

Flexion of hydroid colonies in a current

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Introduction:

Suspension feeding is a common feeding strategy among small sessile invertebrates. While active suspension feeders use metabolic energy to draw water through their feeding apparatus, passive suspension feeders depend on local currents to feed (Sponaugle and LaBarbera 1991). Erect colonies of passive suspension feeders therefore face a potential contradiction: how to increase the feeding surface such that sufficient flow will occur, while keeping drag forces on the feeding modules and colony low? Flexibility is a feature of many sessile organisms, and a strategy for dealing with drag: bending or stretching with the current allows for a morphological reconfiguration that alters the drag footprint of the animal. Vogel (1984) argues that this shape deformation can be adaptively useful, and is not necessarily merely a consequence of drag force on the organism. Several studies have investigated the effects of drag on Cnidarian colonies. Harvell and LaBarbera (1985) find that the natural flexibility of *Abietenaria rigida* (Cnidaria: Hydrozoa) colonies reduced drag on and velocity around polyps, in contrast to artificially stiffened colonies, which experienced a much greater drag force. Sponaugle and LaBarbera (1991) find that flexion in Gorgonian colonies in flow appears to function at least in part to reduce local flow velocity around polyps. Other studies (e.g. Hunter 1989) highlight the importance of flow velocity, directionality, and colony architecture in different flow regimes. This study aims to address questions of flexion in the hydroid *Obelia geniculata* Linnaeus 1758 (Cnidaria: Hydrozoa).

Study system:

The study organism, *Obelia geniculata*, is a colonial hydroid abundant on the tires on the dock at Friday Harbor Laboratories. Like many other colonial hydroids, it is a passive suspension feeder, relying on ambient current to push water through the feeding organ. The polyps are regularly spaced along each colony stem, alternating sides in a zigzag pattern. The colony morphology is fairly simple, with little branching off the main stalk. Colonies grow thickly on kelp blades in low to moderate current.

Materials and Methods:

Kelp blades hosting colonies of *Obelia geniculata* were collected off the dock at Friday Harbor Laboratories. Within an hour of collection, portions of kelp containing individual stalks of live and feeding *O. geniculata* were cut off, and the kelp superglued to microscope slides so that the colony and colony base would not contact the slide directly. Colonies of similar length (approximately 1.7 cm) and similar “branchiness” were chosen. Behavior of colonies in a current was recorded in a racetrack flume, with the slide sitting on the bottom. The slides were oriented such that any natural bend in the colony was downstream. Video of colonies was recorded by a Canon 7D in still water and at four different flow velocities. Flow velocity was determined using Tracker, and deflection angles were determined in ImageJ and Adobe Photoshop CS5.

Results:

The deflection angles of *O. geniculata* colonies are shown in Figure 2, and colony deformation in Figure 3. The thickness of the central stalk is fairly constant from proximal to distal ends of

the colonies, with some thinning between branch nodes; the average thickness of the central stalk of colonies 1, 2, and 4, are 0.15 mm, 0.16 mm, and 0.13 mm, respectively. Colony lengths and thicknesses are shown in table 1.

Discussion:

The three *O. geniculata* colonies studied displayed fairly different morphological responses to flow, though the measured deflection angles of the proximal part of the colony varied across similar ranges (approximately 20°) from no flow to higher velocity flow. This may indicate some general feature of the base of the colony, though the significance of this preliminary finding would need to be verified after further sampling. The colonies themselves showed variation in their initial, no-flow orientation, colony 1 being almost straight in the absence of current, and colony 3 quite bent, with an apparent point of curvature more proximal than distal. Colony 2 also shows some curvature, although the apparent radius of curvature is larger and is centered more distally in the colony.

As there was no apparent difference in stalk thickness along the lengths of the colonies tested, there is no immediately obvious explanation for the variation in bending response. Though these colonies were collected off the same kelp blade, it's possible that each stalk experienced differing and variable currents throughout its development, resulting in flow-induced differences in growth and morphology. This could account for the marked differences in posture of the hydroids in still water. Hughes 1978 noted that stiffness in hydroid colonies was under developmental control, and there is precedent for developmental response to flow in other

animals (e.g. bryozoans) (von Dassow 2006). Phenotypic plasticity has been explored in detail in sessile colonial animals like hydroids and bryozoans (e.g. Dudgeon and Buss 1996), and is likely important in discussions of colony architecture and drag resistance in suspension feeders.

Looking at the effects of drag forces on a single stalk removed from an environment in which many grow may be misleading; large colonies or assemblages of colonies may induce a sort of self-shading effect on some branches. One could imagine a drag effect analogous to self-shading in which the drag forces on interior branches are buffered by branches more exposed to flow. Furthermore, the size of colonies or colony assemblages may dictate at which scale drag effects are more important: small colonies feel drag effects more strongly at the polyp level, while dislodgment by drag forces becomes more important in larger colonies (Harvell and LaBarbera 1985). This study looked only at small colonies, taken outside their environmental context. With such a small sample size, it's impossible to fully explain or generalize these results. There are many avenues for further research which could be explored with *O. geniculata* or other hydroid colonies.

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Colony	Length (cm)	Thickness (mm)
1	1.796	0.153
2	1.737	0.16
3	1.067	0.13

Table 1. Measured lengths and thicknesses of colonies tested.

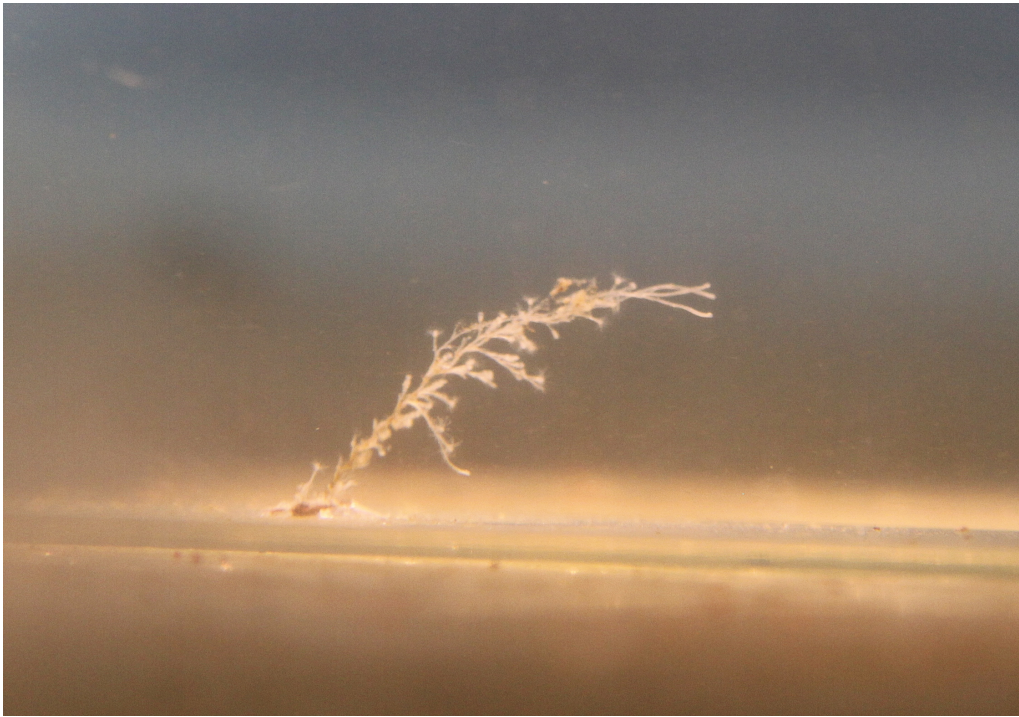


Figure 1. An *Obelia geniculata* colony.

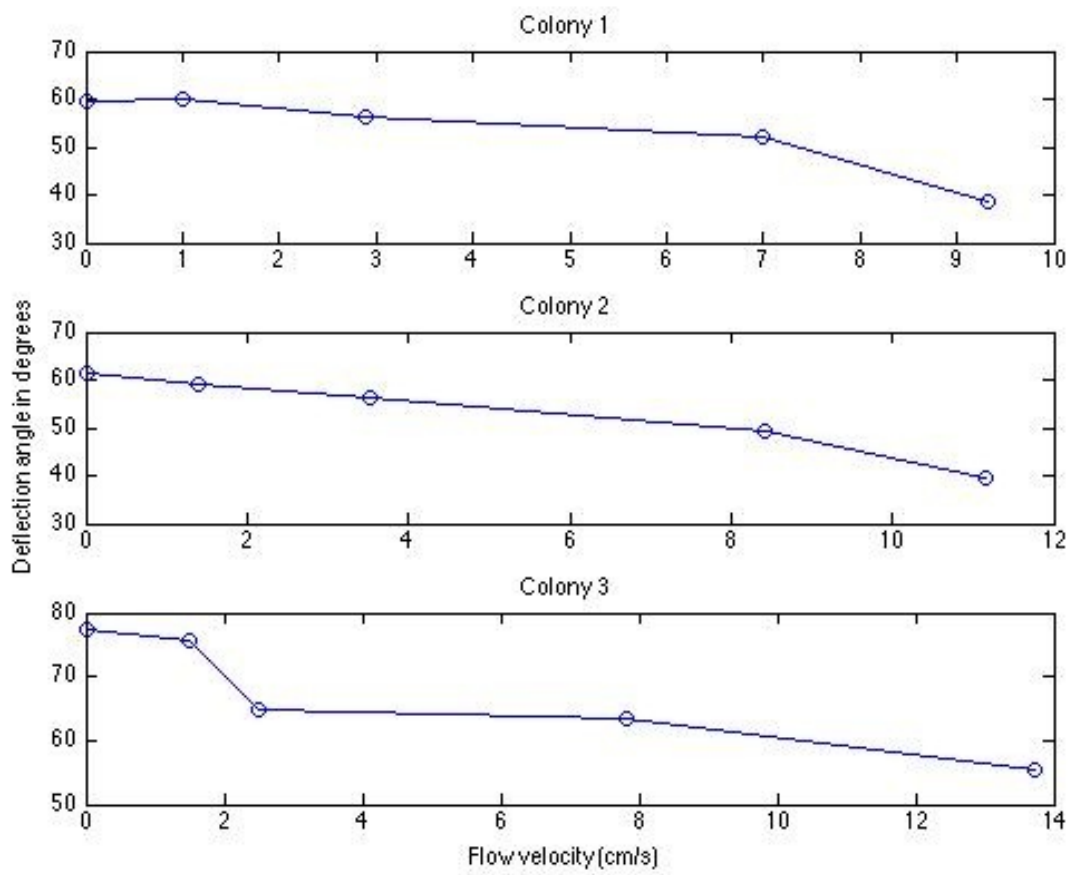


Figure 2. The angle of the deflection of the proximal end of the colony from the horizontal.

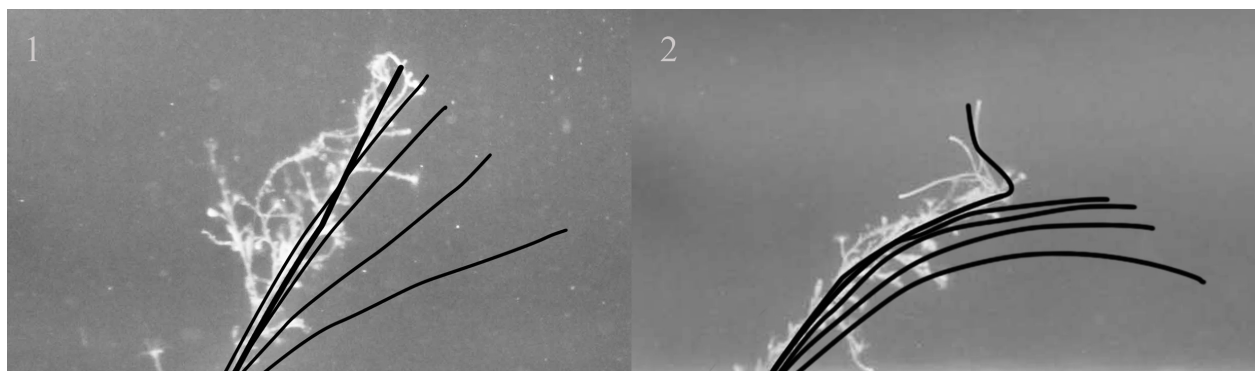


Figure 3. Colony flexion in the three colonies tested. Colony positions in increasing flow are superimposed on images of the colony in still water.