Tilted cellulose arrangement as a novel mechanism for hygroscopic coiling in the stork's bill awn

Abstract

The sessile nature of plants demands the development of seed-dispersal mechanisms to establish new growing loci. Dispersal strategies of many species involve drying of the dispersal unit, which induces directed contraction and movement based on changing environmental humidity. The majority of researched hygroscopic dispersal mechanisms are based on a bilayered structure. Here, we investigate the motility of the stork's bill (Erodium) seeds that relies on the tightening and loosening of a helical awn to propel itself across the surface into a safe germination place. We show that this movement is based on a specialized single layerconsisting of a mechanically uniform tissue. A cell wall structure with cellulose microfibrils arranged in an unusually tilted helix causes each cell to spiral. These cells generate a macroscopic coil by spiralling collectively. A simple model made from a thread embedded in an isotropic foam matrix shows that this cellulose arrangement is indeed sufficient to induce the spiralling of the cells.

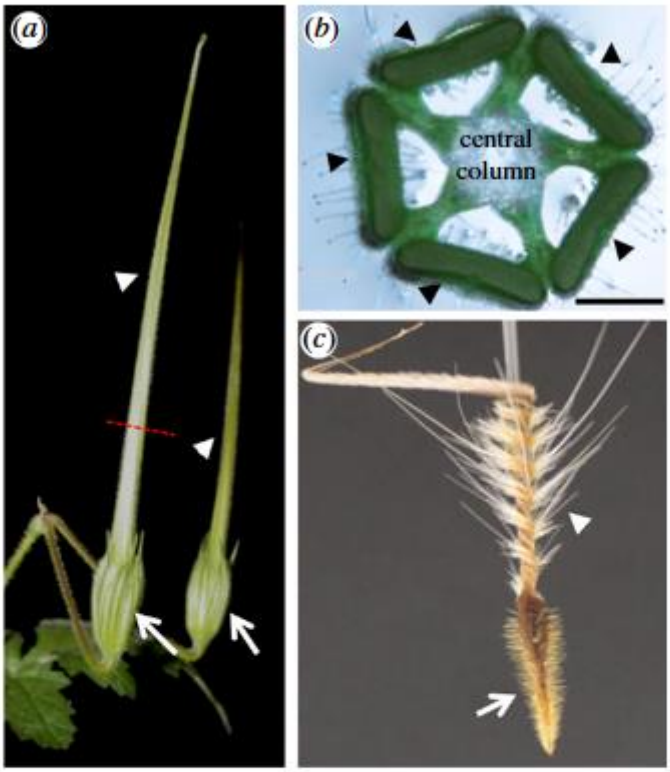

Figure 1. The morphology of the fruit of stork's bill (*Erodium gruinum*). (*a*) Two complete stork's bill-shaped fruits, about 4 days prior to ripening. Arrows indicate the location of the seed; arrowheads indicate the awns. Dashed red line indicates the part from which cross section (*b*) was taken. (*b*) *Erodium gruinum* fruit in cross section depicts five awns (indicated by arrowheads) connected by a central column. (*c*) Dry awned seed showing the coiling region (arrowhead) close to the seed (arrow). Scale bar, (*b*) 1 mm.