How Ants Climb Smooth, Vertical and Overhanging Walls

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Ants can climb smooth walls such as glass even if the wall is vertical or overhanging. It is well known that geckos use van der Waals forces between the foot and the wall to adhere to walls. However, it is a mystery how ants can climb smooth, vertical, and overhanging walls. Ants have claws, thin hair, and arolium pads. Arolium pads have adhesive secretions and are sucker shaped. Also, arolium pads attach to smooth surfaces, but the adhesion force on its own is insufficient to allow ants to climb smooth surfaces. The following four mechanisms are considered to be the candidates for the mechanism which ants mainly use to climb smooth, vertical, and overhanging walls: van der Waals forces, claws and thin hairs which hook asperities of the wall, adhesive secretions, and suckers. Ants fall from the smooth walls when the air pressure of the confining vessel is reduced to about 0.1~0.9 atmospheres depending on the angle of the wall to gravity. This result reveals that ants use arolium pads to suck on to smooth walls using air pressure. In addition, an experiment with glass beads attached on ants' legs and force balance calculations considering the friction force and pressure difference showed that ants use adhesive secretions to assist in adhering to smooth walls. From detailed observations of ant legs and glass surface by electron microscopy and surface energy consideration, effects of van der Waals forces and the use of claws and thin hair are negligible regarding ants climbing smooth walls.

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