Self-organized mechano-chemical dynamics in amoeboid locomotion of *Physarum* fragments

Supplementary Information

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Spatio-temporal organization of traction stresses in migrating *Amoeba Proteus*

Similar to *Physarum polycephalum*, *Amoeba Proteus* has been widely used as a model organism of flow driven amoeboid locomotion [1, 2]. The length of *Amoeba proteus* cells is a few hundred microns, which compares well with the length of the *Physarum* fragments we used for this study. Additionally, both organisms have active endoplasmic flows and undergo shape oscillations during locomotion [1, 3]. However, the dynamics of their cell-substrate adhesions are remarkably different. Unlike *Physarum* fragments, *Amoeba Proteus* forms localized stationary adhesion sites that can be clearly observed in instantaneous traction stress maps (Figure 1*a*). The adhesion sites first appear in the anterior region of the amoeba with the traction stress vector pointing backward and remain at the same location while the cell body moves over them. During this process, the traction stresses vectors gradually change direction from backward- to forward-pointing, as the adhesion transitions from being a frontal adhesion to being a rear adhesion. This spatio-temporal coordination of cell-substrate adhesions can be appreciated in kymographs of longitudinal traction stresses (Figure 1*b*), and is similar to that previously reported for smaller amoeboid cells such as *Dictyostelium* [4]. Our findings are consistent with previous studies that showed *Amoeba Proteus* cells seem to "walk" on the substrate and only adhere to it at discrete locations with small protrusions called minipodia [1, 5].

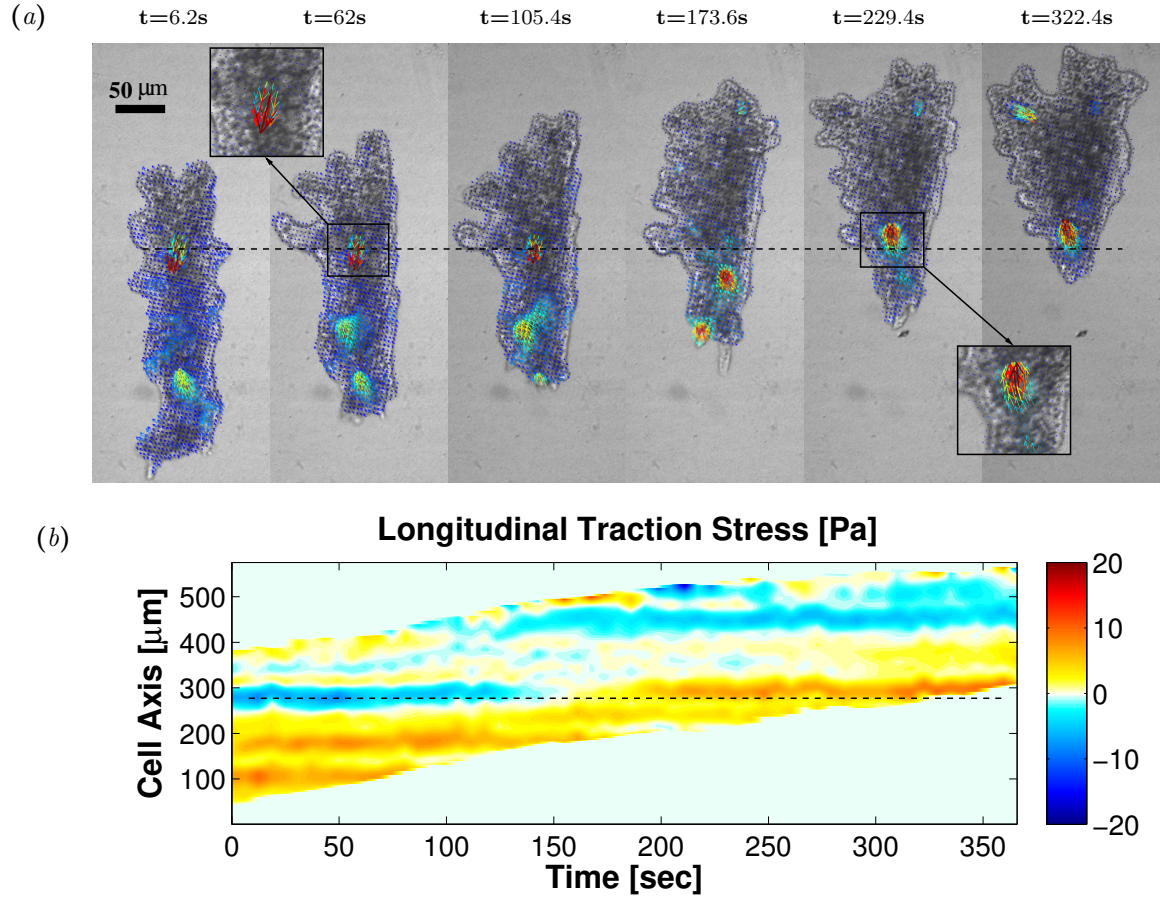

Figure 1: (*a*) Instantaneous traction stresses exerted on the substrate by a migrating *Amoeba Proteus*. The arrows show the tractions stresses. The dashed line indicates the position of a specific adhesion site. (*b*) Kymograph of longitudinal traction stress for the same migrating *Amoeba Proteus*. The dashed line indicates the position of the same adhesion site as in Figure 1*a*.

[1] Dellinger, O. P. 1906 Locomotion of amoebae and allied forms. *Journal of Experimental Zoology Part A: Ecological Genetics and Physiology*, **3**, 337–358.

[2] Yanai, M., Kenyon, C., Butler, J., Macklem, P. & Kelly, S. 1996 Intracellular pressure is a motive force for cell motion in amoeba proteus. *Cell motility and the cytoskeleton*, **33**, 22–29.

[3] Satoh, H., Ueda, T. & Kobatake, Y. 1985 Oscillations in cell shape and size during locomotion and in contractile activities of physarum polycephalum, dictyostelium discoideum, amoeba proteus and macrophages. *Experimental cell research*, **156**, 79–90.

[4] Bastounis, E., Meili, R., Alvarez-Gonzalez, B., Francois, J., Del Alamo, J. C., Firtel, R. A. & Lasheras, J. C. 2014 Both Contractile Axial and Lateral Traction Force Dynamics Drive Amoeboid Cell Motility. *Journal of Cell Biology*, **204**, 1045–1061.

[5] Grebecki, A., Grebecka, L. & Wasik, A. 2001 Minipodia, the adhesive structures active in locomotion and endocytosis of amoebae. *Acta Protozoologica*, **40**, 235–248.