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Acoustic comunication systems and sounds in three species of crickets from central Italy: musical instruments for a three-voices composition

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Natural soundscape has always constituted a reference in cognitive and emotional processes. The imitation of natural sounds contributed to the origin of the verbal language, which has been then subjected to an even more refined process of abstraction throughout history. The musical language also evolved along the same path of imitation.
Among the many sonic elements of a natural environment, the stridulation of crickets is one of the most consistent for its timbre, articulation, diffusion and intrinsic emotional power. More than 900 species of crickets, in fact, have been described. They can be found in all parts of the world with the exception of cold regions at latitudes higher than 55° North and South.
Among the many species we're working on (Order Orthoptera and Suborder Ensifera), we refer here of a comparison between the morphology of the acoustic emission systems and the corresponding waveforms/spectral patterns of sound in three widespread species from central Italy: Gryllus Bimaculatus, Acheta Domesticus (Gryllidae), and Ruspolia Nitidula (Conocephalidae).
The samples of the acoustic apparatus of the target individuals, stored in ethanol, were observed under a Field Emission Gun Environmental Electron Scanning Microscope (FEG-ESEM, Quanta 200, FEI, The Netherlands). The use of this type of microscope allowed to analyze the samples without any kind of manipulation (dehydration and/or metallization), while maintaining the morphological features of the fragile acoustic apparatus. The observations were made with different sensors (SE: secondary-electron sensor and BSE: backscattered-electron sensor), and performed at low-medium vacuum with energies varying from c.ca 10 to 30kV.
Male individuals have an acoustic apparatus consisting in two cuticular structures (tegmina) positioned above wings, while both male and females have receiving organs (tympanum) in forelegs. Stridulation mechanism is produced when the file and the scraper (plectrum) scrub one another. File morphology is one of the main distinctive element in sound emission strategies of insect species. We compared analyses of the microstructures of different species' files (both shape and height of teeth, regularity, distance, etc.) and then confirmed their main characteristics within the acoustic domain. Specific Fourier transforms were employed to derive detailed spectrograms analyses providing a powerful visual tool for understanding. For the three species in this study, the typical stridulation of male individuals were isolated and recorded in high definition (96khz and 192khz / 24bit). These high sampling rates enabled to enter the microcosm of sound – in analogy to the microcosm of morphology – through processes of time and frequency shifting. Different sound design methodologies, then, allowed to compose an imaginary soundscape where the sonic gestures of each individual (or more grouped recordings) were superimposed in a polyphony of rhythms and pitches.
The purpose for crossing bioacoustics, electron microscopy and music in this interdisciplinary work is driven by a pressing need of awareness of the sonic heritage of landscapes and its conservation.