Abstract Submitted
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A numerical and theoretical study on the aerodynamics of a rhinoceros beetle (Trypoxlyus dichotomus) and optimization of its wing kinematics in hover[1] SEHYEONG OH, BOOGEON LEE, HYUNGMIN PARK, HAECHEON CHOI, Seoul Natl Univ — We investigate a hovering rhinoceros beetle using numerical simulation and blade element theory. Numerical simulations are performed using an immersed boundary method. In the simulation, the hindwings are modeled as a rigid flat plate, and three-dimensionally scanned elytra and body are used. The results of simulation indicate that the lift force generated by the hindwings alone is sufficient to support the weight, and the elytra generate negligible lift force. Considering the hindwings only, we present a blade element model based on quasi-steady assumptions to identify the mechanisms of aerodynamic force generation and power expenditure in the hovering flight of a rhinoceros beetle. We show that the results from the present blade element model are in excellent agreement with numerical ones. Based on the current blade element model, we find the optimal wing kinematics minimizing the aerodynamic power requirement using a hybrid optimization algorithm combining a clustering genetic algorithm with a gradient-based optimizer. We show that the optimal wing kinematics reduce the aerodynamic power consumption, generating enough lift force to support the weight.

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