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On Speed of Pentatomid Bug *Tesseratomajavanica*

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Abstract: Flight balance and a low speed wind tunnel was constructed in the laboratory to study the speed of the insect; lift and thrust at different wind velocities ranging from 1 m/sec to 10 m/sec. This wind tunnel provides streamline flow of air and wind speed can be continuously varied. The horizontal speed of *T.javanica*, thus measured, is 283 ± 53 m/sec

Key Words: Suspender, flight balance,angle of attack

1.Introduction

Small insects move through the air at low speeds.But, if the wing beat frequency is high, the movement involves high accelerations. Vogel [1] points out that size and speed of the airflow are complementary factors, since the Reynolds number, the relevant index to the flow regime, involves a product of length and velocity. Re = (ρ V l) / η, where 'ρ' is the density of the air, η is its viscosity, for the flight of *Schistocercagregaria*, Re is approximately 2000 [2]. At such values and above, turbulent motion can occur in the air and high values of lift coefficient C_L are obtained from well-designedaerofoils at optimum angles of attack. As Re falls to the value of about 100 the maximum lift coefficient gets less and is obtained at higher angles of attack (45 – 50). Thom and Swart,[3], Vogel [4,5]. Then drag coefficient increases and becomes less dependent on the angle of attack. Finally at values of Re less than about 20, vertices cannot form and the drag coefficient remains greater than the lift coefficient at all anglesof attack. The drag is now almost entirely due to skin friction and is independent of the shape and orientation of the object, being merely proportional to its surface area. Horridge[6] argued that very small insects must fly by so changing the surface area of the wings that the drag is different on the down and upstrokes.Physicists and aeronautical engineers have developed theories of flight for man-made machines. Walker [7] Holst and Kusheman [8], Osborne[9] and Oheme [10] applied these theories to understand the problem of air flow around fliers like insects, birds and bats. Most recent flight studies of animal fliers were made by Pennycuick[11], Weis-Fogh [12. 13], Norberg [14] and Rayner [15]. They assumed that the animal fliers operate under steady state conditions and are governed by relevant aerodynamical equations. Mazher S. and Adeel A. [16] studied the flight behaviour of *T.javanica* using flight balance.

2. Materials and Methods

The flight balance was used for the determination of speed of *T.javanica*.The details of flight balance have been mentioned elsewhere [16].The experiment was performed in such a way that the flight balance was placed in front of the wind tunnel and *T.javanica* was suspended to it. As the insect was flying it moved in the forward direction (towards wind tunnel). The suspender makes an angle ϕ with the vertical axis.

The speed of the wind from the wind tunnel was so adjusted that the suspender carrying *T.javanica* comes back to the initial position. Then the speed of the insect is equal to that of the wind. This value of wind speed to bring the insect at equilibrium position i.e. the initial position is represented as v.The speed of wind from the wind tunnel was measured using anemometer.This procedure is repeated for a set of insects and parameters like ϕ and α and v were noted and tabulated.

3. Results and Discussion

Table 1 gives the data on speed of the insect, *T.javanica* for seven samples of mass ranging from 0.511gm to 0.921gm in their tethered state of flight. The average speed is found to be 2.8 m/s and standard deviation is 0.53 m/s.

Table 1- Data on speed of insect T.javanica in the tethered state of flight

Sample code	*Mass of the flier, M (gm)*	*Speed of the flier, v (m/sec)*
TJ1	0.511	3.2
TJ2	0.612	3.0
TJ3	0.621	3.7
TJ4	0.717	2.2
TJ5	0.817	2.6
TJ6	0.820	2.1
TJ7	0.921	3.0

Mean: 2.83

S.D : ±0.53

Table 2 presents the data on speeds of *Nine* samples of *T.javanica* of mass ranging from 0.488gm to 0.658gm as a function of angle of attack ranging from 0^0 to 54^0.

Table 2- Data on speed of T.javanica as a function of angle of attack

Sample Code	*Mass of the flier, M (gm)*	*angle of attack, α(degree)*	*Speed of the flier, v (m/s)*
TJ11	0.488	5 7 9 13 26 31	2.4 1.6 1.7 1.4 0.9 0.5
TJ12	0.700	7 12 18 23 26 31	2.8 2.6 1.5 1.3 1.0 0.9
TJ13	0.632	2 11 14 23 28 34	2.3 1.4 1.3 1.2 0.7 0.6
TJ14	0.724	9 21 31 36 39	3.9 3.1 1.7 0.5 0.4
TJ15	0.577	4 8 16 26 12	2.2 2.0 1.4 0.6 1.6
TJ16	0.714	0 8 14 18 25 40	4.5 2.5 1.8 1.3 1.7 0.5
TJ17	0.766	7 11 15 27 21	2.2 1.2 1.7 0.6 0.9

TJ18	0.991	0 8 23 13 40	4.1 3.7 3.0 3.3 0.6
TJ19	0.658	7 15 27 34 54	2.5 2.7 1.0 0.6 0

Fig.1. shows a plot between angle of attack and speed of the flier. It is observed that there is an exponential decrease in speed of the flier with the increase in angle of attack.

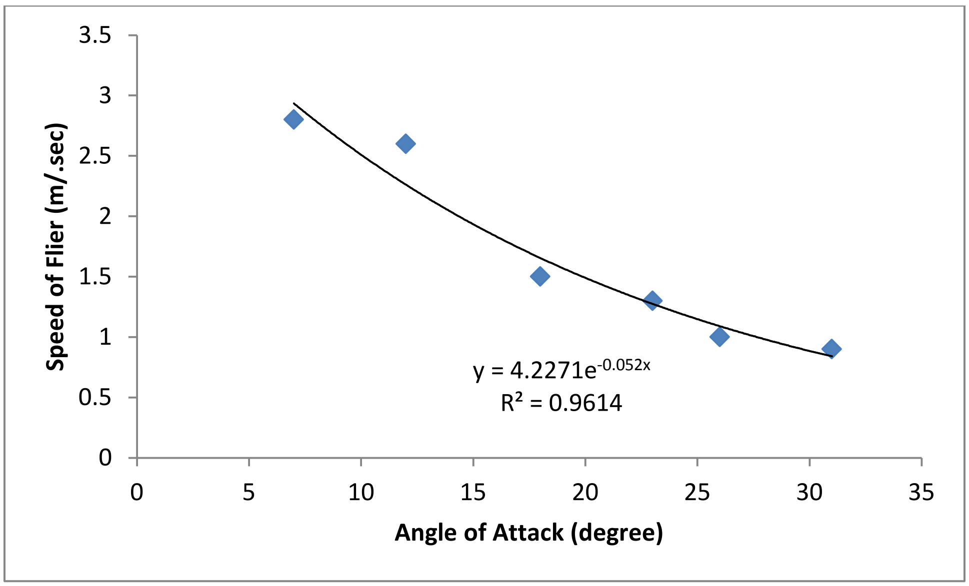

Fig.1. A Typical plot between angle of attack and speed of flier

From the study it can be concluded that the speed of a flier is controlled by its angle of attack. At a particular angle, wing stroke plane becomes horizontal and speed of the flier becomes zero. This condition is known as hovering state of flight.

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