Continuous directional water transport on the peristome surface of *Nepenthes alata*

With the support by the National Natural Science Foundation of China, Prof. Chen Huawei (陈华伟), Zhang Deyuan (张德远), and Jiang Lei (江雷) *et. al.* at the Beihang University, found the directional water transport phenomenon on the peristome surface of *Nepenthes alata* , and uncovered the mechanism endowing this unique directional water transport, which was published in *Nature* (2016, 532(7597): 85—89).

Carnivorous pitcher plant *Nepenthesalata*, living in nutrients poor habitats, can capture and digest insects to meet the fundamental nutrients needs by means of the slippery peristome. This slippery function is caused by the completely wetted peristome surface, resulting in the insects' easy-sliding into the pitcher when crawling on it, known as 'aquaplaning'. Previous studies have investigated the effects of the water film on the insect-prey and characterized the surface morphology, and slippery surfaces have been designed mimicking the slippery function. However, questions remain about the mechanism underlying its function.

They first found the directional water transport phenomenon on the peristome surface of *Nepenthes alata* by observing the water movement on the surface after being deposited. By *in situ* observation and surface structure analysis, they found that this unique water movement phenomenon results from its multiscale structure, which optimizes and enhances capillary rise, and prevents backflow in the reverse direction. The overlapped duck-billed micro-cavities, scattering along the two-order microgrooves, with gradient wedge corner, can produce top-closed gradient capillary rise, resulting in a continuous filling of the microcavity. The sharp edge of the micro-cavity tends to favour water pinning, satisfying the condition of Gibbs inequality. By changing the surface wettability of artificial replica of the peristome surface, they also found the hydrophilicity is crucially important for the directional water transport, which does not occur on the hydrophobic replica. This results not only in unidirectional flow despite the absence of any surface-energy gradient, but also in a transport speed that is much higher than previously thought. The mechanism underlying this phenomenon gives a new insight of designing of surface and materials with directional water transport and might find use in applications in non-powered self-lubrication in mechanical engineering, MEMS, agricultural drip irrigation, anti-adhesion of medical instrument or in the non-powered delivery of microdrugs.

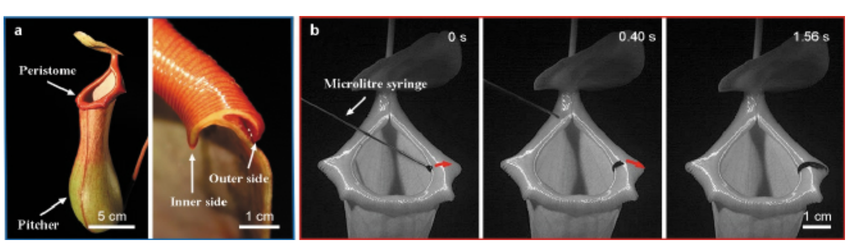

Figure Directional water transport on the peristome surface of *Nepenthes alata*. (a) A Pitcher of *Nepenthes alata* and its cross-sectional. (b) Water is transported directionally from inner side to outer side.