Hearing’s Role in Mosquito Courtship

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outline:

• disease vector
• courtship & mating
• auditory system
• transmit disease when they bite you
• only females need blood meals
• malaria: *Plasmodium falciparum* (protozoan) via *Anopheles gambiae*, 2% of all deaths
• dengue fever: single-stranded RNA virus via *Aedes aegypti*, 30-fold increase since 1960
• hosts found by olfaction (DEET)

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**Figure 35.5** Sequences in the coupling of *Anopheles gambiae* s.s., drawn from photographs of males coupling with females suspended from the thorax. (From Charlwood and Jones, 1979.)

• males swarm around a landmark at dusk
• *An. gambiae*: conspicuous visual landmark
• *Ae. aegypti*: landmark = host = human
• females enter singly
• mate in flight
• acoustic pursuit
• wing beats produce harmonic stack
• males phonotax to female flight tone
• fundamental frequency necessary
• females thought to be deaf

offenhauser & kahn (1949)
hiram maxim (1878), pratt(1900), & weaver

TABLE III

<table>
<thead>
<tr>
<th>Description</th>
<th>No. of samples</th>
<th>Percentage trapped</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female flight sound of 426 c/s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>natural</td>
<td>21</td>
<td>20.1</td>
</tr>
<tr>
<td>with fundamental removed</td>
<td>21</td>
<td>0.9</td>
</tr>
<tr>
<td>Male and female flight sounds adjusted to 500 c/s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>female</td>
<td>21</td>
<td>26.7</td>
</tr>
<tr>
<td>male</td>
<td>21</td>
<td>29.2</td>
</tr>
<tr>
<td>Recording of 125, 250, 1,000, 2,000, and 3,000 c/s*</td>
<td>4</td>
<td>0.7</td>
</tr>
<tr>
<td>without 500 c/s</td>
<td>4</td>
<td>21.2</td>
</tr>
<tr>
<td>with 500 c/s</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Subharmonics and harmonics of 500 c/s.

Offenhauser & Kahn (1949)
Hiram Maxim (1878), Pratt (1900), & Weaver

Wishart & Riordan (1959)
• convergence at the harmonics
• so females aren’t deaf
• female choice; male fitness
• males initiate from afar (~20 cm); acoustic dueting nearby
• but how?
• antennae are ears (and noses)
• 15,000 stretch transducers in ♂; 7500 in ♀
  - cochlea: 15,000 hair cells
  - *Drosophila*: 500 transducers
• Johnston’s organ (1855)
Figs. 47-52. Heads of male *aegypti* showing the various antennal operations performed to determine the function and mode of action of Johnston’s organ.—47. Flagellar segments removed leaving small portions of the third segments extending beyond the pedicelli; 48. Flagellar segments removed and the pedicelli, remains of the third segments, and parts of the eyes covered with shellac; 49. Shellac placed at the base of the antennae covering the pedicelli, segments three and four, and parts of the eyes; 50. Tips of both antennae weighted with drops of shellac; 51. Weighted portions of the antennae in Fig. 50 amputated; 52. Practically all of the antennal fibrillae removed leaving the antennal shafts nearly bare.

*Abbreviations:* E—eye; P—pedicel; S—shellac.

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Abb. 5. (a) Störpegel des Schallpotentials.
(b) Schallpotential bei 140 Hz.
(c) Schallpotential bei 240 Hz.
(d) Schallpotential bei 400 Hz.
(e) Schallpotential des Vokals „u“.
(f) Schallpotential des Lautes „sch“.
(g) Schallpotential des Einschaltstosses eines Lautsprechers.
(h) Schallpotential des Duschingsgeräusches.
(i) Schwebung des Schallpotentials 340/391 Hz.
(k) Schwebung des Schallpotentials 370/392 Hz.
• oscillations disappear by 600 Hz
• Tischner’s filter settings?
• DC response??

“neuroscience” textbook
purves et al, from palmer & russell (1986)
- Hearing to >2000 Hz
- In females too

cator, arthur, harrington & hoy (2009)
• simultaneously hearing self flight tone
• beats from constructive & destructive interference
• pure tones or beats?

• beats: only magnitude, not sign

• tones: efference copy or proprioception
take home messages:
• females transmit disease
• pursue & court in flight
• females can hear too
• communicate at high frequencies
• sexual selection
• encoding similar to mammals
• psychophysical cue unknown