Dragonfly wings

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Dragonflies belong to the order Odonata and are known to be one of the most ancient insects living on the planet. The meaning of the term "Odous " is " tooth ". The dragonflies are aerial predators, grab the prey with their basket type feet/ legs. Post catching, they tear off the wings of their prey with the help of their sharp mandibles. It is believed that the first dragonfly had existed somewhere around 300 million years ago. In fact, the largest insect recorded on this planet *Meganeuropsis permiana*, the extinct ancestor of present-day dragonflies had a wingspan of around three feet. This mighty creature was known to have existed prior to the reign of the dinosaurs. Approximately 6337 species of dragonflies exist worldwide. Their habitats range from wetlands to bogs. Dragonflies are often considered as apex predators in the world of insects. They are known to have nearly 98% success rate as a hunter.

The wings of these insects are outgrowths of exoskeleton which helps them in flight. The wings are located at the mesothorax and the metathorax (second and third thoracic segments). The four wings are mostly referred to as the hindwings and the forewings. Dragonflies have their flight muscles attached to their wings. Unlike other insects dragonflies are known to spread out their wings while resting. Dragonflies have two pair of wings and each of them work independently, allowing them to alter the angle of individual wings and increase their agility during flight. Apart from being agile some species are known to reach a speed of almost 18 miles/ hour.

Dragonflies are known to be expert fliers, their wings are known for stability and can bear high load during flapping, hovering and gliding. The wings are primarily composed of veins and membranes. The membranes, a Nano composite material and veins make the wings extremely versatile thus making dragonflies a maneuverable flier. The structure of the wings, specifically the corrugation is known to intensify their aerodynamic skills. They are among the rare species who are known to mate in mid air. Infact their inability to fly becomes a reason for them to starve to death. They are known to hunt preys only during flight. Dragonflies

catch flies or any other insects during their flight and eat them. Studies and observations have confirmed that the thorax of this insect needs to reach 25˚ Cprior to its first flight of the day. Therefore, it is very essential that each of them basks in the sunlight before starting a whole new day

The unique flying pattern has set dragonfly apart from the rest in the insects and flying animals. Majority of the flying creatures are known to engage in a back-and-forth stroke. In contrast to the common pattern, a dragonfly pushes its wings downward and backward followed by upward and forward directions. They do not try to overcome the drag, instead use the same to stay aloft. This asymmetrical flapping of wings results in downward strokes which in turn creates the drag.

The drag plays a crucial role in supporting the weight of the body. The asymmetrical flapping also helps in conserving the body energy. As it beats out of phase the wings located at the back creates an induced flow which again reduces the drags on its fore wings. When a dragonfly flaps its wings, it unintentionally creates a tiny whirlwind below it. The asymmetric rowing motion, i.e. the upward drag is created during the down stroke helps support their body weight.

The architectural properties of the wings make a dragonfly an excellent flyer. The main structure components i.e the veins are connected by the resilin which are known for its high elastic property, at many joints. The wings have numerous longitudinal veins which are often connected. They form closed cells in the membranes. It has been observed that though dragonflies are stiff insects yet they can easily undergo passive deformation during their flight. This action contributes massively to their unique aerodynamic performances. The secret to this extraordinary ability is the presence of resilin which is believed to be the key component that contributes to the movement to their wings. The presence of this rubber-like protein in their wing vein joints and connecting longitudinal to the cross veins. Thus, endowing their wing with the chord wise flexibility. It is believed that resilin is responsible for the flight performance of this insect.

Resilin is also found in the internal cuticle layers of the veins. Along with the structural feature of veins of the wings, the thickness and the number of the cuticle layers, cross sectional shape and material composition, resilin probably contributes to the material properties of the veins and also determines the degree of the elastic deformation. Dragonflies are known to be highly corrugated insects, this unique feature helps in maintaining the stiffness and strength of their wings. The lightweight structure significantly contributes to its aerodynamic performance. Each wing of a dragonfly has muscles that allow the wings to swap the frequency of strokes, angle of attack, phase and amplitude. As already mentioned during the flight the hind wings make frequent upbeat whereas the fore wings beat downwards.

AUTHOR

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