

Turbidity triggers larval release by the intertidal barnacle *Semibalanus balanoides*

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Supplement 1

Data filtering method for the Massachusetts site

The chlorophyll and turbidity raw data in Little Harbor, Massachusetts, exhibited some unrealistically high values, probably caused by a piece of macroalga that wrapped itself around the instrument. Since the instrument sampled at a high frequency and not all of the data seemed to be contaminated, we devised an ad hoc method for filtering out bad data. It proceeded in 3 steps:

1. The instrument sampled once per second for 5 s every 5 min, so we computed the median for each of the 5 s sampling bursts. This eliminated bad data in situations when only some of the values in the sampling burst were contaminated (Figs. S1b & S2b).
2. To remove bad data in instances when the entire sampling burst was contaminated, we divided the sampling period into 2 h bins, and we filtered the data in each bin as follows: we calculated the mean and standard deviation of the values in the 2 h bin. If the standard deviation of the mean was equal to or greater than half of the mean, then we eliminated the highest one-third of values from the 2 h bin (Figs. S1c & S2c).
3. Finally, we calculated the median values for each 1 h bin, and those are the values that we used in our analyses (Figs. S1d, S2d & S3).

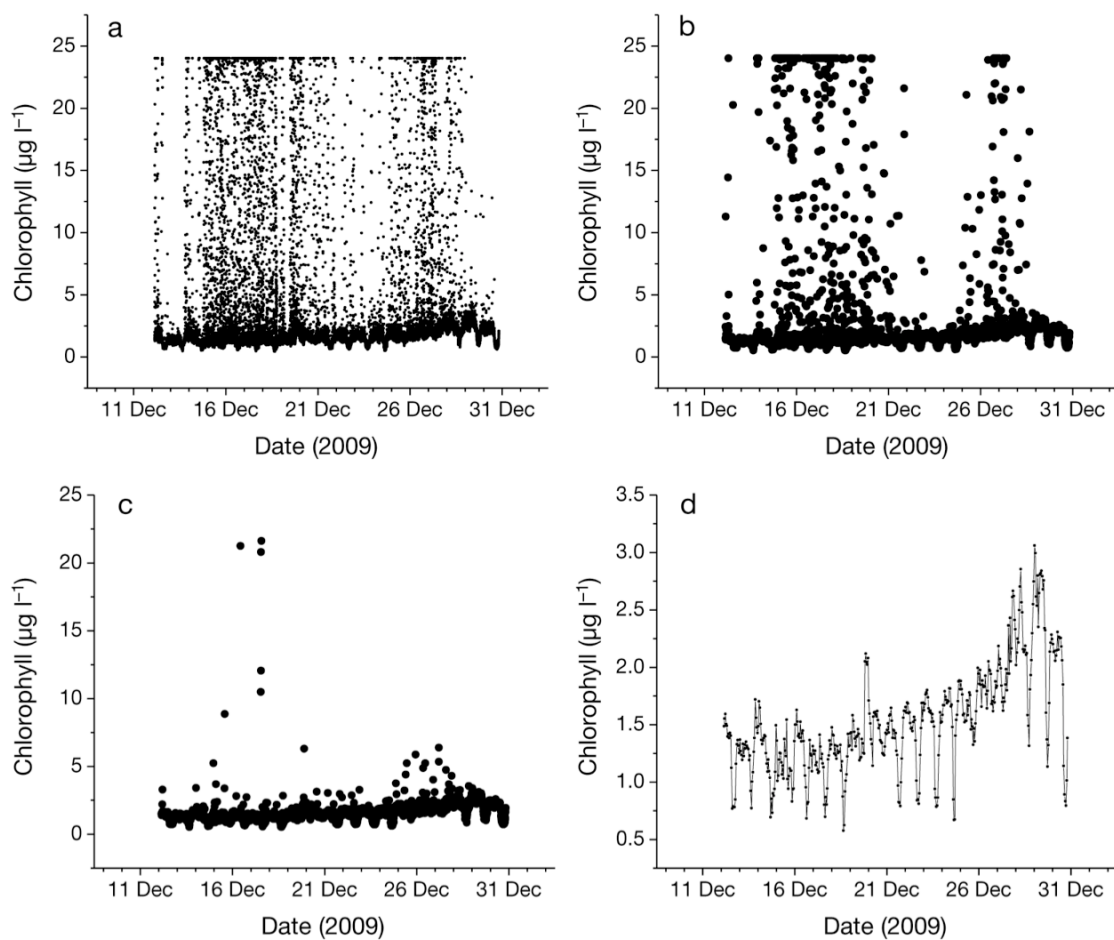


Fig. S1. The process of data filtration for chlorophyll measurements from Little Harbor, Massachusetts. (a) Raw chlorophyll data. (b) Median values for each 5 s sampling burst. (c) Results of filtering data in 2 h bins. (d) Median values for each 1 h bin. Note that the y-axis scale differs from the other 3 plots

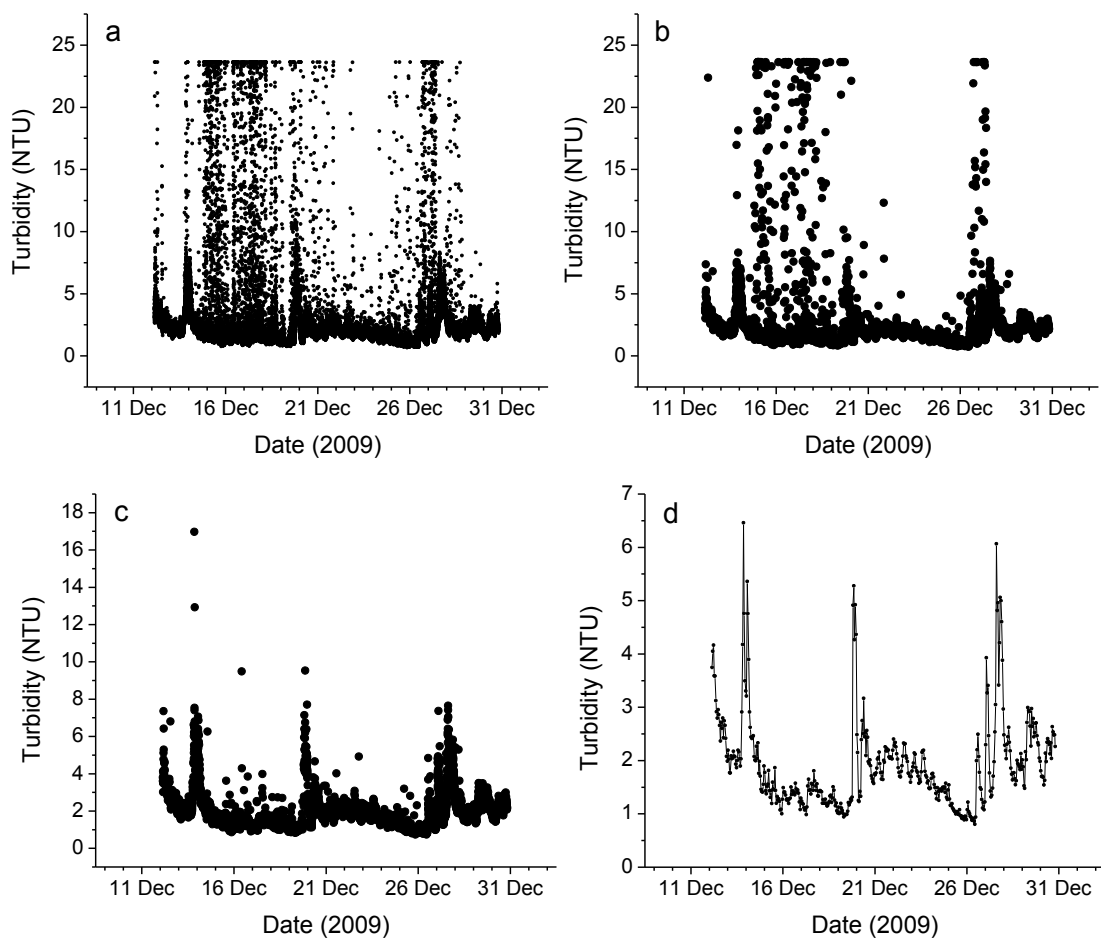


Fig. S2. The process of data filtration for turbidity measurements from Little Harbor, Massachusetts. (a) Raw turbidity data. (b) Median values for each 5 s sampling burst. (c) Results of filtering data in 2 h bins. (d) Median values for each 1 h bin. NTU: nephelometer turbidity units. Note that the y-axis scale differs among plots

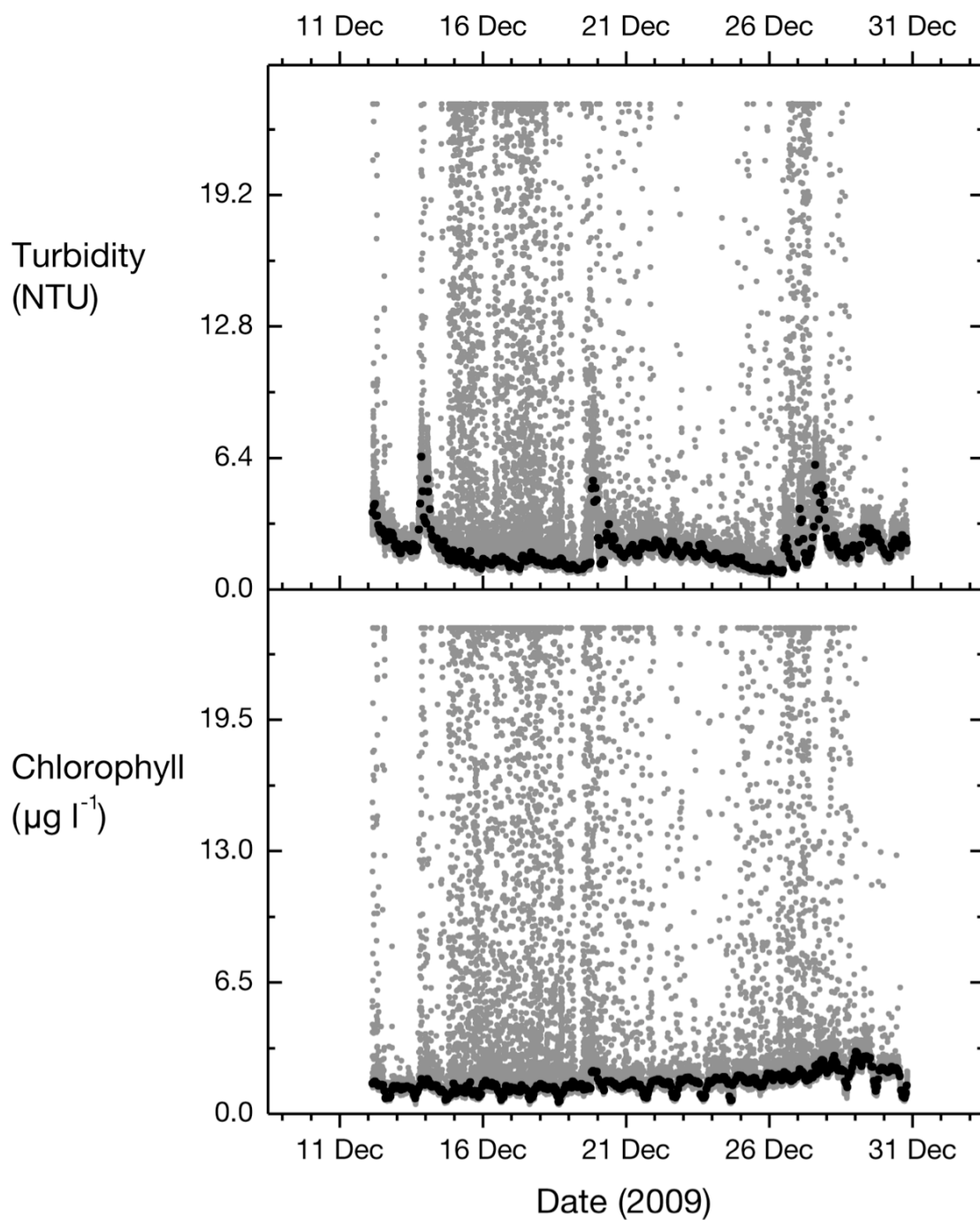


Fig. S3. Raw turbidity and chlorophyll data are shown in gray dots. The black dots represent the data that have been processed via the filtering method described above. NTU: nephelometer turbidity units

Supplement 2

Statistical model for testing the hypothesis that there is a difference in the larval release response of adult barnacles when exposed to 1 of 3 treatments

To begin with, consider a single experimental jar. Let m be the known number of barnacle adults and let y be the observed number of nauplii in the jar at the end of the experiment. An adult is not necessarily capable of producing nauplii, either because it had released the larvae prior to the start of the experiment, or because it does not respond to the experimental treatment. Let p be the unknown probability that an adult is gravid and receptive to the larval release cue being tested. We allow p to be different for each of the 4 experiments we conducted.

Under the model, the unknown number N of adults capable of producing nauplii has a binomial distribution with a probability mass function given by:

$$p(n) = \binom{m}{n} \pi^n (1 - \pi)^{m-n} \quad \text{Eq. (S1)}$$

where n is the number of adults that release larvae.

Conditional on its being gravid and receptive to the larval release cue, we assumed that the number x of nauplii produced by a single adult follows a geometric distribution with a probability mass function such that:

$$p(x) = \theta (1 - \theta)^x \quad x = 0, 1, 2, \dots \quad \text{Eq. (S2)}$$

with unknown parameter q ($0 < q < 1$). The geometric distribution is commonly used as a model for count data with a long upper tail. The mean and variance of x are $(1 - q) / q$ and $(1 - q) / q^2$, respectively.

The total number y of nauplii observed inside a jar at the end of an experiment represents the sum of a random number N of independent and identically distributed geometric counts. The probability mass function of y is given by:

$$p(y) = \sum_{n=0}^m p(y | n) p(n) \quad \text{Eq. (S3)}$$

where $p(y|n)$ is the conditional probability mass function of y given $N = n$, which can be shown to be a negative binomial with scale parameter n and shape parameter q . The negative binomial probabilities required for the calculation of Eq. (S3) were approximated by the method of Best & Gipps (1974).

The analysis proceeded using the basic model outlined above, allowing p to vary among the 4 experiments and with interest centering on testing the null hypothesis H_0 that the geometric parameter p is the same for the 3 treatments (control, synthetic beads, and *Skeletonema marinoi* diatoms) against the alternative hypothesis H_1 that it is not. We used the LR test, which involved fitting the model under both H_0 and H_1 . The LR test statistic is given by:

$$L = 2 [\log L_1 - \log L_0] \quad \text{Eq. (S4)}$$

where L_1 is the maximized likelihood value under H_1 and L_0 is the maximized likelihood value under H_0 . Under H_0 , L has an approximate chi-squared distribution with degrees of freedom given by the difference in the number of parameters under H_1 and H_0 . In this case, there are 7 parameters under H_1 (1 geometric parameter for each treatment and 1 binomial probability for each of the 4 experiments)

and 5 under H_0 (1 common geometric parameter and 1 binomial probability for each treatment). Thus, there are 2 degrees of freedom.

We repeated the entire analysis but omitted the outlier from the *Skeletonema* treatment, as this has undue influence on the results. We also used the LR test to test the null hypothesis that the geometric parameter is the same for the bead treatment and the *Skeletonema* treatment. Here is a summary of the variables involved in the statistical analysis of experimental data:

m	Number of adult barnacles in a jar
n	Number of adults that release larvae
p	Unknown probability that an adult is gravid and receptive to a larval release cue
N	The unknown number of adults that are gravid and receptive to a larval release cue
x	Number of nauplii produced by a single adult
q	Unknown shape parameter of the negative binomial distribution
y	Total number of nauplii inside a jar at the end of an experiment
L	Test statistic of the likelihood ratio test

LITERATURE CITED

Best DJ, Gipps PG (1974) An improved gamma approximation to the negative binomial. *Technometrics* 16:621–624