

ACOUSTIC BEHAVIOUR OF ANIMALS

EDITED BY

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P R E F A C E

The idea of compiling this volume was first formed in 1956 at University Park State College, Pennsylvania, at the time of the meeting convened to form the International Committee of Bio-Acoustics (I.C.B.A.), which was organised on the initiative of our colleague and friend, Professor H. FRINGS.

Bio-Acoustics is a scientific discipline which has made enormous strides during the past decade and this book was designed to present the relevant data available at the time.

In spite of the generous collaboration of all concerned and of my own efforts, the intervals between the delivery of the various articles were unfortunately longer than had been hoped. For this reason, and also because of the constant influx of fresh results in recent years, the first articles to come in had to be supplemented with addenda.

On some points the book has already been outstripped by subsequent specialised studies which have added considerably to our knowledge in the last two years, such as those of GRIFFIN, of KELLOGG, of TAVOLGA and of LILLY in the U.S.A., those of HASKELL and of THORPE in Great Britain, and that of TEMBROCK in Germany. Nevertheless, I believe our book is original inasmuch as it covers a wide range of problems, with something of interest for every specialist. A further advantage is the diversity of the authors' scientific qualifications—including anatomists, zoologists, psychophysiologicals, entomologists, engineers, physicians, etc.—, thanks to which the phenomena can be compared in their different aspects and surveyed within a wide context.

The book shares the defects of every collective work, namely lack of unity, differences of style and in terminology; but the editor, wishing to preserve the original character of each article, has not attempted to eliminate these; notwithstanding, it is to be hoped that each contribution will, like the facets of a diamond, reflect the light and shed some brilliance upon the whole. I know that this book will only be up to date for a short time, but it will have the merit of presenting within its covers the facts that this new branch of biology has discovered up to the present.

Although the various authors wrote the articles in their own language, Elsevier Publishing Company asked us to publish them in English so that the book might be accessible to the widest possible professional public. The articles written in other languages had, therefore, to be translated, which accounts for a few awkward turns of phrase and sometimes a certain heaviness of style. For this I would crave my Anglo-Saxon readers' indulgence, begging them to remember that it is no easy matter to render a text, or even to correct one, in a foreign language.

I trust that my colleagues will approve of what I have done as editor and that they will pardon me for any mistakes or omissions I may have overlooked.

I offer my sincere thanks to all those who helped me to produce this book and to make its publication possible.

The fact should not be allowed to pass unmentioned, I feel, that all the contributors have kindly waived their copyright in favour of the I.C.B.A. for the purpose of establishing a fund to enable young research workers to undertake voyages of study.

R.-G. BUSNEL

INTRODUCTION

Advances in electronics and acoustics during the last twenty years have furnished the biologist with new and powerful tools for the production, analysis, and recording of sounds. These are particularly valuable to students of sensory physiology and animal behavior, making possible precise and critical studies in these areas. While today relatively few laboratories throughout the world are engaged in studies on animal sounds and acoustical communication, the future should witness a tremendous expansion of effort in these fields as the potential value of the newer acoustical devices is fully appreciated by biologists.

In view of the actual and potential increase in research on animal sounds and communication, an International Conference on Biological Acoustics was held, in April, 1956, at The Pennsylvania State University, U.S.A. Forty-five scientists from five countries attended to discuss the problems facing workers in bio-acoustics, particularly the problems of communication—not between the animals, but between the workers themselves.

As a result of this Conference, the International Committee on Biological Acoustics was formed, with two major objectives: (1) to arrange for an International Collection of Animal Phonography, for storage of recorded samples of sounds illustrating scientific articles acoustically, as pictures illustrate them visually; and (2) to support exchange of information about research in bio-acoustics among workers in the field. There are, at present, about 60 members of this Committee, representing fourteen countries.

This book represents the first large undertaking in furtherance of the second objective of this Committee. Comparative physiologists, animal behaviorists, sensory physiologists, neurophysiologists, ecologists, taxonomists, and evolutionists, all are finding studies of animal sounds valuable. In this book, members of the International Committee on Biological Acoustics summarize recent work in their fields of interest. The articles obviously cannot cover all the fields of bio-acoustics, nor all the active lines of research in each field. Instead they represent a selection from a much larger whole. Even today, another volume of the same size could be written without much duplication of what is here. Within a relatively few years, many volumes will be necessary to cover some of the fields here reviewed in single chapters. This volume is an indication of current and future paths, rather than a summation. It should be a source of critical information for the specialist, a review of current progress in selected areas of bio-acoustics for the interested non-specialist, and an inspiration for the beginner in the field. As such, it represents the first substantial realization of one of the aims of the International Committee on Biological Acoustics.

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PART I
DEFINITIONS AND TECHNIQUES

CHAPTER 1

METHOD IN BIO-ACOUSTIC TERMINOLOGY

by

W. B. BROUGHTON

1. Summary

1. The need for some standardization of bio-acoustic terminology is discussed. Some opinions have been tested by circulating a memorandum; the response is briefly analyzed.

2. A very large majority of terms are uncontroversial; these are not dealt with here, but in the Glossarial Index at the end of the book.

3. Abused and controversial terms are discussed. The practice of defining a term in a particular way "to hold for the purposes of this paper alone" is criticized as a question-begging procedure more often resorted to than justified.

4. Extensions of meaning, of concepts already defined in physical terms, must be no more than extensions; redefining by reference to biological criteria is not legitimate.

5. *Pulse*, in particular, probably the most difficult concept of all, is discussed in detail from the viewpoints of graphic representation, mode of production and effect on various types of ear. All these considerations demonstrate that the generally accepted physical connotation (a simple wave-train) is not only the sole legitimate but also the sole safe connotation. Certain special cases are reviewed.

6. Past usages of *chirp*, *phrase*, *sequence*, *trill* are discussed; a good many other terms receive incidental examination.

7. The available levels of analysis of animal sound are reviewed: the physical wave-form level (frequency, pulse properties etc.); the phonative act level (phoneme, syllable etc.); the level of subjective human audition (pitch, timbre, rhythm, melody, harmony, etc.); the level of the "relevant hearer's" audition (action potentials, and behaviour—combined with study of the emitter's behaviour).

8. Proposals are put forward based on the normal practical sequence of analysis. The author abandons his former specialized definition of *chirp* in terms of the motor act of emission, accepts the much more general and traditional concept (any *unitary sound*), and makes this the central concept in an empirical terminology for the logical first analysis of any given sound in terms of what the investigator himself hears.

9. To this are then grafted the data from progressive physical studies which, by filling in the gaps, complete and objectivize the empirical scheme into a rigorous system.

10. In some groups (*not including Man*), only one term is needed to convert this in turn into a scheme valid also for analysis by reference to the motor acts of emissions: for this, the German orthopterists' concept of *Silbe*, translated as *syllable*, is proposed; confusion with its human phonetic and etymological connotations (which differ from each other anyway) will not arise, since this particular scheme will not embrace human phonation.