3D Traction Force Microscopy Reveals Asymmetric Cortical Forces in Migrating Dictyostelium Single Cells and Slugs

J.-P. Rieu[1], H. Delanoë-Ayari[1], M. Sano[2], Y. Hayakawa[3]

[1] Laboratoire de Physique de la Matière Condensée et des Nanostructures, Université Lyon I, 43 Boulevard du 11 Novembre, 69622 Villeurbanne, France;[2] Physics Department, The University of Tokyo, Japan ; [3] Tohoku University, Sendai Japan.

We present a 4D (x; y; z; t) force map of Dictyostelium vegetative cells and multicellular slugs crawling on a soft gel substrate.

Someway, both uni- and multicellular force maps look like the one of a capillary droplet on a surface: vertical forces are of the same order as the tangential ones. The substratum is pulled upward along the cell or slug edges, and it is pushed downward under the central part of the organism.

More specifically,

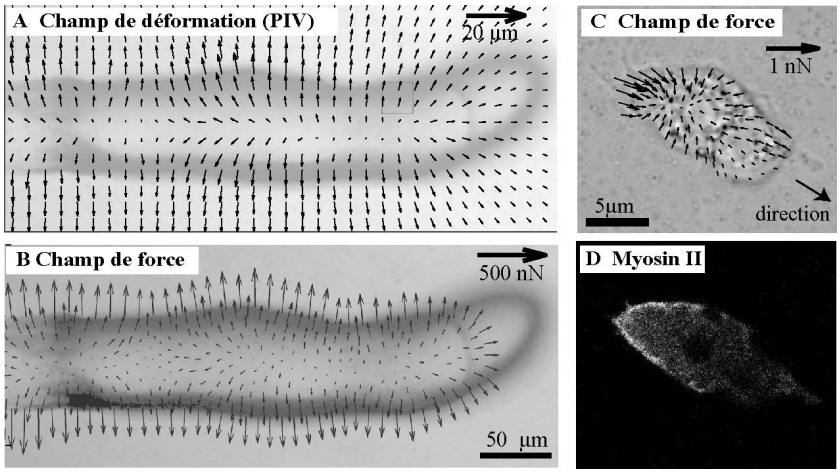
(1) In case of single cells, vertical forces are not detected in the extended pseudopods. We demonstrate quantitatively that the variations in the asymmetry in cortical forces correlates with the variations of the direction and speed of cell displacement. The nucleus and cytoskeleton seems to play an important role in the vertical pushing force [1].

(2) In case of slugs, the so called slime sheath, extracellular matrix (ecm) surrounding the slug, plays a fundamental role in the force transmission. Slug migration is not just the sum of individual cells crawling in response to chemotactic cAMP wave [2]. A completely different hydrodynamical mechanism with an internal tissue pressure acting against a shell with a lower resistance in the slug tip seems to propel forward the slug.

Figure:

(A) Deformation and (B) force map of a *Dictyostelium* slug.

(C) Force map of a single cell expressing fluorescent myosin II (D)



[1] H. Delanoë-Ayari et al. Phys. Rev. Lett. 105 (2010) 248103

[2] D. Dormann and C. Weijer. Development 128 (2001) 4535-4543