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Group Techniques of Ecological Adaptation

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 **Routledge**
Taylor & Francis Group
LONDON AND NEW YORK

First published 1971 by Transaction Publishers

Published 2017 by Routledge

2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN

711 Third Avenue, New York, NY 10017, USA

Routledge is an imprint of the Taylor & Francis Group, an informa business

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Library of Congress Catalog Number: 2006051023

Library of Congress Cataloging-in-Publication Data

Kummer, Hans, 1930-

Primate societies : group techniques of ecological adaptation / Hans Kummer.
p. cm.

Originally published: Chicago : Aldine-Atherton, 1971.

ISBN 0-202-30904-5

1. Primates—Behavior. 2. Social behavior in animals. I. Title.

QL737.P93K79 2006

599.8'156—dc22

2006051023

ISBN 13: 978-0-202-30904-0 (pbk)

Foreword

The study of cultural ecology is essentially the investigation of human adaptability. The roots of human adaptive behavior lie deep in man's phylogenetic history. Hans Kummer illuminates this by his careful analysis of primate social life, showing how the genetically programmed behavior of baboons and other monkeys is subject to adaptive modification to meet the exigencies of both their physical and their social environment.

Dr. Kummer does not involve himself in the fruitless argument whether these infrahuman animals have "culture" in the anthropological sense. He is fully aware that they do not have the elaborately coded system of symbols which is the essence of the human context and the very stuff of culture. What he does show, however, is that monkey bands show patterned forms of behavior that are adaptive to local situations. Among these situations are those created by special elements in the physical environment, such as food resources and sleeping areas; and these affect the nature of collaborative action. Collaborative action, in turn, requires the structuring of social relationships among the primates, necessitating a further adaptive modification of behavior. At the same time, limits on this adaptive capacity in each species of animal are set by its genetic preprogramming.

The analysis of primate ecological adaptation is based primarily upon field studies by Kummer and his colleagues. Dr. Kummer has made ingenious use of natural experimental sit-

uations to discover the nature of primate adaptability. Thus he has examined the social organization of a single species under diverse environments and has studied the behavior of different species in a constant environment. These field studies have been enriched by equally ingenious experiments. He also brings into consideration relevant research by other students of primate ethology.

Although this book does not deal with humans nor does it (in a strict sense) deal with culture, I am glad to include it in *Worlds of Man*, which is a series of books on human cultural ecology, because by traversing these boundaries we perceive the crucial region lying between the cultural and the noncultural. We are thus able to see both the limitations placed on behavior by inherited characteristics and the scope of behavioral adaptation.

This book has a broader mission as well: it is a corrective to the recent spate of popular works that have endeavored to extrapolate from animal behavior to man. I have in mind such simple-minded conceptions as that man is the inheritor of a territorial imperative, as Robert Ardrey has argued, or an aggressive instinct, as Konrad Lorenz implies. What implications can really be drawn for the biological programming of man from the simple lives of stickleback fish or herring gulls, when man's closest relatives display such complex and varied behavior? Dr. Kummer demonstrates that in crucial matters relating to social organization, the various species of primates have diverse repertoires of innate behavior and these, in turn, they modify to meet the exigencies with which their environment confronts them. Dr. Kummer shows clearly that ecological adaptation, both biological and cultural, is a complex phenomenon, and thus points up the inadequacies of popular oversimplifications. Without trying to extrapolate from primate to human behavior, but rather by examining the forces that shape that behavior, he succeeds in giving us real insight into the world of man.

Walter Goldschmidt

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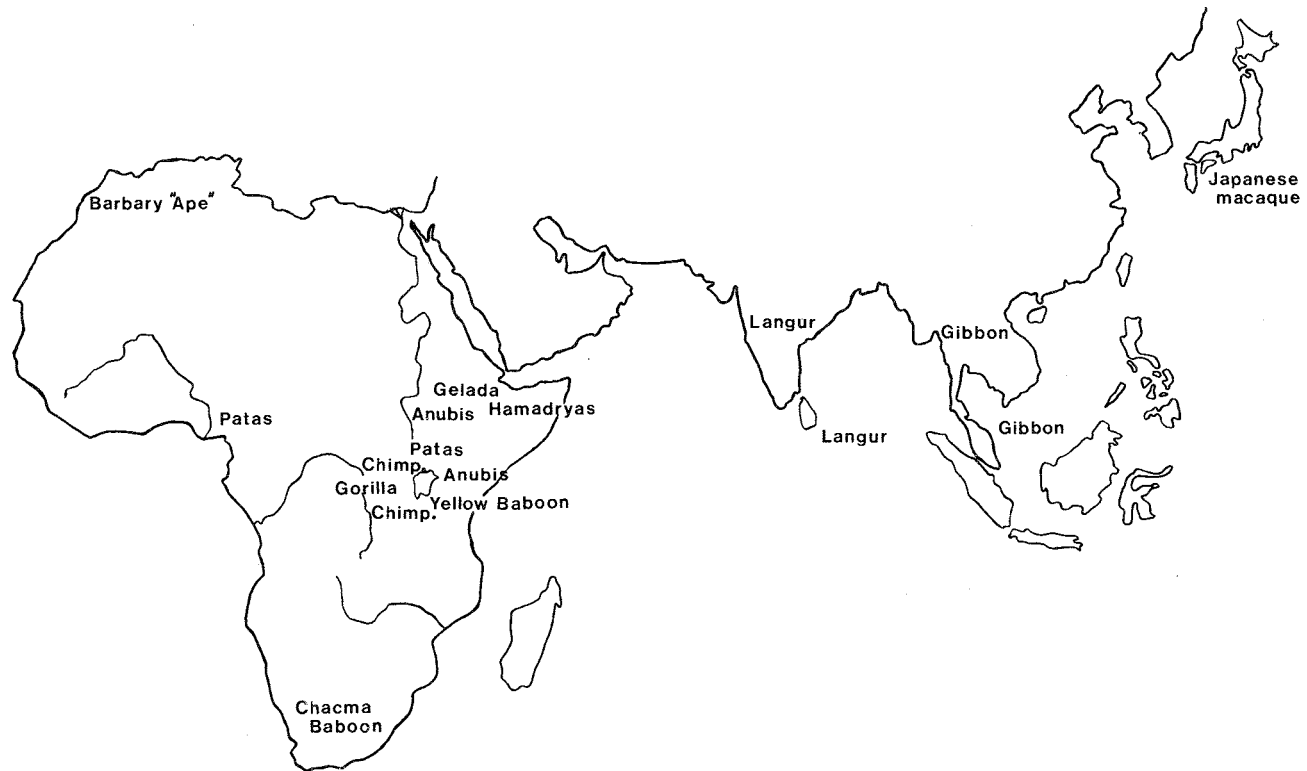


Fig. 1.1. Study areas of species most frequently mentioned in this text.

Chapter 1

"CULTURE" AND THE CONCEPTUAL FRAME OF BIOLOGY

In this volume, the anthropological concept of cultural ecology is subjected to a double stress. First and worse, it is delivered into the hands of a disciple of an alien science, a zoologist, who approaches it with a frame of thought that has virtually no place for culture as this term is usually understood. Second, it is applied to tribes that, though close relatives to man, are nevertheless nonhuman animals. These are the costs of our comparative outlook; its returns will have to be judged by the reader.

The fact that we shall deal with nonhumans is a difficulty that, I hope, will be overcome by the first and last chapters of this book, where I shall try to introduce the reader to primate societies with as much of an anthropologist's outlook as I can muster. The difficulty of the alien frame of thought, however, is not so easily overcome. The conceptual world of the zoologist is as much part of this text as the data presented in it and must therefore be made explicit. Explicitness is commendable for yet another reason: When thinking in terms of ecological adaptiveness, anthropologists use a zoological concept outside its native context of thought. Our

first task here is to confront the student of anthropology with the context of zoological thinking from which the term “adaptiveness” is taken.

The main concepts that guide biological observations, experiments, and discussions can be grouped into five dimensions or viewpoints. First, there is *structure*. The structural or, as it were, the anatomical, outlook describes momentary situations of a living system; it records the proportions of a bone or the composition of a group. Such situations, however, are constantly changing, forcing us to think in terms of processes, such as the growth of a bone or the division of a group. Biological processes are traditionally judged from two contrasting viewpoints that form the second and third of our dimensions: Processes leading to the situation in which we are interested are analyzed as possible *causes* of that situation. Processes emerging from the reference situation are its possible *functions*. By “function” we mean the effect of a process on the success of the living system in which the process takes place. Thus an “adaptive function” enhances the survival chance of the animal or population in which the process takes place.

The fourth and fifth dimensions of biological thinking deal with a larger time scale. *Ontogeny* is the process by which a fertilized egg cell, endowed with a set of genes, develops into a mature and finally an old adult. The study of ontogenetical life cycles attempts to untangle the enormously complex internal processes of individual development. It also analyzes the inputs from the social and ecological environment that affect the course of development. The directing action of such external, nongenetical stimuli is “modification” in biological jargon. Finally, biologists are interested in the long-term processes that alter the genetic endowment from which ontogenies start. These processes are summarized under the heading of *evolution*.

This, in rather crude form, is the biologist’s world of concepts into which he fits his observations. Like all such frameworks or viewpoints, biological thinking is useful only within limits; it simplifies phenomena in which it is not primarily

interested. The phenomenon of "culture," for example, can readily be recognized as a "social modification." However, this biological definition ignores some of culture's most important aspects. A biologist is helpless in the face of such concepts as "attitudes" or "value system," not because he denies their reality, but simply because he has no research tool for detecting any such thing in an animal. He cannot interview his subjects and thus never obtains an inside view of an animal society. He can only read behavior.

For a biologist, the term "culture" comes to mean a set of behavior characterized by its *origin*. An individual develops a particular behavior partly because its genetic endowment directs its development, and partly because the environment feeds information into the process of development. If a behavior were entirely programmed by genes, it could be called "innate"; if it were an exclusive product of environmental stimuli during the animal's ontogeny, it could loosely be called "acquired" behavior. In reality, these extremes do not occur. Although the swimming movements of a fish and the skill of a translator come close to the extreme forms, the fish will never swim unless it finds suitable conditions for its development, and the translator's faculties depend on a genetic basis that is uniquely human. Each observed trait is thus shaped by both information contained already in the egg cell and by information drawn from the ontogenetical environment; nevertheless, the distinction between the two sources of information is real. If two fish with diverse genotypes, but raised under the same environmental conditions, develop different swimming movements, it is safe to say that the *difference* is an effect of genotypes, not of environment. If, on the other hand, identical twins acquire different languages when raised in different nations, the environment must be responsible. The important thing to note is that only a difference between traits, not a trait as such, can be called "innate" or "acquired."

This puzzling statement, which is the solution of the now obsolete nature-nurture controversy, may need some thinking. The argument is that no trait can possibly develop in

total seclusion from either environmental influences or an ever so indirect action of genes. A person speaks French not only because he grew up among Frenchmen, but also because he inherited a genetic basis for language. The trait is neither "acquired" nor "innate" but both. But speaking French *rather than Italian* can be caused by the environment alone; the difference is purely acquired. Or, in an analogy: It takes a drum and a drummer to produce a sound. Nobody would try to differentiate between sounds produced by the drummer and sounds produced by the drum. But we can very well discuss whether two recorded performances sound different because of a new drummer or a new instrument.

With this in mind, we can now approach a distinction whose making I consider one of the important tasks of this book and of research in our field: a clear understanding of the main types of biological adaptations and of their mutual relationship.

The first type is so-called *phylogenetic adaptation*. This is an adaptation of the evolving genotype, not of the ontogenetical process. It occurs when two populations of animals or people have different behavioral adaptations because their egg cells were endowed with different genes. These two populations will, as a rule, develop different forms of behavior even when they are raised in identical environments. Obviously, the process of adaptation occurred before their egg cells were formed, by an evolutionary sorting out of advantageous genotypes. Phylogenetic adaptation is a slow process. It can provide only a generalized behavioral program which is adapted to the *general* features of the habitat in which the interbreeding populations evolved.

The egg cell starts out from this general array of available programs, and at this point, the second type of adaptation takes over. It is *adaptive modification* and is manifested when two populations with the same genotypes develop different behavioral programs in adaptation to the particular environments in which they happen to grow up. The fact that a monkey grows hair is a phylogenetic adaptation, but the fact that he grows thick and long hair when he is exposed

to a cold climate is an adaptive modification. Similarly, a baboon may be phylogenetically programmed to spend the night above ground, but his consistent choice of a particular cliff or tree grove is a modification induced by local conditions and by the traditions of his group.

Adaptive modifications can be divided according to the source of these modifying stimuli. If they stem from the physical environment, such as the terrain or the climate, or from other species living in the same habitat, the modification can be termed ecological. However, the individual's behavior can also be modified by its mother or by the group in which it is raised. If such social modification spreads and perpetuates a particular behavioral variant over many generations, then we have "culture" in the broad sense in which a student of animals can use the term. It can be defined as follows: Cultures are behavioral variants induced by social modification, creating individuals who will in turn modify the behavior of others in the same way. If this definition is accepted, the behavior of two groups with the same gene pool and with the same type of habitat can differ only by culture. The definition states nothing about the precise mechanism of the social modification (because it is unknown in most cases), nor about the categories of behavior that should or should not be accepted as cultural (because animals seem to offer no meaningful criteria for such a distinction).

The concept of culture obviously loses a great deal when accommodated to the dimensions of biology. What we can gain from the operation is the wider context of evolution from which culture emerged as one possible way of life; a context from which it can not break loose and which therefore has to be analyzed. Adaptation by culture is only one way of adapting. Its stage is prepared by phylogenetic adaptations that affect cultural developments. In the human species this stage appears so large that its existence and limits are easily forgotten. In the case of nonhuman primates, phylogenetic programming offers much less choice for social modification and thus for rapid change. The investigator's

attention is focused on their phylogenetic dispositions and on the problems of distinguishing them from modifications.

The distinction between cultural and noncultural components of behavior is difficult to make, and for most behavioral adaptations in primates it has not even been attempted. In the first part of this book, I must therefore neglect it entirely, describing the ecological functions of primate social behavior in professed ignorance whether such adaptations are cultural, ecological, or phylogenetic in origin. In the second part, however, I shall address myself to these distinctions and to the *process* of adaptation. To know the type to which an adaptation belongs is not merely to gain an academic insight into its origin. The speeds at which the different types of adaptation can occur are so enormously different that to know the origin is to know the prospects of future flexibility.

After explaining the conceptual world from which I must approach the subject, I should add a remark on the material presented here. Although primate societies have been discussed from the viewpoint of their adaptiveness for about ten years now, the factual knowledge on such correlations is meager. Most of the available data are not even quantitative, let alone experimental. Many of the speculations that were printed a few years ago have been badly shaken by more recent information. When, in 1960, Kurt and I found the first example of a one-male group organization in old-world monkeys, this social structure was interpreted as being an adaptation to the extremely harsh semi-desert habitat of the hamadryas baboon which we had studied. In the ten years since then, more and more primate species have been found to live in one-male groups—and most of them are forest monkeys which inhabit the richest habitat that dry land can offer. In a recent review of the correlations between the social structures and the habitats of all investigated African cercopithecine monkeys, the primatologist Struhsacker finds little support for an understanding of social structures as simple correlates of simple classes of habitats.

Solid research has yet to begin, and we shall therefore use an ungraceful amount of speculation. I propose in the follow-

ing chapters to describe traits of primate societies and a way of thinking about their adaptive function. The results of this thinking, however, should be viewed as hypotheses at best.

One of the reasons for such caution is the concept of adaptiveness itself. To say that a trait is adaptive is, by itself, vague: A few examples will show the possible complexities. In certain human populations of Africa, the recessive gene for sickle-cell anemia is surprisingly high. Up to 45 per cent of the individuals are heterozygous for this allele which, in homozygous subjects, may cause a lethal anemia. There is evidence that heterozygous carriers are more resistant to malaria than genetically "healthy" subjects. The success of the heterozygous condition apparently explains the enormous frequency of the lethal factor in the investigated populations. We may define adaptiveness as the quality of a trait which, under a given range of conditions, increases the number of offspring of the carriers of this trait. (Note the technical acultural content of this biological definition.) If the above conclusion is correct, sickle-cell anemia is an adaptive trait in these populations, even though it may kill.

Male hamadryas baboons have an inhibition which prevents them from appropriating females belonging to other males of their troop. A poorly developed inhibition should allow a deviant male to collect the females of subordinate troop members; he would thus produce more offspring than his inhibited rivals. A low-level inhibition appears "adaptive" for its carrier, but it is likely to be maladaptive in its effect on the social stability of the troop.

Some ungulates chew with stereotyped motor patterns of the jaw. In camels, the mandible alternates between a motion to the right and a motion to the left, whereas duikers ruminate on one side for quite a while and then shift to a similar series of motions on the other side. The adaptiveness of these patterns does not lie in their particular form, but in their rigidity as such, which prevents the formation of chewing habits that would wear only the teeth on one side. Adaptive function must be sought on the appropriate level.

A primate male may have a stronger than usual tendency

to approach and distract predators. As long as only one or two males of a group are thus inclined, the trait may be called adaptive defense of the group, but the same trait will assume a negative value if too many males of the group expose themselves to the danger of being killed.

Chimpanzees can paint. While it is difficult to imagine the survival value of such artistry, it is possible that the performance is an output of a behavioral subsystem that is part of a larger, adaptive system.

A conclusive statement on the adaptiveness of a trait would require data on its positive and negative effects on many levels of organismic and social organization, and under a wide variety of environmental situations. This volume can offer no such data. Every one of its statements on adaptation would in principle require experimental testing. Since we cannot reasonably hope to carry out such experiments on the appropriate scale, I shall try, in Chapter 5, to outline some correlative methods that can improve the quality of our present knowledge.

SUMMARY

1. The main dimensions of biological thinking are structure, causation, function, ontogeny, and evolution.
2. Phylogenetic adaptation is an adaptive change of the gene pool by mutation and selection; adaptive modification is the shaping of the ontogenetical process by the individual environment.
3. In the limited conceptual framework of biology, the term "culture" can be defined only as a behavioral modification induced by the social environment.
4. A given trait can be adaptive in one functional context or level and maladaptive in others.