From Ecology to Biomechanics – Animal attachment in an aquatic flow environment

Living in extreme aquatic habitats, such as the marine intertidal or running waters with strong currents, often requires mechanisms to hold station. Animals attaching to submerged substrates in an aquatic environment face considerably different challenges than terrestrial ones. Flow forces, which are usually the dominant detachment forces in the aquatic environment, can reach very high magnitudes and are hard to predict.

Moreover, aquatic substrates have a wide variety of surface roughness, reaching from smooth to extremely rough. Benthic animals have evolutionary developed different attachment strategies to deal with these challenging conditions. Certain attachment devices show distinct advantages for certain substrate properties. For example claws need a minimum surface roughness, whereas some mayflies' attachment pads function on smooth surfaces as well. While manmade suction cups can only stick to smooth surfaces, animal suction discs can hold onto rough surfaces as well. Fouling presents another challenge since aquatic substrates are not clean, but rather are covered by bacteria, algae and invertebrates. This growth changes the attachment conditions for benthic organisms considerably. Depending on the type of attachment device attachment forces decrease or increase in the presence of biofilm.

Animals making a living in currents like the wave shaped marine intertidal or streams, can teach us how to attach in a challenging environment. Learning from Northern clingfish, a small fish living in the marine intertidal we developed a bioinspired suction cup (prototype) with the ability to reversibly and strongly attach to rough surfaces.

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