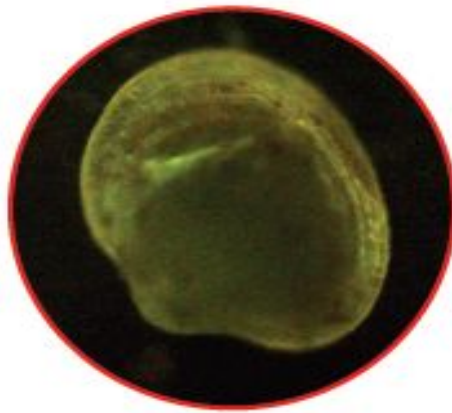


BIOFOULING METHODS



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transcriptional regulatory system. GacS, a transmembrane sensor kinase, perceives an environmental signal (likely acetate [30]) and autophosphorylates. Phosphorylated GacS then transphosphorylates a response regulator GacA, which binds to the promoter region upstream of the *csrB* sRNA gene to regulate its expression. The *csrB* regulatory RNA can sequester up to 18 CsrA molecules. Free CsrA protein binds to mRNA of target genes to either stabilize or de-stabilize messages. Stabilized messages are translated (*flhDC*) and de-stabilized messages are targeted for degradation (*rpoS*).

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promoter reporter in the wild type *E. coli* MG1655 (), or *gacA* (*uvrY*) mutant RG133 (), with pBAD18-*gacA* in the presence of 50 mM arabinose () or with the pBAD18 vector control in the presence of arabinose (). The substitution of glucose for arabinose eliminated complementation by *gacA* borne on pBAD18-*gacA* ().

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Figure 6.1 (A) Schematic plan view of a slide rack showing a randomized and replicated arrangement of slides. Only one batten is shown, though another one at the bottom can be used for security of the slides in turbulent waters. (B) Side of view of rack showing how neoprene pinches the slide in place as the bolt is

tightened. (C) and (D) show how the deployment ropes should be tied with a weighted bridle to minimize excessive swinging in currents and waves. The buoys (D) maintain the rack at a constant depth in a tidal regime. (E) shows a rack attached to a T-boom for deeper water deployment. (Not to scale.)

Figure 6.2 (a) Example data presentation that is not correct as the bars are means across all levels of replication, in this case that includes field of view, replicate and block. The error bars are standard deviations. (b) This is also incorrect as the bars are means of all levels of replication and the use of 95% confidence intervals is therefore misleading and encourages the reader to eyeball the data and make subjective and, therefore, erroneous interpretations. This is the most common form of data display. (c) Probably the best way to present these data as the bars represent the estimated means from the generalized linear model and the errors indicated are simply standard deviations. (d) Treatment group centroids of two discriminant functions summarize all variables measured, including species data, for this experiment. There is a clear grouping of some treatments with the rest scattered across the plot. Interpretation requires examination of the two function matrices.

Figure 6.3 Ballast Organic Biofilm [BOB] sampler used to acquire biofilm samples in ballast water tanks.

Figure 6.4 Photo of tray of test plates (left). As shown on the right, two of these trays fit into the BOB sampler.

Figure 6.5 Amount of chlorophyll ($\mu\text{g cm}^{-2}$) on the rock surface in a single plot across sampling times:

(a) before removal of macro-algae - day 0; (b) day 1 where algae were removed at top left and bottom right quadrants; (c) day 44; (d) day 75; (e) day 117; (f) day 160. Elevated amounts of chlorophyll at 'A' and 'B' are due to growth of macroalgal sporelings or cyanobacteria [14].

Figure 6.6 Reflectance spectra (350-850 nm) of macro- (top panel) and microalgal (bottom panel) biofilms on a rocky substratum. The horizontal black lines at the top of each graph show the wavelength regions covered by a multispectral (CIR) camera (G = green; R = red; NIR = near infrared). Absorptions by pigments are shown: PE = phycoerythrin; PC = phycocyanin.

Figure 6.7 Reflectance spectra of a marine biofilm grown on a sandstone tile (350-850 nm).

Figure 6.8 Second- and fourth-order derivatives (400-750 nm), respectively, of biofilms of green microalgae (a, b), cyanobacteria (c, d), and diatoms (e, f). The original reflectance spectrum is shown in gray.

Chapter 07

Figure 7.1 Schematic and photograph of the parallel plate flow cell (U.S. Patent No. 4,175,233). Many other types of test plates can be substituted for the germanium prisms indicated in the drawing on the left. The rigid outer shells of Plexiglas, are shown in the photo on the right.

Figure 7.2 Views of the Portable Biofouling Unit [PBU] showing two different styles of manifolds. In the photograph on the left, six parallel plate flow cells are installed, with water directed to the flow cells from the manifold on the opposite side of the unit.

The electrical cord from the small submersible pump is seen at the lower right corner of the PBU.

Figure 7.3 Examples of microscopic views of ocean biofilms after immunofluorescent staining: (a) *Comamonas terrigena*; (b) *Vibrio alginolyticus*; (c) *Achromobacter*; (d) *Pseudomonas putrefaciens*.

Figure 7.4 Mixed population fermentor system schematic. Details of the component systems are given in Table 7.2.

Figure 7.5 Biofilms grown in the mixed population fermentor on a single, standard nonbiocidal coating but in four separate weeks (columns) over the course of a few months differ in coverage, color, and structure.

Chapter 08

Figure 8.1 Boat-based pumping system with water being pumped through the corrugated hose into a small plankton net suspended from a PVC frame inside a shipping drum. Note the webbing straps securing the drum to the rail of the boat.

Figure 8.2 Blow-up schematic of larval trap with (A) rubber cap with the top cut out and secured with hose clamp that holds the funnel and plankton net in place, (B) funnel and ball valve, (C) small plankton net into which the funnel nests (opening is upward); the trap body is composed of a (D) large diameter PVC pipe with drainage holes glued to (E) a flat-bottomed PVC end cap. The trap is secured to the substrate with stainless steel brackets. A sleeve (not shown) can be sewn into the side of the plankton net and loaded with a formalin-impregnated chalk block to kill and fix captured larvae. For simplicity, the plankton net is illustrated as a shallow cup shape but

should actually be deep enough that about 3 cm of the top edge can be folded down over the rim of the trap body (D) so that the net is firmly held in place by the rubber cap and hose clamp (A).

Figure 8.3 Cylindrical tube trap constructed from conical tubes and flexible PVC tubing [19, 20, 32].

Figure 8.4 PVC crosses for deployment of cylindrical tube traps on moorings [32].

Figure 8.5 A small cleared area has been scraped in the mussel bed to allow attachment of settlement collectors: a 10 × 10 cm PVC barnacle settlement plate and an orange plastic pot scrubber (Tuffly™) for mussel settlement.

Figure 8.6 (a) Binarized input, (b) labeled cyprids and (c) all cyprid tracks processed from color AVI sequence in ImageJ. In this video a total of 75 cyprids are tracked in the ROI.

Figure 8.7 (a) Mean and error bar (95% confidence interval) plot of standard derived variables for larvae exploring seven surfaces. Note how difficult it is to understand the difference between the surfaces. (b) Discriminant function plot for the same data showing clearly the separation between two groups of surfaces, with surface G quite different to all others.

Figure 8.8 Radar plots of the same surfaces shown in Figure 8.7. The plots take much more space but identifying differences is quite straightforward.

Chapter 09

Figure 9.1 (a) Example of a fouling community on a PVC panel submerged for six months. (b) With overlaid grid points to estimate percentage cover. (c) Removal of all but one species using threshold color