Comment on “Chemically Mediated Behavior of Recruiting Corals and Fishes: A Tipping Point That May Limit Reef Recovery”

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Comment on “Chemically mediated behavior of recruiting corals and fishes: A tipping point that may limit reef recovery”

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Abstract

Dixson et al.1 report that coral larvae navigate towards chemical cues associated with healthy reefs and avoid cues from degraded reefs. However, the swimming capabilities of coral larvae and well-established patterns of recruitment and reef hydrodynamics indicate that coral larvae will not be able to use these cues to recruit to healthy reefs.

Main Text

Dixson et al. (1) present a series of experiments suggesting that coral larvae can distinguish between chemical cues associated with healthy and degraded reefs, and subsequently imply that coral larvae will use these cues to navigate to healthy reefs. However, many of their results are contrary to our current understanding of coral larval swimming capabilities and
well-established patterns of recruitment in the field. In addition, the flow structure in their
flume is likely to be more dynamic than suggested, making choice experiments with coral
larval difficult to interpret.

In a first set of flume experiments, larvae of three species of *Acropora* overwhelming
preferred to spend time in water collected from areas of reefs protected from fishing when
compared to water collected from areas lacking protection. However, coral larvae are very
slow swimmers and based on previously published work are unlikely to be able to maintain
their position in the flume for the 5 min duration of the experiment. The reported flow speed
of 4.2 mms$^{-1}$ is greater than the mean of all average swimming speeds reported to date, even
when larvae are assisted by gravity (i.e., swimming downwards; Fig. 1). The maximum
horizontal swimming speed recorded for a coral larva is 3.45 mms$^{-1}$ (Table 1), which is well
below the minimum speed required to maintain position in the flume, let alone navigate
between the two water bodies. The remarkable consistency of larval behavior in the flume
(Fig. 1A; Dixson et al.) is highly unusual and suggests that a physical rather than behavioral
mechanism is operating. Indeed, the flow structure in their flume is likely to be much more
complicated than they describe due to the presence of a barrier initially separating the two
water sources and the barrier’s abrupt end at the beginning of the test section. It is highly
unlikely that visual inspection of a dye plume would sufficiently characterize flow conditions
experienced by such small larvae in this flume. Well established techniques such as particle
image velocimetry, laser-Doppler velocimetry or planar laser-induced fluorescence (2) should
have been used to verify that flow biases do not exist at the scale relevant to coral larvae.

The spatial pattern in the recruitment of corals to settlement tiles are also highly
unusual for a reef system that has a high number of reefs in close proximity, such as Dixson
*et al.* sites in Fiji. Their results imply a strong positive correlation between adult coral cover
and recruitment to settlement tiles. Indeed, not a single recruit was found on tiles placed in
the non-protected reef areas where coral cover was uniformly low. In contrast, in a two year
study of 33 reefs spanning the length of Great Barrier Reef there was no correlation between
adult abundance and coral recruitment to settlement tiles (3). Furthermore, only one of the
132 sites (4 sites per reef and 8 tiles per site) had no recruits (3). The lack of an effect of algal
clearance on juvenile recruitment to the substratum is also anomalous. In contrast, artificial
exclusion of herbivores reduces rates of coral juvenile recruitment 3-fold, presumably due to
dramatic increases in abundance of seaweeds in herbivore exclusion plots (4).

Even if coral larvae can distinguish between chemical cues associated with healthy
and degraded reefs it is highly unlikely they will be able to use this information to navigate
against ubiquitous tidal and other currents to preferred reefs for recruitment. Currents
connecting reefs rarely fall below 100 mms\(^{-1}\) (5), which is almost two-orders of magnitude
greater than typical coral larval swimming speeds (Table 1; Fig. 1). All existing measures
indicate that coral larvae are very slow swimmers and therefore will behave as passive
particles relative to inter-reef hydrodynamic regimes (6). Perfuming degraded reefs, as
suggested by Dixson \textit{et al.}, will not enhance recovery rather it will distract from the difficult
task of reducing fishing effort and improving water quality.
References


Table 1. Swimming speeds in mms⁻¹ for hermatypic scleractinian coral larvae. n = number of larvae; SE = standard error; a = mean calculated as average of maximum and minimum value; b = mean calculated from larvae aged 2 to 7 days old.

<table>
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<th>Species</th>
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<th>Max</th>
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<th>SE</th>
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Figure 1. Coral larvae are notoriously slow swimmers. The minimum swimming speed required to hold position in the experimental flume used by Dixson et al. (4.2 mms⁻¹, red star) is more than twice the mean horizontal swimming speed of larvae in other studies. Mean swimming speeds were taken from 14 studies representing over 450 speed measurements (for references see Table 1. The raw data is available at coraltraits.org). An ANCOVA for log-transformed speed data against larvae size and swimming direction found only a significant effect of direction (after dropping size: F²,₁₅ = 13.72, p < 0.001), where gravity-assisted swimming (downward) was significantly faster than other swimming directions (letters a and b denote significant differences at a = 0.05, post-hoc Tukey’s test).
Minimum horizontal swim speeds in Dixson et al.