

Planetary Exploration Using Biomimetics

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The Mars environment, particularly the low atmospheric density, makes flight much more difficult than on Earth, requiring an aircraft to fly within a very low Reynolds number/high Mach number regime. A possible solution is the use of an entomopter, a mechanical flying machine utilizing insect flight characteristics. Their similar Reynolds number flight regime indicates air vehicle system potential for future Mars exploration missions.

Insects are able to fly at a significantly higher Coefficient of Lift (C_L) than conventional airplanes ($-C_L = 1$), due to their unique lift generation mechanisms. Utilizing these mechanisms as well as flow control over the wings, an entomopter can achieve lift coefficients from 5 to 8 times higher than those theoretically possible from the wing shape itself. This enhanced lifting capability could allow an entomopter to carry up to 15 kg of payload while flying at 30 m/s.

The Phase II program will involve investigation of the aerodynamics, appropriate propulsion methods, Mars compatible propellants, and the potential for fuel synthesis from indigenous materials. Autonomous and self-stabilizing behavior and control will be investigated for flight operations, refueling, communications, and navigation. The existing body of knowledge from terrestrial applications research and patents will be leveraged to enhance the vehicle's capabilities.

An entomopter based exploration vehicle system with *in situ* generated refueling could provide a flexible system for long duration exploration of the Mars surface. A 1 m. wingspan entomopter may be an elegant and practical architecture to produce a vehicle with the ability to take off, land, return samples, and even hover, providing significant mission capability enhancements over conventional aircraft.

