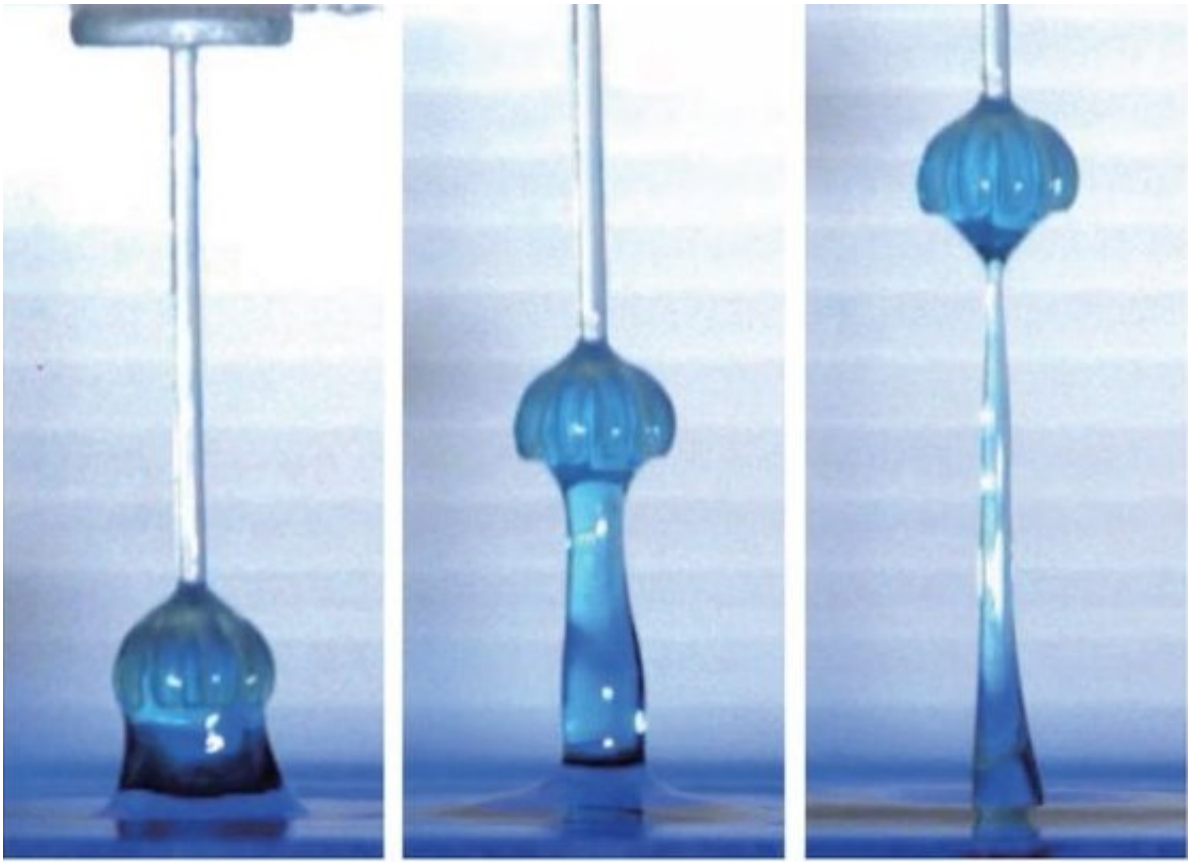
Bioinspiration—plant-inspired pipettes

May 7 2018, by Anita Kristiansen



Credit: The Royal Society

The authors of a new article published in *Journal of the Royal Society Interface*, "Plant-inspired pipettes", sought inspiration from the liverwort, a widely spread plant, for the creation of a bioinspired pipette. We asked one of the authors, Hirofumi Wada, about the study.

What inspired the study?

Two years ago, by chance, I got to know Dr. Tetsuya Hisanaga, who is a developmental plant biologist. He showed me a photo of a liverwort (Marchantia polymorpha) grabbing a large droplet of water, which caught my eye as a physicist. This interaction inspired the idea of this work.

At that time, my student Keigo Nakamura had just started his master's degree. He was looking for a research subject about capillarity. We first started the project to understand how the liverwort organ can grab the water, but we soon redirected the project towards designing bioinspired technology. We were convinced by our biologist co-authors that real liverworts are too complex to study with a physical approach.

The first generation of plastic models exactly mimicked the shape of the liverwort and showed a complicated meniscus that was difficult to analyse. We inverted the structure of the model, and focused on its basic physical behaviours. Nakamura then played with the 3-D-printed models and discovered several remarkable properties, such as velocity-dependent water capture and tilt-induced dropping. At that point, we were convinced that it could be a pipette. We then eventually designed systematic experiments to search across various parameter spaces, as described in the paper.

Why is 3-D printing used for the creation of the pipettes?

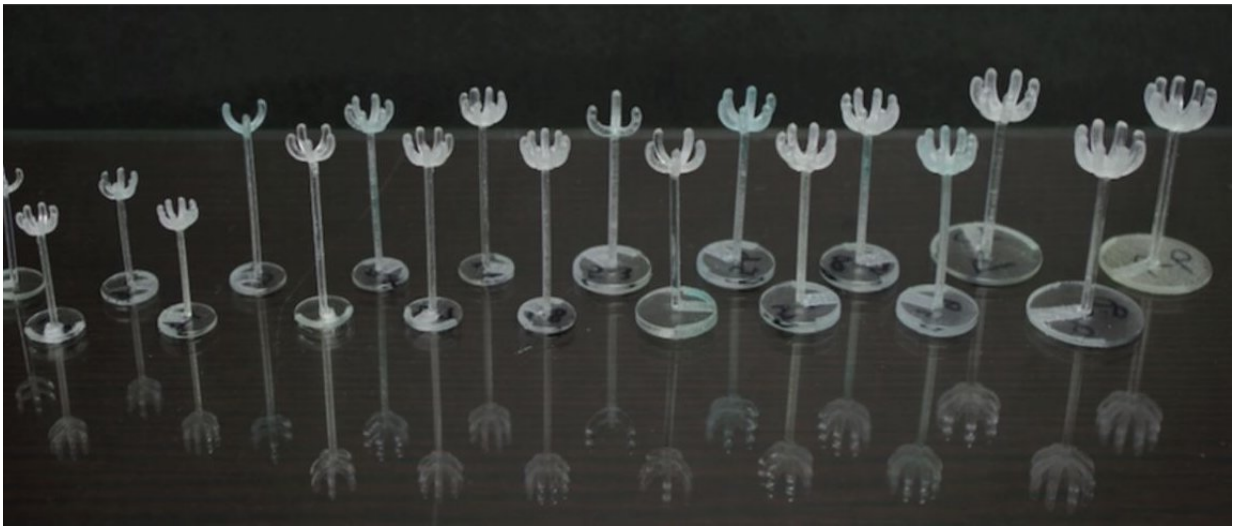
We wanted to design a precision experiment of physical models with controlled geometric parameters for a quantitative study. Computer-assisted 3-D printing was the best approach for this purpose. Before this project, we had no experience with a 3-D printer. However, our

department has a manufacturing centre with technicians and several 3-D printers available for us to use. The technicians provided great support in the beginning, and soon, Nakamura became an expert at fabricating with the printers. Using a 3-D printer to create various plastic models to play with was not challenging, but rather, great fun.

Why are the results of the paper important?

Firstly, the main result of our study is easily accessible to anyone. It is also fun and counter-intuitive to see such a simple device grab that much water. Our study, for the first time, sheds light on the biomechanic aspect of the liverwort, which is a land plant present in almost every available habitat on Earth.

In addition to these academic reasons, our study contributes a new perspective on how to deal with a large water droplet, which might find future applications in different areas of engineering. One possibility is medical engineering. We envision the pipettes could be a low-cost option for pipetting in resource-poor situations (e.g. small clinics in developing countries). More realistically, we envisage them being used during science education in schools.



Credit: The Royal Society

We are a team of physicists and biologists, and therefore hope that these results will be relevant to the research of physical scientists working with soft matter and biophysics. Additionally, we hope that engineers and product designers will be interested in our work, and that this study will be accessible to students and schoolteachers.

"We envision the pipettes could be a low-cost option for pipetting in resource-poor situations."

Why did you decide to submit to Interface?

We believe *Interface* is the best place to publish this work, since the journal provides a unique meeting point of physics, biology, and engineering, with visibility and a high standard. Overall, we are satisfied with our experience, and are really excited we published our paper in *Interface*. We received three review reports which were constructive and useful: they helped us improve the paper significantly. The revision phase was a bit tight, with only three weeks for us to complete our revision. The deadline seemed strict. However, the process was quick, precise, and reasonable, and there was no frustration at all throughout the entire editorial process. We greatly appreciate the careful and precise handling and editing of our paper by the editor and the publishing team.

What is next for you/your group?

We want to extend this work by including elasto-capillarity, i.e. elastic

deformations of a flexible object by the surface tension of a liquid. We are also interested in creating new bioinspired systems and exploring the underlying physics.

More information: Keigo Nakamura et al. Plant-inspired pipettes, *Journal of The Royal Society Interface* (2018). DOI: 10.1098/rsif.2017.0868

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