SUPPLEMENTARY INFORMATION

Model morphology of Diaphanoeca grandis

To prepare the geometry of *D. grandis* for CFD simulations, we use data collated from six individuals that are viewed from the side [6]. We assume that the cell surface and the outline of the lorica have rotational symmetry about the longitudinal axis. In polar spherical coordinates, the cell and the outline of the lorica are described as:

$$R(\theta) = R_0(1 + \alpha_1 \cos\theta + \alpha_2 \cos 2\theta + \alpha_3 \cos 3\theta) \quad \text{(S1)}$$

where θ is the polar angle, and R_0, α_1, α_2 and α_3 are shape parameters. Table S1 describes the shape parameters used for the cell and the lorica dome. The centerline of a single microvillus with circular cross-section of radius $0.075\,\mu$m is described as:

$$R_F(\theta) = R_C(\theta_C) + [R_L(\theta_L) - R_C(\theta_C)]\frac{\theta - \theta_C}{\theta_L - \theta_C} \quad \text{(S2)}$$

where $\theta_L = 25$ deg and $\theta_C = 76$ deg are angles where the microvillus connects to the cell and the lorica, respectively. This microvillus is then copied in a circular pattern to obtain 50 evenly distributed microvilli to construct the collar filter.

case	$R_0\,(\mu\text{m})$	α_1	α_2	α_3
Cell	2.8	-0.24	0.10	-0.10
Lorica	8.1	0.15	0.05	0.00

TABLE S1: Average morphology parameters used to describe the cell and outline of the lorica

Movies

Movie S1 shows a video recording of freely swimming individual of *D. grandis*. Movies S2 and S3 show the CFD simulation of the freely swimming *D. grandis* with and without its lorica, respectively.