Adaptive morphology of spiriferides for generation of passive feeding flows

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Optimality of sulcus function to generate passive feeding flows in the Devonian spiriferide brachiopod *Paraspirifer bownockeri* was theoretically examined by means of fluid dynamics simulations. The unsteady incompressible flow was solved using the finite volume method. Under a preference direction of a ventral valve facing an upstream flow, the pressure distribution along the gape showed that the models with a deeper sulcus could generate a strong inflow through the sulcus gape with comparative high pressure difference between the gape, as opposed to the case of the less-sulcus model. The inflow of the sulcus-bearing models formed a passive spiral flow with an axis of right-to-left direction inside the models, which seems to be favorable for a passive feeding because of its alignment on the spiriferid spiral lophophore. The passive flow inside the sulcus-bearing models behaved a similar movement as an outward spiral, but differed in its velocity. The model with a normal sulcus depth, whose form was same in original *Paraspirifer*, generated a stable and slow passive flow, unlike sensitively increased velocities in the deep and shallow sulcus models in the increasing velocity. The extant brachiopods appear to prefer a fairly slow and stable flow for their feedings, which is comparable with the present results of the original form. Ultimately, the hyperplastic sulcus may enhance function to generate a pressure difference along the gape, whereas the swift passive flow by an inflow through the sulcus gape seems to be unfavorable for passive feeding in spiriferides. These lines of evidence suggest that the suitable form of sulcus was dependent of a lotic environment.