

1. Acoustic Communication

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- This introductory lecture briefly presents several physical aspects of sound communication, which will be dealt with in more detail in later lectures.
- The efficiency of sound emission from a vibrating surface depends on the ratio between its diameter and the wavelength of sound, on the properties of the medium (air, water), and on whether the sound emitter is a monopole.
- At a certain time, in a monopole all parts of the surface exposed to the surrounding medium "agree" on generating a surplus pressure (and a rarefaction a little later). In contrast, in dipoles and multipoles, some parts of the surface generate a surplus pressure, while other parts generate a rarefaction (and vice versa). If the surplus pressures and rarefactions are not far apart, they may interact destructively (acoustic short-circuiting). The sound emission from biological monopoles (e.g., a singing bird or cicada) therefore tends to be more efficient than that of dipoles (e.g., the wing of a singing grasshopper).
- Irrespective of the kind of emitter, small animals have to use high frequencies, and the habitats tend to act as low-pass sound filters. Small animals may therefore be restricted to a narrow band of frequencies.
- The "choice" of communication sounds depends on the expected filtering of sounds in the habitat. For example, it may not be wise to use pure tone signals a short distance above a sound reflecting surface.
- Many animals are so small that they give up emitting sounds into the air. Instead, they may send their songs through the substrate (e.g., their host plant) This mode of communication can be quite efficient. Less than one μg of muscle is sufficient to generate a bending wave in a reed, which travels metres and reaches the receiving animal with the amplitude well above threshold.
- The sound frequencies of signals are generally much above those of muscular contractions. The muscles therefore have to activate frequency multipliers, often a stridulatory organ or a vibrating membrane. Emitted sound amplitude may be boosted by a resonant sound emitter, but its long time constants makes it unsuited for fast rhythms.
- Most biological sounds have been measured far away from the source (in the far field), although much communication takes place at close range (in the near field). Theory predicts large differences between far- and near field sounds, but this problem has hardly been studied in bioacoustics.