Supporting Information

Idling Time of Motile Bacteria Contributes to Retardation and Dispersion in Sand Porous Medium

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Figure S1 Images of packed sand column experimental system

Figure S2 *P. putida* F1 diffusion profiles observed in static capillary assays

Document S1. Physical characteristics of bacterial strains

Based on visual inspection of the bacteria under a microscope prior to injecting into the column, the sizes of all *E. coli* strains were approximately 2 μm in length and 1 μm in diameter, with the exception of the smooth-swimming mutants HCB437, which were noticeably larger. A previous report by Vigeant et al. (*1*) indicated HCB437 to be 5 μm in length and 2 μm in diameter.

From previous work in our laboratory (unpublished) zeta potentials were calculated from electrophoretic mobility data for several of the *E. coli* strains in motility buffer at an ionic strength of 0.2 M: HCB1 = -15.63 mV, HCB136 = -15.82 mV, HCB359 = -15.43 mV, and HCB437 = -16.02 mV.

The swimming speed of *P. putida* PRS2000 is 44 μm/s (*2*) and *E. coli* HCB1 is 22.8 μm/s (*3*). The run times are 0.63 s for *P. putida* F1 (*4*) and 1.24 for *E. coli* HCB1 (*3*). The turn angle distributions are bimodal for *P. putida* F1 with an average turn angle of 85 ± 50 degrees (*4*) and unimodal for *E. coli* HCB1 with an average turn angle of 70 ± 39 degrees (*3*).

Document S2. Packed sand column experimental system setup

Figure S1 displays the packed sand column experimental system setup.

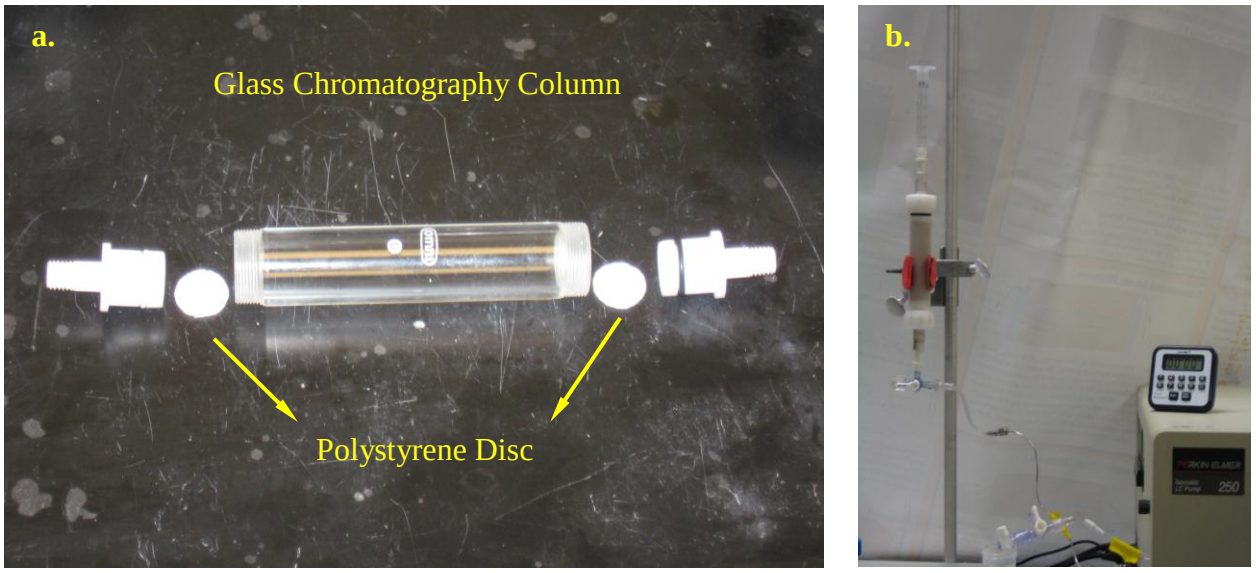

Figure S1. (a) Image of a 1.5 cm diameter, 6.8 cm long Omnifit glass chromatography column with 1.5 cm diameter polystyrene discs at two ends. (b) Image of packed column experimental setup.

Document S3. Bacterial diffusion coefficient determination

Figure S2 exhibits *P. putida* F1 bacterial random motility coefficient (μ_0) determined through capillary assays.

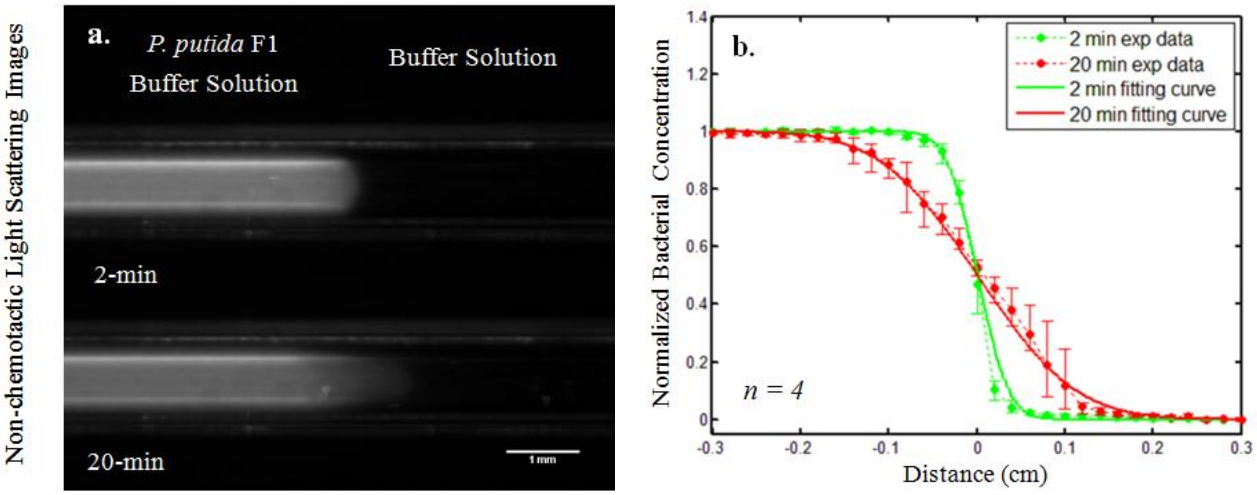

Figure S2. *P. putida* F1 initial 2-min and final 20-min light scattering images observed in static capillary assays (a) and corresponding normalized concentration profiles (exp data in b) with 1-D transport model fitting curve (fitting curve in b). The best fitted bacterial random motility coefficient (μ_0) is $3.2 \pm 1.2 \times 10^{-6}$ cm^2/s. The number of replicate experiments is indicated by n.

References:

(1) Vigeant, M. A.-S., M. Wagner, L. K. Tamm and R. M. Ford, Nanometer distances between swimming bacteria and surfaces measured by TIRAF microscopy. *Langmuir,* **2001,** *17*, 2235-2242.

(2) Harwood, C. S.; Fosnaugh, K.; Dispensa, M. Flagellation of *Pseudomonas putida* and analysis of its motile behavior. *J. Bacteriol.* **1989**, *171*, 4063-4066.

(3) Lewus, P.; Ford, R. M. Quantification of random motility and chemotaxis bacterial transport coefficients using individual-cell and population-scale assays. *Biotechnol. Bioeng.* **2001**, *75*, 292-304.

(4) Duffy, K. J., and Ford, R. M. Turn angle and run time distributions characterize swimming behavior for *Pseudomonas putida*. *J. Bacteriol.* **1997**, *179*, 1428-1430.