Biomechanical Analysis of Labial Movement in the Hunting of Dragonfly Nymphs

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Dragonfly nymphs are known for their ability to rapidly snatch prey by extending their folded labia, despite the resistance of water. The labia of dragonfly nymphs can be categorized into two types based on their shapes; Scooped and Flat. Orthetrum albistylum and Anax parthenope were selected respectively as the most representative species of the labial types. This study aimed to examine the hunting behavior of dragonfly nymphs through analyzing the biomechanical characteristics of the labia. First, we conducted a quantitative analysis of the labium structures by measuring the length, mass, and joint angle of each part through anatomical dissection. The result showed that the scooped labium has limitations in opening its joints compared to the flat one due to structural difference. Second, we analyzed hunting videos of dragonfly nymphs using the Tracker program to measure physical quantities such as velocity and acceleration. The average striking velocity of the labium is 0.4m/s in O. albistylum and 1.5m/s for A. parthenope. Third, we conducted two additional biomechanical analyses: (1) we calculated the magnitude of the force involved in the strike and (2) we compared the water resistance that the labia encountered during hunting using a second-order differential equation that calculates terminal velocity of damped oscillation. In summary, ecological differences between O. albistylum and A. parthenope. can also be explained. O. albistylum is better adapted to catching small prey, whereas A. parthenope is more adept at catching larger and faster prey. This study is not only expected to contribute to better understanding of insects but is also expected to be highly valuable for future research on biomimetic devices.

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