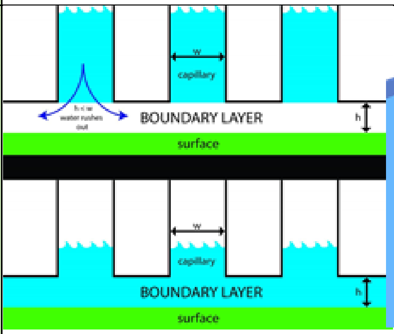
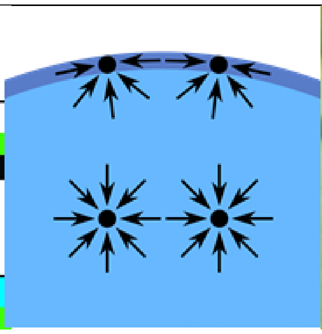
生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	附著於平滑表面上的吸盤 (Pads Attach to Smooth Surfaces)
生物系統 LIVING SYSTEM	吸盤足蝠 *Myzopoda aurita* (Sucker-footed bats)
功能類別 FUNCTIONS	#在固體上移動 #暫時性附著 #Move in/on solids #Attach Temporarily
作用機制標題	吸盤足蝠手腕和腳踝上的吸盤藉由濕附著性而吸附在光滑的表面上 (Pads on the wrists and ankles of sucker-footed bats attach to smooth surfaces via wet adhesion.)
生物系統/作用機制示意圖	  

作用機制摘要說明 (SUMMARY OF FUNCTIONING MECHANISMS)

大多數種類的蝙蝠都利用腳趾甲抓在粗糙的表面上倒吊著棲息。吸足蝙蝠(sucker-footed bat) 則是個例外，因為牠們用手腕和腳踝上的吸盤 (pad) 緊緊吸附在葉片表面，在捲起的葉片裡以頭部朝上的方式棲息。這些蝙蝠最初被認為用吸力附著在樹葉上，但近年的證據顯示，牠們實際上使用濕附著性 (wet adhesion) 來附著在葉片表面。

濕附著性是由水的幾種特性引起的。第一種叫做「表面張力」 (surface tension)，這使迴紋針能被小心地擱置在一杯水的表面上，即使它的密度比水更大，如果掉進液體中還是會下沉。水分子被許多叫做「氫鍵」(hydrogen bond) 的微弱鍵結所吸引。水被其它水分子從各方面包圍著，例如在一定體積的中心，會以各個方向均勻地被拉開。然而在表面的水，或是在邊界層，就只有幾個鄰近分子，所以水與水分子們更強烈地連結，使這裡的分子更難分離。正因為這個原因，水表面就像一個拉伸的彈性膜，允許迴紋針停在上面。因為水分子相互連結的內聚力 (cohesion)，它們也可以互相拉扯，如虹吸現象 (siphoning)。最後，水的黏性也導致附著於表面的附著力 (adhesion)，這是你可以看到它爬在玻璃表面的方式。在「毛細作用」(capillary action) 中，對表面的附著力與表面張力相結合，使水即使在重力作用下也能在狹窄的管子上爬行。濕附著性是結合水的所有這些特性而產生作用的。

吸盤足蝠透過釋放液體到手腕和腳踝的吸盤來附著在葉子上。這些吸盤上飾滿脊紋 (ridge)，這充當了毛細管 (capillary) 並在液體釋放時幫助保留這些液體。當吸盤與葉片接觸時，毛細作用會將液體從脊紋中拉出，並進入吸盤和葉片表面之間的間隙，又稱為邊界層 (boundary layer)。當邊界層的高度 (h)（或是蝙蝠吸盤和葉片表面之間的距離）小於吸盤的脊紋的寬度 (w) 時，毛細作用就會使液體流到葉子表面。附著力確保液體附著在葉片表面，而內聚力則將所有保持液體在一起，使蝙蝠能附著。當蝙蝠吸盤從葉片表面上拉開時，會增加邊界層的高度，毛細作用會使邊界層中的液體流回脊紋中以被再次使用。

透過利用水特性產生的濕附著力，吸盤足蝠可以在光滑的表面上附著並爬行，而無需額外的外力支撐。

Most species of bats roost upside-down, using their toenails to cling to rough surfaces. Sucker-footed bats are an exception, as they roost head-up inside furled leaves by clinging to the walls of the leaf with pads on their wrists and ankles. It was originally thought that these bats attached to leaves using suction, but recent evidence has shown that they actually use wet adhesion to attach to leaf surfaces.

Wet adhesion is caused by several properties of water. The first, called “surface tension”, is what allows paperclips to be carefully rested on the surface a container of water, even though they are denser than water and sink if dropped into the liquid. Water molecules are attracted to each other by lots of weak bonds called “hydrogen bonds”. Water surrounded by other water molecules on all sides, for example in the middle of a volume, will be pulled equally in every direction. However, water on the surface, or boundary, has only a few neighbors, and so it binds more strongly to them, making molecules here harder to separate. Because of this, the water surface acts like a stretched elastic membrane, allowing paperclips to sit on top. Because water molecules bind to each other (“cohesion”), they can also be used to pull each other, as in siphoning. Finally, the stickiness of water also makes is adhere to surfaces (“adhesion”), and you can see this in the way it creeps up the side of a glass. In “capillary action”, adhesion to surfaces combines with surface tension to enable water to creep up narrow tubes, even against gravity. Wet adhesion is a combination of all of these properties of water working together.

Sucker-footed bats attach to leaves by releasing fluid onto their wrist and ankle pads. These pads are studded with ridges, which act as capillaries and help retain the fluid as it is released. When the pad comes in contact with the leaf, capillary action pulls the liquid out of the ridges and into the gap between the pad and the leaf surface, known as the boundary layer. Capillary action causes the liquid to flow onto the leaf surface when the height (h) of the boundary layer (or the distance between the bat’s pad and the leaf surface) is smaller than the width (w) of the ridges of the pad. Adhesion ensures the liquid is attached to the leaf surface, while cohesion keeps all the liquid together and the bat attached. When the bat pulls its pad off the leaf surface, increasing the height of the boundary layer, capillary action causes the liquid in the boundary layer to flow back into the ridges to be used again.

Through wet adhesion, which takes advantage of the properties of water, sucker-footed bats are able to adhere to and climb along smooth surfaces without additional external support.

文獻引用 (REFERENCES)

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