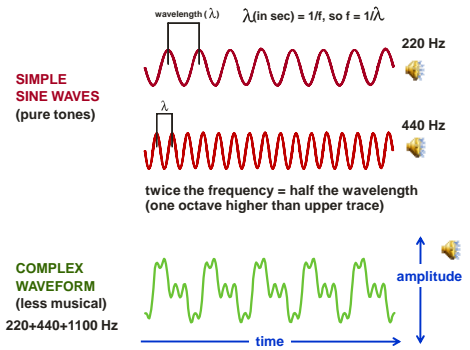


COMMUNICATION

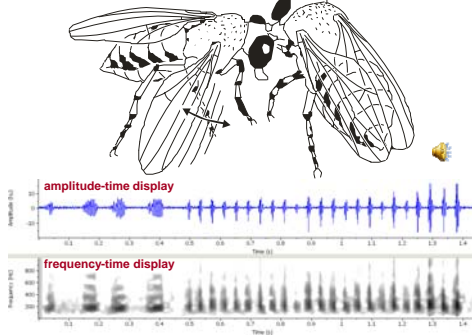
- A. Visual (vision)
- B. Chemical/Olfactory (pheromones)
- C. Mechanical (movement)
 - 1. Tactile (touch)
 - 2. Vibrational (periodic signals)
 - a. Near-field (puffing)
 - b. Substrate-borne
 - normal (impact)
 - tremulation (shaking)
 - c. Airborne (sound)

Waveforms of signals



a. Near-field vibrations (air-pulsing or "puffing")

Drosophila (Diptera: Drosophilidae)



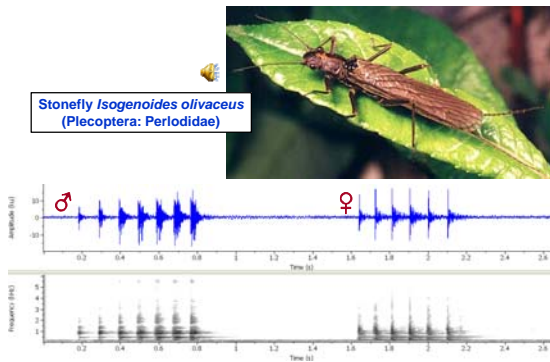
More near-field vibrations

Apis mellifera (Hymenoptera: Apidae)



b-1. Substrate-borne vibrations: Normal (impact)

Stonefly *Isogenoides olivaceus* (Plecoptera: Perlodidae)



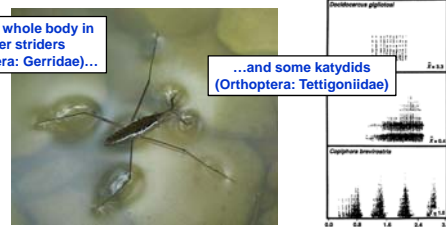
b-2. Substrate-borne vibrations: Shaking (tremulation)

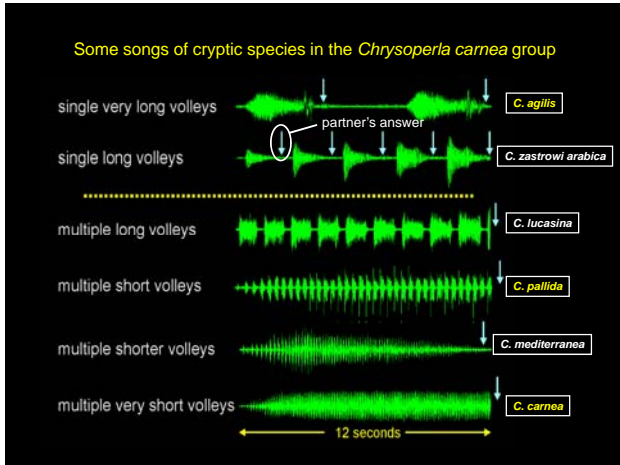
Oscillation of a body part – e.g., the abdomen in green lacewings (Neuroptera: Chrysopidae)...



...or the whole body in water striders (Hemiptera: Gerridae)...

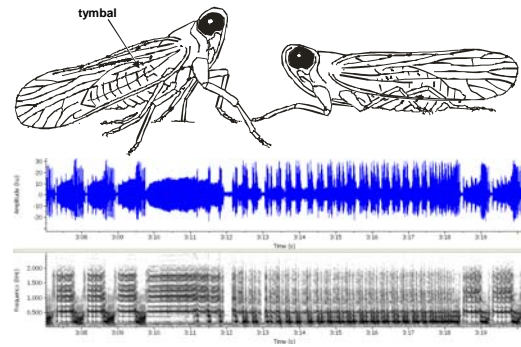
...and some katydids (Orthoptera: Tettigoniidae)





b-3. Substrate-borne vibrations: Buzzing

Application of a tymbal to the substrate – e.g., planthoppers (Hemiptera: Fulgoroidea) et al.

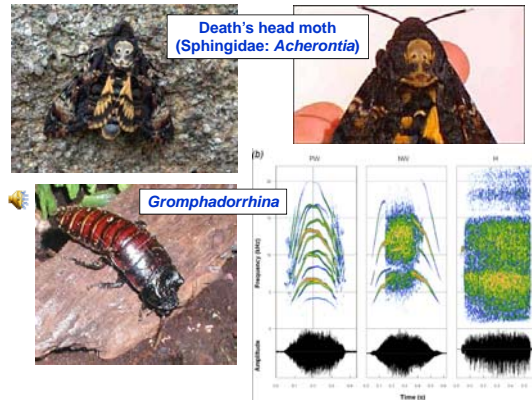


c. Airborne sounds ("real" sounds)

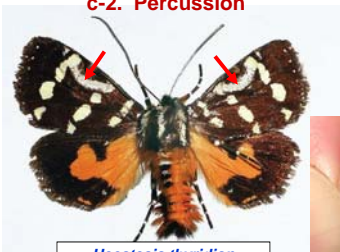


1. Forced air
2. Percussion
3. Wing beating
4. Stridulation (wings, head/thorax/abdomen, genitalia, legs, almost anything)
5. Tymbals (thorax or abdomen)

c-1. Forced air



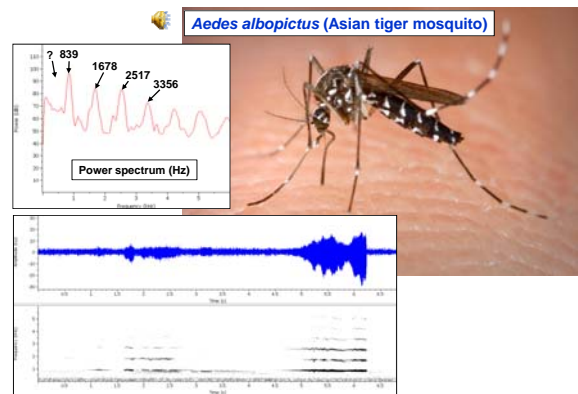
c-2. Percussion



c-3. Wing-beating (crepitation)



c-3. Wing-beating (tones with harmonics)

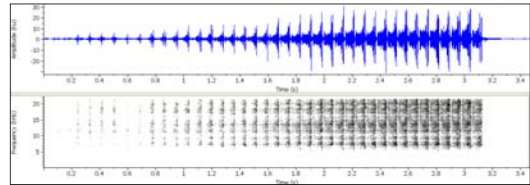
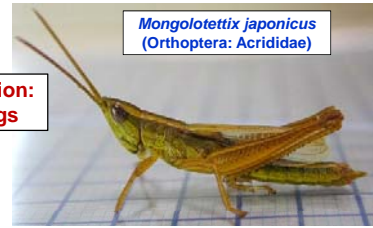


c-4. Stridulation: Files and scrapers

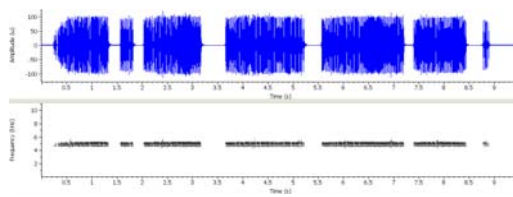
Dung beetle *Geotrupes* sp. (Coleoptera: Scarabaeidae)



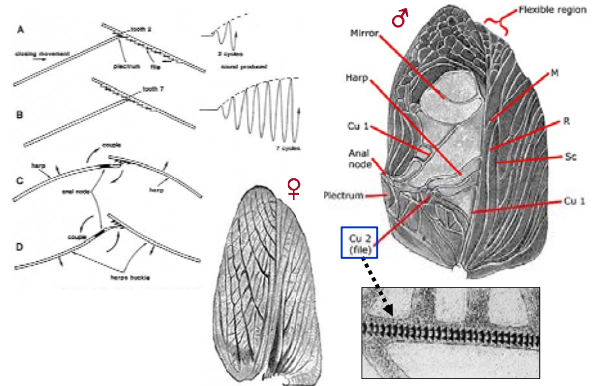
c-4. Stridulation: legs on wings



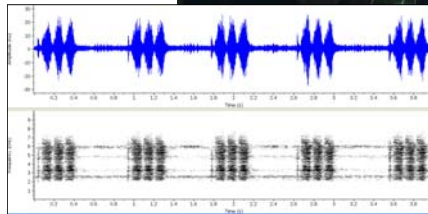
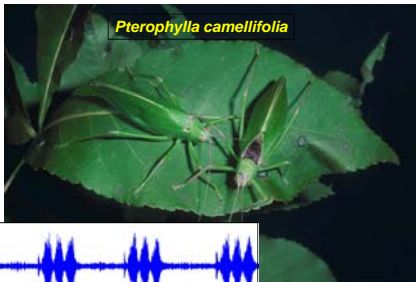
c-4. Stridulation: Narrow-band, "musical" sound, using wings



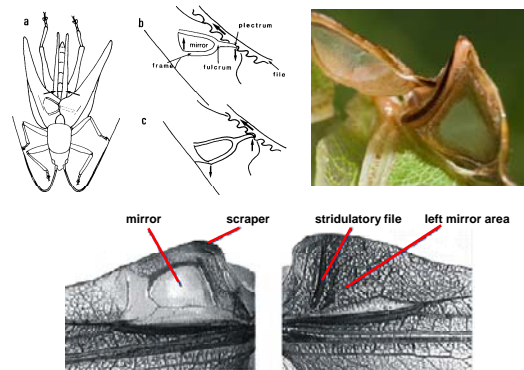
Stridulatory structures of crickets (*Gryllus* spp.)



c-4. Stridulation: Broad-band, "noisy" sound, using wings



Stridulatory structures of katydid

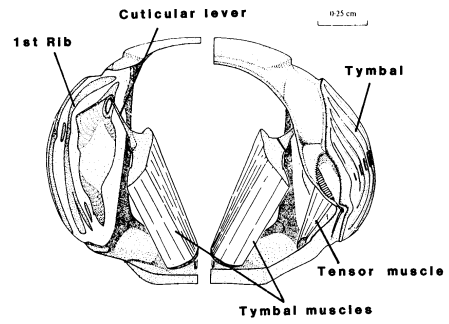


c-5. Tymbals

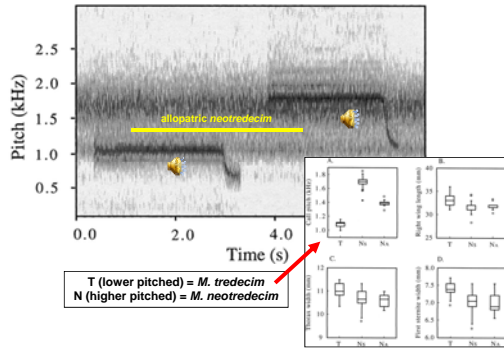


The periodical cicada, *Magicicada septendecim* (Hemiptera: Cicadidae)

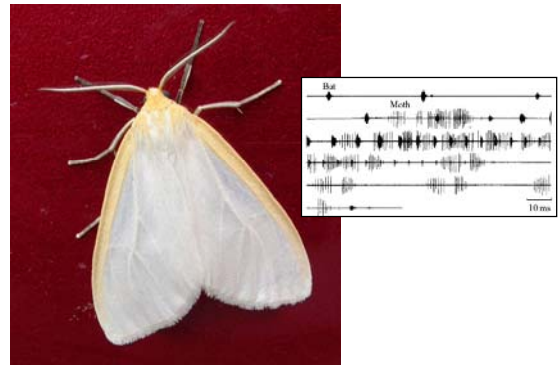
Tymbal structure and function



Reproductive character displacement in two periodical cicadas, *Magicicada tredecim* & *M. neotredcim* (Marshall & Cooley 2000)



Jamming of bat echolocation by thoracic tymbals in an ariid moth, *Cycnia tenera*



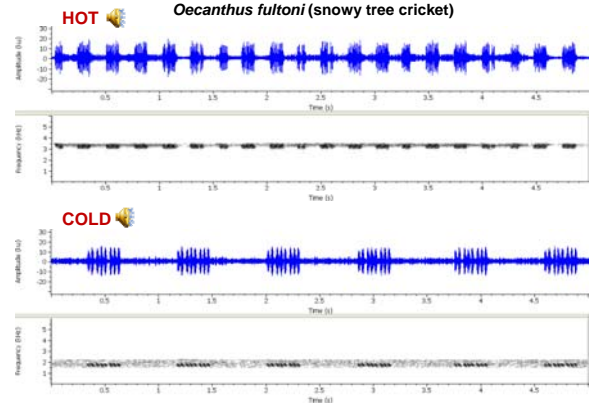
Using an acoustic baffle to increase efficiency



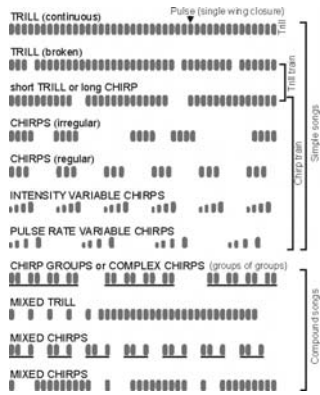
Oecanthus fultoni (snowy tree cricket)

Temperature effects

Oecanthus fultoni (snowy tree cricket)



Song temporal patterns in cricket evolution (after Otte)



Songs & phylogeny in the *carnea*-group

