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Ground Effect on Marine Midge Water Surface Locomotion

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Abstract : Midges can move on the surface of the water at speeds of approximately 340 body-lengths/s and can move continuously for >90 min. Their wings periodically scull the sea surface to push water backward and thus generate thrust; their other body parts, including their three pairs of legs, touch the water only occasionally. The aim of this study was to investigate the locomotion mechanism of marine midges with a size of 2 mm and living in shallow reefs in Wanliton, southern Taiwan. We assumed that midges generate lift through two mechanisms: by sculling the surface of seawater to leverage the generated tension for thrust and by retracting their wings to generate aerodynamic lift at a suitable angle of attack. We performed computational fluid dynamic simulations to determine the mechanism of midge locomotion above the surface of the water. The simulations indicated that ground effects are essential and that both the midge trunk and wing tips must be very close to the water surface to produce sufficient lift to keep the midge airborne. Furthermore, a high wing-beat frequency is crucial for the midge to produce sufficient lift during wing retraction. Accordingly, ground effects, forward speed, and high wing-beat frequency are major factors influencing the ability of midges to generate sufficient lift and remain airborne above the water surface.

Keywords : ground effect, water locomotion, CFD, aerodynamic lift
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