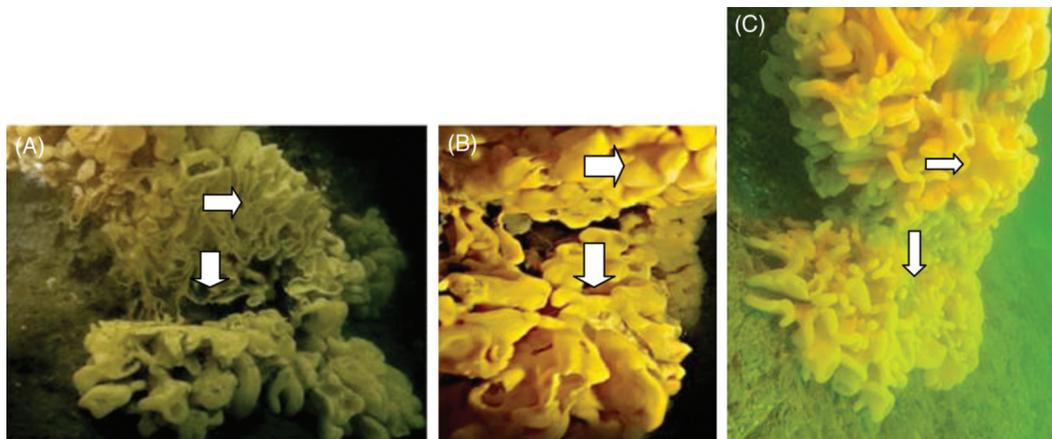


FIGURE 1. (A) Original cuts produced by fishing gear in an attached Cloud Sponge (*Aphrocallistes vastus*) in April 2012. (B) Same cuts in December 2012 with view angle shifted to the right, upslope side. Note healing of cuts. (C) In February 2015, growth is apparent. Tissue healing occurred over the first two years, then initial growth became apparent by 2015. Size of arrows indicates approximate scale. Photos: Jeff Marliave.

ments on four subsequent dives in May. On 3 May 2012, a large fragment cut from a sponge was resting against an attached Cloud Sponge below the damaged parent sponge. On 10 May, this fragment had drifted deeper to the east. On 15 May, divers transplanted the fragment to two contiguous boulders lying at right angles to each other. The fragment was seated on the north side of the southerly, downhill boulder and against the west side of the rock abutting the upper east corner of the downhill boulder. Several smaller sponge fragments from the same damaged parent sponge were tucked into a space at the corner where the two boulders met, between the rocks and the large sponge fragment. Note that the majority of sponge (about 2 m³) removed by cutting had been swept away by currents before any of our observations. On 5 September 2012, the retrieved and placed fragments had drifted upslope from the array of rocks; thus, six small rocks were rolled into place to create a complete box around the sponge fragments at the transplant site, thereby securing them against further drift.

Photographs were taken during 20 dives conducted over three years. The extent of tissue recovery (healing of open damage, fusion of fragments to each other, and attachment to rock) was determined through examination of these photographs. No attempt was made to measure growth expressed as increase in size.

In addition to the loss of fragments, the damaged parent sponge had sustained a slice wound at its top, with the uphill portion still attached but lying against the bedrock. The outcome of this tissue damage to the

intact parent sponge was also monitored with photography during inspection of the transplanted fragments.

Results

On 5 July 2012, healing of cuts and breaks and fusion of separate fragments were visible. The healing remained superficial (it did not encompass glass spicule deposition) through the winter of 2012–2013. Soft tissue covering former breaks was visible in April 2013 (Figure 2). Obvious adhesion to the rocks was observed by March 2014 (Figure 3B). Figure 3A, from 4 December 2012, shows an intact face, which had not been cut, of the largest sponge fragment, as well as a separate, protruding fragment at the rear.

By 16 February 2015, the healed, fused, and attached sponge appeared to have grown higher than the southern, downslope rock (Figure 3C). Although measurements were not taken, the growth approximated 10 cm upward and outward, which is within the range of rate of growth reported by Austin *et al.* (2007).

During the same period, the attached fragment from the slice wound on the parent sponge demonstrated comparable healing: cuts were covered with soft tissue by 5 July 2012 on both the transplanted fragment and on the attached cut pieces. Healing of the attached cuts appeared to involve spicule architecture by 4 December 2012 (Figure 1B). However, it was not until 2014 that new attachments to rock were observed at both the upper attached cut piece and in the transplanted fragment (Figure 1C and Figure 3B, C).

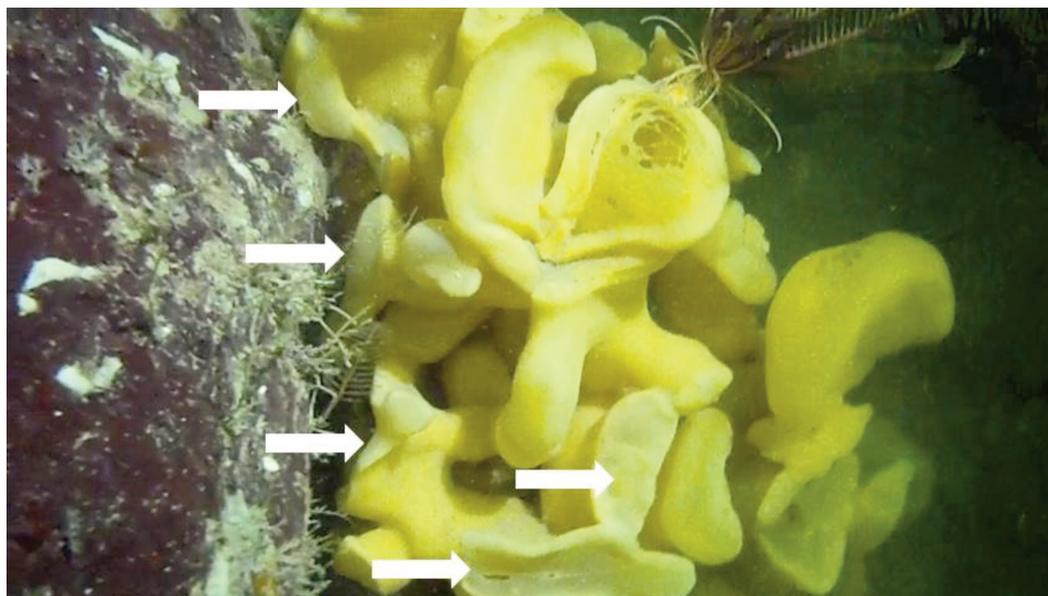


FIGURE 2. Early healing of cuts and breaks in Cloud Sponge (*Aphrocallistes vastus*), indicated by arrows, viewed from above, adjacent to the north side of south rock in April 2013. Sponge has yet to attach to rock. Photo: Jeff Marliave.

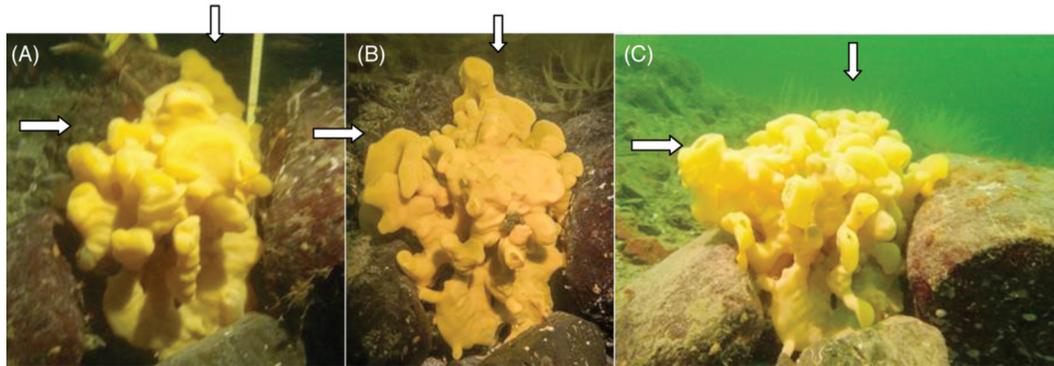


FIGURE 3. (A) In December 2012, view from west shows Cloud Sponge (*Aphrocallistes vastus*) fragment and south rock at same height. Note gloved fingers (not sponges) and ruler at top of photo. In September 2012, smaller rocks had been placed to the west and north (bottom and left) to hold fragments in place. Sponge had yet to attach to rock. (B) In March 2014, the same view shows healed sponge attached to rocks. The rear portion protruding upward at the east side was previously a separate pair of smaller fragments that fused together during 2012 and attached to rock in 2013. Note that the main body of the sponge is not appreciably higher than at the outset of the observations, as evidenced by the relative position of the south rock at the right. (C) In February 2015, the sponge had grown above the rocks and was spreading over them. The photo angle in C is more horizontal than in A and B; thus, the elevated eastern portion indicated by the upper arrow is behind the forward, western mass of sponge. Photos: Jeff Marliave.

Discussion

The current observations of tissue recovery and fusion occurred during a cooling La Niña climate phase. None of the earlier literature on glass sponges has contextualized observations in terms of the El Niño/Southern Oscillation phase of climate occurring at the time.

Prior accounts emphasize frailty and slow growth of glass sponges (Austin 2003), but these observations were mostly conducted during warm conditions associated with the 2002–2003 El Niño. The growth observations of Austin *et al.* (2007: Figures 1 and 3) provide dated measures that span a sequence from El Niño to La Niña climate phases, with slower growth occurring during the 2002–2003 El Niño, followed by faster growth during the 2005–2006 La Niña. In the absence of online index values (Climate Prediction Center Internet Team 2015), the results were interpreted as faster growth related to larger size.

However, our recent observations suggest that healing capacity increases during cooler La Niña phases, although the extent to which growth rates may vary according to such climate phases remains to be determined. To further support this hypothesis, it will be necessary to document glass sponge healing and growth during subsequent El Niño and La Niña events, and to record temperatures continuously at monitoring sites.

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