THE USE OF A CONDENSER MICROPHONE FOR THE STUDY OF STRIDULATION OF AQUATIC AND SEMI-AQUATIC BEETLES

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The use of condenser microphone for the study of insects is a really important part of understanding behavior inside species. Insects have three main acoustic signals, which are stress, mating and predation trials. Other signals depend on the group of insects which we study. The main tools to investigate these signals are condenser microphone with different specifications and structures. Each microphone has special characteristics, such as frequency range, approximate sensitivity and approximate input-referred self-noise level. If the sensitivity level is 70 dB or less we need to use a preamplifier. Aquatic and semi-aquatic insects have a hidden way of life. Most of species can't use chemical communication because all pheromone liquid dissolve by water. In this case they use their organs (stridulatory organs) which produce different sounds. The frequency of these insects is between 0,2 to 10 kHz [1]. Many species from this group are produced when they are in the water and we use a waterproof condenser microphone. For example, many male species from the family Dytiscidae attract female only in water and the condenser microphone can't record interesting sounds for us.

Aquatic and semi-aquatic beetles were collected from the Kuban river near the All-Russian Research Institute of Biological Plant Protection (45°02'56.5"N 38°52'22.1"E) between June and September 2019. Adult beetles were collected using the superbright LED's trap. Males and females were stored in plastic containers with wet soil and kept at 20–26°C in constant climate chamber (model KBF720; Binder; Germany). Sounds were recorded from insects under stress using a measurement condenser microphone (model ECM8000; Behringer, Germany), audiophile vacuum tube preamplifier with limiter (model MIC100; Behringer, Germany) and stored as .wav files on a notebook (model HP Pavilion g series; USA). For sound processing used to the software Sony Sound Forge Pro 10.0 was used. All trials were conducted in the Laboratory of Chemical Communication and Mass Rearing Insects, at temperatures of 22–24°C.

Stress signals for *Berosus frontifoveatus* Kuwert, 1888 (Hydrophilidae) were simulated in accordance with a procedure used to create stress signals in another *B. frontifoveatus* [2]. Each adult was restrained by the appendage and sounds were recorded of 1 cm from the Behringer condenser microphone. For the recording of stress signals for *Heterocerus fenestratus* Thunberg, 1784 (Heteroceridae), each adult was held by the head and recorded 0,5 cm from the Behringer condenser microphone. Stress signals were recorded for 25 adults in each family. *B. frontifoveatus* is an aquatic species and *H. fenestratus* is a semi-aquatic species. Both are a bioindicator of water quality.

Each species has a different frequency range. For *B. frontifoveatus* the frequency range was from 935,56 to 974,85 Hz. For *H. fenestratus* the frequency range was from 1594,95 to 1698,74 Hz. Furthermore, every sound consists of pulses which has pre-pulse, main-pulse and major-pause. Sound *B. frontifoveatus* consist of seven alternating pulses (five main-pulses and two pre-pulses which separated six major-pauses). The duration of one pulse is 0.2852 s (main-pulses are 0.1692 s and pre-pulses are 0.116 s). The sound of *H. fenestratus* consist of short pre-pulse chirp trains. The duration of one pulse is 0.156 s. Both species have different locations of the stidulatory organ. *B. frontifoveatus* has abdomino-elytral stridulatory organs; *H. fenestratus* has abdomino-femoral stridulatory organs.

The use of a proper condenser microphone for bioacoustics study is a natural way to understand conversation between insects. For successful experiments, the researcher should know which condenser microphone with specific characteristics needs to the chosen. It depends on the frequency range of sounds for each species. These characteristics depend on the location of special organs which produce sound. Researchers can select which condenser microphone with special characteristics they need to use for experiments if they know about the location of these organs.

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[2] E. R. Van Tassell, An audiospectrographic study of stridulation as an isolating mechanism in the genus Berosus (Coleoptera: Hydrophylidae), Annals of The Entomological Society of America **58**, 407-413 (1965).