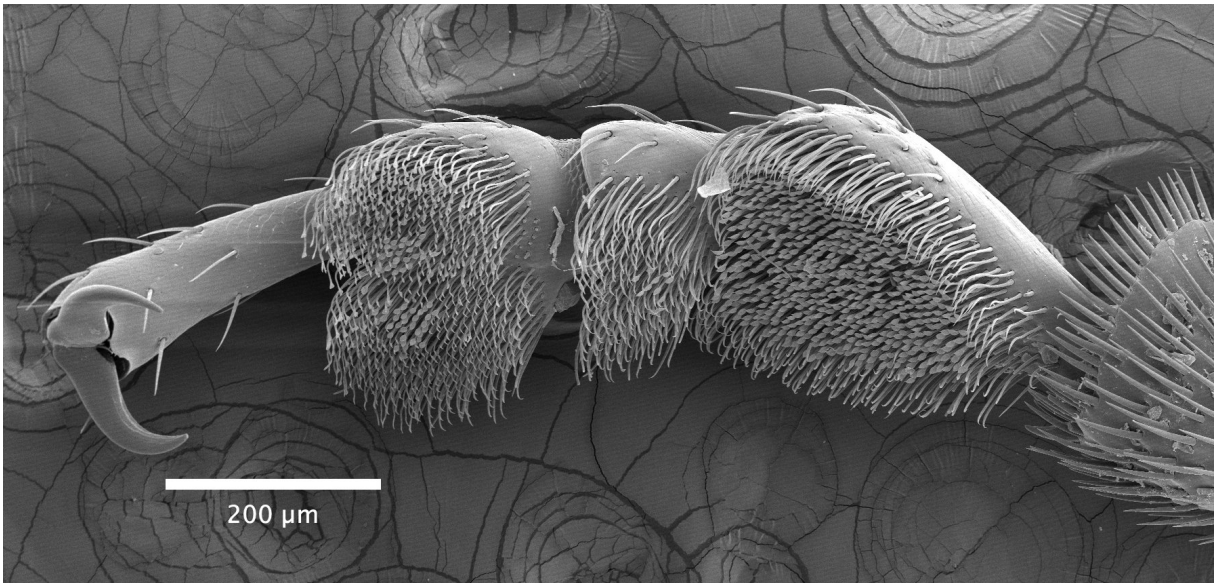
How can insects walk upside-down ?
The mechanics of beetle's wet and hairy adhesive pads

Tristan Gilet
Microfluidics Lab, Dept. Aerospace & Mech. Eng., University of Liege, Belgium



The miniaturization of pick-and-place robotics is currently limited by the challenge to control adhesion forces on a wide variety of substrates and on very short timescales. Insects have already solved this challenge: most of them can walk on about any surface in any orientation. Thanks to the adhesive pads on their tarsi, they generate appropriate adhesion and friction forces, and cancel them a fraction of a second later.

This talk will be focused on the hairy pads of beetles. I will mainly discuss two ingredients that guarantee a robust, efficient and controllable adhesion to different substrates: compliant microstructures (the hair tips), and the presence of a liquid secretion. I will first present *in vivo* experiments on the walk kinematics and mechanics of these hair tips. Our observations provide evidence that the hairs are in elastocapillary equilibrium. In a second time, I will show experimental measurements on a scaled-up physical model of a hair tip. The net adhesive force generated by the elastocapillary equilibrium is measured as a function of the proximity of the hair to the surface. I will finally discuss a beam model that captures well the experimental data and provides further insights about the mechanical behavior of these wet hair tips.