*BIOACOUSTICS* 15, 143-161

# CLASSIFICATION OF AFRICAN ELEPHANT *LOXODONTA AFRICANA* RUMBLES USING ACOUSTIC PARAMETERS AND CLUSTER ANALYSIS

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**ABSTRACT**

It has been suggested that African savanna elephants *Loxodonta africana* produce 31 different call types (Langbauer 2000). Various researchers have described these calls by associating them with specific behavioural contexts. More recently Leong et al. (2003) have attempted to classify elephant call types based on their physical properties. They classified 8 acoustically distinct call types from a population of captive elephants. This study focuses on one of these call types, the rumble, in a wild population of elephants in Kruger National Park, South Africa. A single family group of elephants was followed to record group behaviours and vocalizations from January through August 2001. By measuring the physical properties of 663 rumbles and subjecting these to cluster analysis, we present evidence that shows that rumbles can be categorized by their physical properties and that the resulting rumble types are associated with specific group behaviours. We characterize three types of rumbles that differ significantly by ten acoustic parameters. Two rumble types were associated with the elephant group feeding and resting, while the third was associated with socializing and agitation.

Keywords: African elephant, *Loxodonta africana*, acoustic communication, call categorization, cluster analysis.

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*BIOACOUSTICS* 15, 163-174

# SPERM WHALE TRUMPET SOUNDS

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**ABSTRACT**

Sperm whale *Physeter macrocephalus* L. clicks have been studied for nearly fifty years, during which time great efforts have been made to understand the functions and production mechanisms of this sound. Other than clicks, sperm whales may also produce low intensity sounds arranged in short sequences, named trumpets, which have been recorded occasionally in the past by few groups of researchers. Sperm whale recordings collected in the Mediterranean Sea with a towed array and digital tags were used to describe the temporal and spectral characteristics of trumpets. This sound is made of a series of repeated units, around 0.2 s long, arranged in short sequences lasting between 0.6 s to 3.5 s. Each of these units comprises an amplitude modulated tonal waveform with a complex harmonic structure, and a spectrum composed of a low frequency component at 500 Hz and a mid-frequency component at 3 kHz. The apparent source level could be estimated for one of the trumpets and was estimated to be 172 $dB_{pp}$ *re*: 1μPa at 1m with energy flux density of 147 dB *re*: 1μ $Pa^2s$.

Keywords: sperm whale sound, trumpeting, *Physeter macrocephalus*, Mediterranean Sea, sound production.

*BIOACOUSTICS 15, 175-193*

# THE ECHOLOCATION BEHAVIOUR OF *NYCTICEIUS CUBANUS* (CHIROPTERA: VESPERTILIONIDAE): INTER- AND INTRA-INDIVIDUAL PLASTICITY IN VOCAL SIGNATURES

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**ABSTRACT**

We studied the echolocation behaviour of *Nycticeius cubanus* in the field in western Cuba. During hunting, *N. cubanus* search for insects emitting cries that sweep from 80 to 40 kHz in 4 to 12 ms. Search call characteristics correlate with the clutter structure of the hunting areas. Bats hunting in an uncluttered space broadcast longer and narrower signals, while bats hunting in cluttered space broadcast shorter and broadband signals. Longer calls were emitted with longer intervals while the duty cycle was kept below 15 % during search and approach phases. The call's minimal frequency remained about 43 kHz showing variation coefficients of less than 3%. As a consequence, bandwidth correlates positively with the maximal frequency. Calls emitted by different sympatric individuals are accurately classified by sender using a discriminant function analysis, suggesting vocal signatures in *N. cubanus*. The statistical analysis of several passes of calls broadcast during the hunting activity of a single individual, demonstrates a high intra-individual plasticity in vocal signatures and points to a dynamic system.

Keywords: bats, echolocation, vocal signature, plasticity, *Nycticeius cubanus*

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*BIOACOUSTICS* 15, 195-206

# PORPOISE CLICKS FROM A SPERM WHALE NOSE – CONVERGENT EVOLUTION OF 130 KHZ PULSES IN TOOTHED WHALE SONARS?

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**ABSTRACT**

Small toothed whales of the family Phocoenidae and delphinid genus *Cephalorhynchus* produce long-duration, narrowband biosonar clicks above 100 kHz, that might be seen as an adaptation for short range echolocation in shallow water. This paper presents data showing that the distantly related, and larger pygmy sperm whale *Kogia breviceps* (Kogiidae), that is a deep-diving, cephalopod-eating toothed whale, produce narrow-banded high frequency (NBHF) clicks identical to those of *Phocoena* and *Cephalorhynchus* ($f_0$ = 130 kHz, $Q_{3dB}$>10, duration > 80 msec). Thus, NBHF biosonar signals have evolved on three independent occasions in the odontocete suborder, but the apparent functional convergence does not relate to anatomical or niche similarity. Rather, it is suggested that a biosonar strategy adapting to a minimum in ocean ambient noise above 100 kHz in concert with high Q auditory filters have led to convergent evolution of the NBHF biosonar clicks. Since these biosonar signals carry all their energy at frequencies above the upper hearing limit of the killer whale *Orcinus orca*, predator avoidance may also have been a evolutionary shaping factor of the sonar signals from these non-whistling odontocetes.

Keywords: *Kogia*, echolocation, biosonar, sound production, click