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A mathematical model for the mode transition of locomotion in *Amoeba proteus*

In amoeba locomotion, pseudopods extend toward the direction of motion [1]. Recently, we found that the pseudopod of *Amoeba proteus* shows the characteristic extension modes depending on the tail speed of amoeba. When the tail speed is high, the pseudopod extends at almost constant speed (Smooth mode.) On the other hand, when the tail speed is low, the pseudopod extends and stopps alternately (Oscillatory mode.) Namely, the extension of the pseudopod shows the mode transition from the smooth mode to the oscillatory mode as the tail speed decreases. In the conventional understanding, the tail contraction was considered to be the origin of motile force of the locomotion in *Amoeba proteus* [2]. Our finding suggests that the tail contraction also contributes the pseudopodial extension patterns which exhibit the mode transition.

To understand the mechanism, we construct a mathematical model. In our model, the amoeba is described as an elastic tube in which the protoplasmic sol is confined. The locomotion is driven by the tail contraction. The head is extended by the inner pressure, and the velocity of the head is controlled by the softness of the head. Our model successfully represented the mode transition from the smooth mode to the oscillatory mode as the tail speed decreases.

References

[1] McNeill, A. R., *Exploring biomechanics: Animals in motion* W.H.Freeman and Company, New York, 1992.
[2] Sonobe, S., and Nishihara, E. *Cell biology of Amoeba proteus.* Jpn J Protozool, **37** 159–167, 2003.