ISSN 2348 – 7968

A Simple Optical Technique to Determine Wing Beat Frequency of *Tesseratoma javanica* inTethered State of Flight

Mazher Saleem And Adeel Ahmad
Biophysics Laboratory, Department of Physics, Nizam College (Autonomous), Osmania University, Hyderabad – 500 001, India
mazhersuf@yahoo.com dr_adeelahmad@yahoo.com

Abstract: The paper discusses a simple technique to find the wing beat frequency of *Tesseratoma javanica* in tethered state of flight. Different theories for wing beat frequency are discussed. The values of wing beat frequency are found to be in good agreement with that of flight sound method. Wing beat frequency of *Tesseratoma javanica* ranges from 60 to 75 Hz.

Key Words: Wing beat frequency, flight sound, tethered state.

1. Introduction

The Wing beat frequency of a flier (insects, bats or birds) is an important parameter not only from the point of view of dynamics and bio energetics, but also from the point of view of ecological relationships. Flight surface (wing) of a natural flier is the basic and the most important flight apparatus and as such it is not the same with respect to structure and design in different fliers.

Gad flies, horse flies, bot flies and wrable flies cause negative response in cows and other animals when flying around them and trying to bite or deposit their eggs, Bureister [1], Landois [2], Rudow [3]. Certain Lepidopterous caterpillars show a similar negative response to the parasite flies that pursue them, Sotavalta [4]. Flying nocturnal insects cause a positive response in bats that catch their prey in flight, Lane [5]. The wing beat frequency of flight sound of insects also plays an important role that one can determine the temperature and humidity of environment because these have a definite effect on the wing beat frequency of insects like *Diptera (Drosaphila Mosquitos)*, certain larger flies *(Musca, Boreellus)* certain flies *(Tipula)* and in the moth *(Hemaris)*, Sotavalta [4], Gaul [6] Sotavalta [7]. The recent reports reveal that attempts are being made to track insects by using the radar equipment and to analyse their wing beat frequency in order to identify the species and to protect the crops from these pests.

Several attempts have been made in the past both theoretical and experimental to study the wing beat frequency of insects, birds and bats.

Earlier observers, Landois [8] and Marey [9] used kymographic techniques. They measured the wing beat frequencies of insects by allowing the wing tip of a fastened specimen to brush lightly against a smoked surface moving at a known speed. For the first

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time Chadwick [10] used electronic stroboscope in the study of insect flight. Magnans made improvement in high speed film photography and published extensive list of wing beat frequencies of several insects. He has also reported the data on the body parameters of a large number of birds in his voluminous paper, but it is not informative with respect to their wing beat frequencies. First time Albertus Magnus [11] noticed the association of the buzz with the motion of the wings, but not much was recorded until 1969. Davis and Frankel [12], employed microphone and oscilloscope for the study of the flight tone measurements.

Sotavalta [4], in his monograph has highlighted the problem of the insects. He has studied it in Apis mellifica, Bombus licorum and chronomforcipomia. His review article on the flight sounds of insects cover a wide ground. Pringle [13] and Reoder [14] have reported that the fundamental frequencies of the thoracic movement appears to be identical with that of the wings, by attaching a flying insect to the stylus of a piezoelectric phonograph pickup and feeding the output through the amplifier to an oscillograph. Vanderplanck [15], using a similar mounting, fed the output into the controlling circuit of a stroboscopic light source in order to get the synchrony between the flash frequency and that of the wings, for studying the pattern of wing movements.

Two techniques have been developed by Boettiger and Furshpan [16]. Here the insect is given an electrostatic charge and potential changes are observed on oscillograph, when the wings move back and forth. The other method is to photograph the movements of a light reflected from a tiny mirror which has been cemented to the scutellum.

Williams and Galambos [17] made an attempt to study the flight sound of Drosophila Oscilloscopically and stroboscopically in order to establish a direct correlation between flight sound and the frequency of wing beat.

In the present investigation an attempt has been made to study the wing beat frequency of *Tesseratoma javanica* in tethered state of flight. The flight sound was recorded and its frequency was measured. The wing beat frequency was also measured simultaneously with a photocell which is further connected to a CRO. It was observed that the wing beat frequency noted from the flight sound was in good agreement with the wing beat frequency measured on CRO.

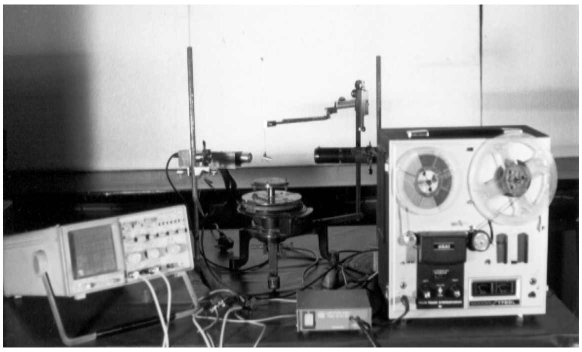
2. Materials and Methods

The soap nut bug, *Tesseratoma javanica* are available in and around Hyderabad on the soap nut trees, which are collected freshly for the experiments. Fresh 10 soap nut bugs *T.*

ISSN 2348 – 7968

javanica. (Heteroptera : Insecta), of the family *Pentatomidae* were captured from the soapnut trees sapindus emarginatus, for experiments.

The experimental setup is as shown in fig. 1 in such a way that the flier *(Tesseratoma javanica)* is fastened by a wax in its tethered state. The flier is kept in the same horizontal axis as that of the photocell and the laser source. A microphone of the tape recorder (Akai stereo : 17201) is kept at a distance of 1 or 2 cm near the wings of the *Tesseratoma javanica* such that the recorded sound is further fed to the oscilloscope.



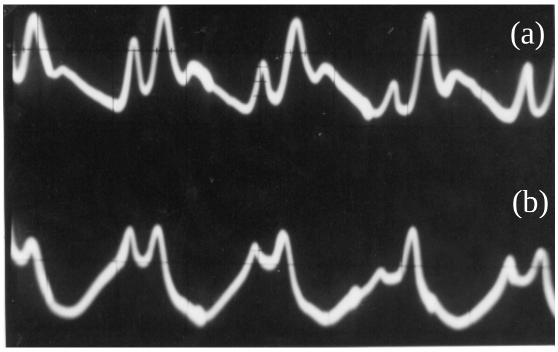


Fig. 1 Experimental Setup

Fig.2 Oscillogram

The wing beat frequency of the flier can be determined from the oscillogram shown in fig.2 (a). This is the wing beat frequency of the flier recorded from the flight sound method. The laser beam which falls on the photocell is obstructed by the to and fro motion of the wing of T. *javanica.* The photocell is further connected to oscilloscope. This gives us the signal from which the wing beat frequency is calculated (fig. 2b). It is observed that this wing beat frequency measured from CRO matches well with the wing beat frequency determined from flight sound method.

Table 1 - Comparison between wing beat frequency of T. javanica using optical and flight sound technique

Insect Code	*Mass of the flier, M (gms)*	*Frequency of wing beat*	
		Optical method υ_1 *(Hz)*	*Flight sound method* υ_2 *(Hz)*
TJ1	0.578	75	72
TJ2	0.670	72	76
TJ3	0.841	72	69
TJ4	0.932	80	72
TJ5	1.086	60	62
TJ6	0.489	64	65
TJ7	0.519	74	74
TJ8	0.544	69	71
TJ9	0.611	62	62
TJ10	0.642	65	67

3. Results and discussions

Table 1 gives a comparison of results of wing beat frequency as obtained from optical method and that obtained from flight sound method. It is observed that the wing beat frequency of *T. javanica* found from the two methods is in good agreement with each other. Also the oscillograph obtained is complex in nature and it is observed that fundamental frequency is the wing beat frequency of *T. javanica*. This technique to determine the wing beat frequency is preferred as it is less expensive and easy to handle.

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