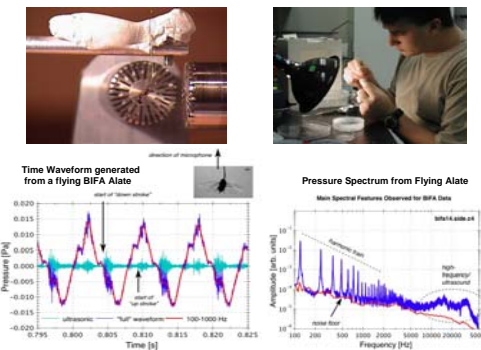


Acoustic and high-speed videographic analysis of flying Imported Fire Ants

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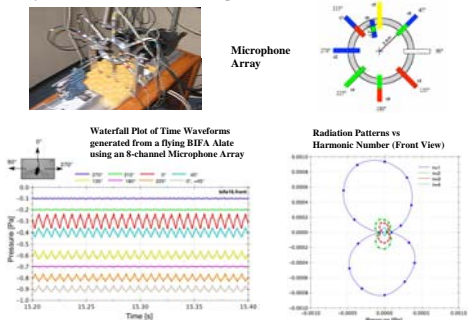
Measurement of Wingbeat Frequencies of Imported Fire Ant Alates

- Measured fundamental frequencies from 80-130 Hz for males and females (differences in species and sex are being studied)
- Both low-frequency sound and ultrasound ($\leq 48\text{ kHz}$) have been measured in experiments to date from wingbeat motions



Sound Directivity of Tethered Alates

- A real-time microphone array is used to determine the acoustic profiles of fire ant alates as small sound sources
- Static tethered flights and the associated wingbeat frequencies are expected to be aerodynamically different from actual dynamic flights that occur in nature (the study of dynamic flight requires the use of a low-speed wind tunnel)
- A model will be developed to predict the measured wingbeat frequencies and associated acoustic profiles of both male and female alates under dynamic conditions (a nonlinear problem)

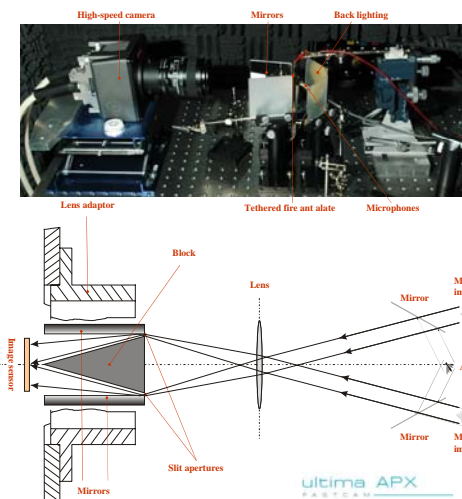


Summary of Sound Tests

- Wing beats from flying alates produces audible sound, with a fundamental associated with wing beat frequency, multiple harmonics.
- Vortex shedding from wings (essential for insect flight) produces measurable ultrasound.
- It is unclear if either of these sound sources are utilized by the alates. Because the alates lack a tympanic mechanism or similar hearing organ, sound would have to be coupled to the body or antenna of the insect in order for detection (associated frequencies approximately 35-50 kHz).
- Sound patterns are generally dipolar, with some difference in the pattern between order of harmonic. If the insect can perceive sound at these frequencies, this changing pattern could be used as a cue for the relative orientation of another flying alate. Systematic differences in wingbeat frequencies for males vs. females could also be used as a cue for the sex of the other flying alate.

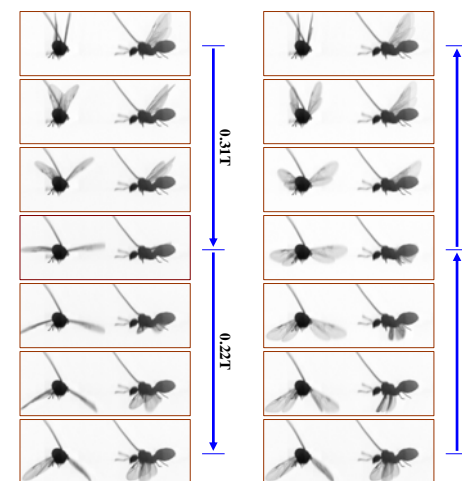
High-speed, Stereo Imaging of Fire Ant Alate

- Determining fundamental wing beat frequency to better understand the sound recordings of flying fire ant alates
- Mapping position and shape of fire ant alate wings with sufficient phase resolution in a wing beat period to enable an aerodynamic analysis & numerical simulation of the wing beat induced flow



High sensitivity digital imaging
 10-bit CMOS sensor, 17.5µm pixels

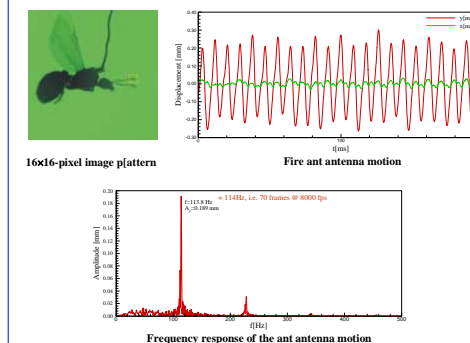
High frame rate & digital resolution
 1024x1024 @ 2000 fps
 1024x256 @ 8000 fps



Stereo images of a female BIFA alate in wing beat period of $T=8.75\text{ ms}$

Fire Ant Image Pattern Tracking

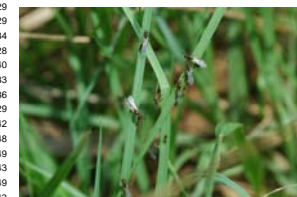
- Determining fundamental wing beat frequency at a higher precision
- Determining higher order ant body motion responses to the fundamental wing beat frequency



Measuring WingBeat Frequency of Fire Ants Flying from Grass

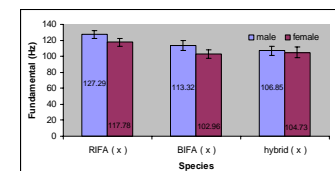
- Objective: Measure WingBeat Frequency from Field/Non-Tethered Ants
- Method: Hold 0.25 or 0.5 inch B&K microphone above Ant that is ready to take off from grass and record on Laptop Computer

Sex	Ind.#	Date	Frequency (Hz)
Female	1	12-Jul-05	139
Female	2	12-Jul-05	129
Female	3	12-Jul-05	129
Female	4	12-Jul-05	134
Female	1	20-Jul-05	128
Female	1	20-Jul-05	140
Female	2	20-Jul-05	133
Female	3	20-Jul-05	136
Female	4	20-Jul-05	129
Female	5	20-Jul-05	142
Male	1	20-Jul-05	148
Male	2	20-Jul-05	149
Male	3	20-Jul-05	143
Male	4	20-Jul-05	149
Male	5	20-Jul-05	143



Fundamental Wing Beat Frequency Statistics

- Significant difference b/t RIFA/ BIFA hybrid (regardless of sex)
- No difference b/t BIFA and hybrid (regardless of sex)
- Significant difference b/t male and female (regardless of species)



(SAS Statistical Analysis Courtesy of Ms. Debbie Boykin)

Near Future Research Plan

- Aerodynamic research on IFA wing beat induced flows by using particle image velocimetry (PIV) to better understand the sound source
- Acoustic research on identification of IFA sound patterns
- Acoustic tests with non-tethered ants in a low-speed wind tunnel