How Do Butterfly Wings Repel Water? The Relationship between Super-Hydrophobicity and the Fine Structure Common to Butterflies

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Butterflies can fly on rainy days without their wings getting soaked with water. However, there are few studies comparing differences in hydrophobicity and in the factor among species or wing parts from the viewpoints of contact angle and sliding angle. The purpose of this study is to characterize the microstructures on wings for applications in biomimetic products. Droplets of water (2.5 μL) were dropped on the wings of 9 species of butterflies, and the measured contact angles indicated super-hydrophobicity. To identify minute bumpy structures that could be factors for hydrophobicity by the lotus effect, wings were observed under field-emission scanning electron microscopy. Fine network structures with intervals of 1 to 2 μm were observed on the scale surfaces. To measure sliding angle, 2.5 μL water droplets were placed on wings from 6 species, and the wings were tilted in each direction (with and against the scales). Sliding angle was smaller for tilt in the direction of the scales, particularly for the undersides of the wings for all butterflies. For the underside of the wing, electron microscope observations confirmed that scale angles were smaller, so that the difference in sliding angle is greater due to the pinning effect. On rainy days, butterflies fold their wings with the undersides facing outward and hang under leaves so that these structures function to protect the butterfly from getting soaked. Replicating the microstructures of butterfly wings is considered useful for the development of materials with directional hydrophobicity like raincoats or umbrellas.

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