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John T. Bonner

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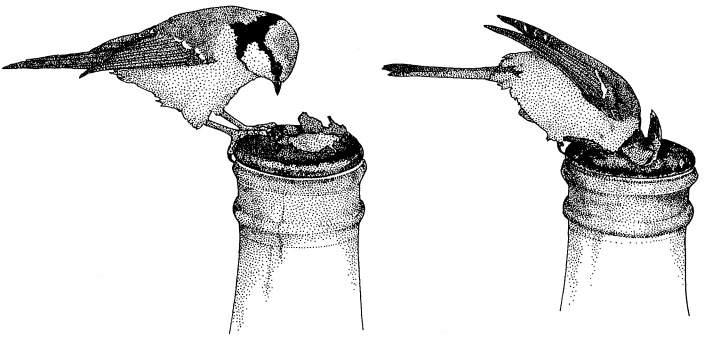

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Preface

The stimulus for this book came in 1975 when I was invited to a Daedalus Conference organized by Talcott Parsons and Hunter Dupree on the relation of biological evolutionary theory to social science. From this small meeting of anthropologists, sociologists, psychologists, neurobiologists, and evolutionary biologists I gained a full appreciation of my own confusion on the subject and a desire to do something about it.

The first stage was writing a short essay that was never published, but that produced numerous comments and criticisms both from social scientists and biologists who were kind enough to read it. In this groping fashion I began to see how things fit together, at least in my own mind, and I half decided to work on the problem further, possibly in the form of a book. What decided me finally to take the plunge was the possibility of a leave from Princeton University and the encouragement of my good friend George Berry.

I began the first draft in our small house in Cape Breton and finished it at the University of Edinburgh in the stimulating environment of the zoology department. There I received endless help and advice from my many friends. In particular I want to mention John Godfrey who time and again drew my attention to some key bit of information that always seemed to be just what I was seeking. But I must also thank many others, especially Phillip Ashmole, Aubrey Manning, and Linda Partridge for many helpful discussions. My greatest debt is to Murdoch Mitchison who made my stay possible in his department, and who, with many kindnesses, saw to it that it was maximally pleasant and profitable. The School of Epistemics at the University of Edinburgh asked me to give a general lecture on the subject of my book that was very helpful to me in learning how to communicate my thoughts. I had the good sense to give the lecture the day before I left town to return to Princeton.

This preliminary draft was circulated either *in toto* or in parts to a large number of people who sent me criticisms. Furthermore, in the spring of 1978 a group of social scientists at Princeton held a weekly seminar on sociobiology and I spent three of those sessions discussing my draft. There were so many people involved in that

public-spirited enterprise that it is impossible to list them all, but I owe each one of them a large share of gratitude. I should particularly like to mention James Beniger, John Burns, Roberta Cohen, Peter Huber, Susanne Keller, Marion Levy, Norman Ryder, Susan Watkins, Maxine Weiss, Robert Wuthnow, and all the others who contributed to the meetings. Also I want to give special thanks to my old friend Marion Levy for spending so much time with the manuscript and giving me a better understanding of how I could say something that might be useful to the sociologist. I am also grateful to Hunter Dupree and Talcott Parsons, not only for starting me on this course, but giving me good comments on the draft.

Among my biological colleagues my list of critics is even greater. In particular I want to thank Henry Horn, Aubrey Manning, E. O. Wilson, and an anonymous reader. Also many helped me with specific points: Joan Aaron, Edward Cohen, John Endler, Alan Gelperin, James Gould, Robert May, W. G. Quinn, and Thomas Sanders, among others. I would like to single out Henry Horn's major contribution, for which I am truly grateful. His marginal notes were worthy of being set into print intact had not some of them been so uncomplimentary.

And I have not exhausted the list. Edward Tenner of Princeton University Press gave me numerous good ideas and advice. Of particular help was my wife Ruth's meticulous attention to inconsistencies in my grammar, style, and thought, and she was unfailingly diplomatic in giving me the bad news. I also thank Kathryn Schneider for her library research, her most helpful comments on the first draft, and the skilled preparation of the first two drafts. It has been a special pleasure working with Margaret La Farge who did all the splendid original drawings for the book.

I have never before been helped by so many kind and forebearing people, but I do not want to imply that the final draft of the book was written by a committee. While in many places I have been saved by my friends from making absurd and embarrassing statements, in others I retained the right to do so, as the reader may enjoy discovering. The statement in this book is a personal document. It reflects what seem to me, as a biologist, the important issues that lie between the biological and the social sciences. It avoids political issues and avoids all those issues that have produced such intense emotion in the last few years. This is not because I don't take a certain morbid fascination in such popular matters; it is only that it is not possible to discuss them constructively at this time. For

the moment they have removed themselves from the realm of science, and this book is about science.

Finally, and I have saved it to the last because of its importance, let me acknowledge with gratitude the Josiah Macy, Jr. Foundation for its grant supporting the preparation of this book. The president, Dr. John Z. Bowers, was unfailing in his enthusiasm for the project, and this did much to keep my spirits up when the going seemed slow.

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The Evolution of Culture in Animals

CHAPTER 1

Philosophy and Less Grand Matters

This is a book on evolutionary biology. It stresses certain aspects in a way that will perhaps provide some new insights into old problems. I say "perhaps" because there are many sophisticated evolutionary biologists who will point out that there are really no new or revolutionary ideas; what I have to say is essentially what they knew all along. That is most likely the case; yet they have not put it all quite this way. The difference will be in the grouping and arrangement of facts and ideas. It is often true that, as a subject advances (especially when it advances rapidly), we do not always appreciate immediately all the riches we have before us.

While it is my hope that I can convince the professional biologist that there are new things to learn from old facts, I also want to reach the anthropologist, the sociologist, and the well-read layman. Therefore I will couch my arguments in as little jargon as possible. This is not to mean that I subscribe to vagueness or that I court imprecision. To the contrary, I want to make my exact meaning immediately clear.

My purpose is to trace the origins of the human cultural capacity back into early biological evolution. It will soon be evident that I am not a catastrophist and do not believe that, like the great flood, culture suddenly appeared out of the blue at a restricted moment in the early history of man. Rather, to continue to borrow from the nineteenth-century geologists, I am a uniformitarian and believe that all evolutionary changes were relatively gradual and that we can find the seeds of human culture in very early biological evolution.

A Brief Abstract of the Book

There is a main point, a principal conclusion to this book, and I should like to state it in the beginning so that it will be easier to follow the thread of my argument. It is that even though culture itself does not involve genetic inheritance or, therefore, Darwinian

evolution by natural selection, the ability of any animal to have culture is a direct product of such an evolutionary mechanism. Passing information by behavioral rather than genetic means has made it possible in some cases to pass kinds of information that either cannot be transmitted genetically at all or are less effectively transmitted by genes. Natural selection operates on the genes and only involves gene transmission; yet the power to transmit by behavioral means is as a method adaptively advantageous. Therefore, there has arisen a genetically determined behavioral capacity to transmit information by signs, by language, by imitation.

This kind of nongenetic transmission is mediated by the brain, and so there has been a selection pressure for a larger and more complex brain. The advantage of culture both in its present form as seen in man, and in its more primitive forms as seen in other animals, has continuously exerted pressure for brain expansion. As a result there was first an increase in the ability to learn and later in the ability to teach. A related trend can be seen in the increase of the flexibility of responses ranging from single, rigid, genetically determined responses to multiple responses that can either be learned or even invented. These trends form a progression ultimately leading to culture. I shall also examine the early origins of these trends and follow the complete sequence of biological events that are the antecedents of culture.

Culture is transmitted by behavioral rather than genetic means, and it will be important to keep this distinction clear. The problem is that any pattern of behavior could have both a genetic and a learned or acquired component, which involves the old intractable question of nature versus nurture. Many reasons can be given for the intractability, but none of them makes the question any less interesting, and human nature is such that we shall continue to try and find ways of identifying what is inherited and what is learned. However, for various reasons, involving both its difficulty of analysis and the intellectually destructive political emotions it generates, this is a subject I shall be careful to avoid in this book. Instead I shall ask why culture exists at all, a question that can be answered in the straightforward Darwinian manner just indicated.

Reductionism and Holism

The conflict that has arisen between biology and the social sciences can, in large measure, be seen in terms of the conflict between re-

ductionism and holism. By reductionism we mean a science (or a hierarchical level) can be understood in terms of its component parts from the level below; for instance, the symmetrical structure of a crystal can be interpreted largely from the properties of its constituent molecules. By holism we mean that there are emergent properties arising at each hierarchical level and that these properties cannot be understood in terms of those of a lower level. The holist believes the living organism has properties that would not be predictable on the basis of what we know of chemical substances and the characteristics of human society cannot be interpreted in terms of lower level biological properties. The old adage of holism is that the whole is more than the sum of its parts.

Biology has undergone, in its most recent flowering, a period of extraordinarily successful reductionism. It is hard to know exactly when this began, but let me give a few milestones: the interpretation of heredity in terms of unit characters by Gregor Mendel; the demonstration by T. Boveri, E. B. Wilson, W. S. Sutton, T. H. Morgan, and others that those characters resided in the chromosomes of the nucleus; the discovery of the structure of DNA by J. Watson and F.H.C. Crick; and finally the cracking of the genetic code by M. W. Nirenberg and others who showed which triplets of nucleotides in the DNA specified particular amino acids in the proteins. By any measure these and other advances in molecular biology have been staggering and at this very moment the rapid progress continues unchecked.

If we turn to evolutionary biology, there has been a similar trend, although it is less spectacular in its progress. Its origins of course can be traced to Charles Darwin. The next step forward was the rise of population genetics in the 1920s and 30s, especially the work of R. A. Fisher, J.B.S. Haldane, and Sewall Wright. This era of neo-Darwinism was truly reductionist because its concern was for the rates of change of individual genes in a population over time. In the 1940s and 50s the field was criticized because it was oversimplified; it did not seem to reflect the real world, and therefore was unable to cope with what were perceived as the new and more significant problems.

The next surge forward came in the 1960s when Robert MacArthur and his colleagues and followers saw that one could make simple theoretical models that applied not only to the more complex aspects of evolution, but in particular to the morass of problems in ecology. Their method of simplification and approximation

dramatically illuminated possible mechanisms in a way that made order out of chaos. There was great resistance from the traditional evolutionists and ecologists because it seemed that the very complexity of the problems, which had been cherished as their most important characteristic, was consciously ignored. MacArthur (1968) countered these arguments with: "Think how physics would be without its frictionless pulleys, conservative fields, ideal gases" (1968:162). Theoretical ecology and evolution have already proven, in a very short time span, to be enormously powerful as analytic tools.

Nevertheless its proponents have not rejected holism, but they believe that progress can most effectively be achieved by a balance between holism and reductionism. Again to quote MacArthur (1972): "Most scientists believe that the properties of the whole are a consequence of the behavior and interaction of the components. This is not to say that the way to understand the whole is always to begin with the parts. We may reveal patterns in the whole that are not evident at all in its parts. Species diversity, for example, is a community property and is not a property of the individual component species. It can be understood as a consequence of the interaction of these species, but its patterns were discovered and explained by people aware of communities; ecologists primarily interested in the separate species have never made any progress in unravelling community patterns" (1972: 154, 155). In his own research MacArthur showed that, using an overall holistic view as his guide, he could generate simple hypotheses that were effective in summing up the parts of a lower level of organization thereby illuminating the properties of the higher level.

That there is a trend toward reductionism in modern population biology is beyond doubt, and one example clearly illustrates this fact. One of the important contributions of W. D. Hamilton (1964) was the notion of inclusive fitness, the idea that fitness should include the survival and reproduction of kin. This means, as was explicit in the early ideas of the population geneticists, that the genes are the object of selection. R. Dawkins (1976) has stated the matter most elegantly in nonmathematical terms in his book *The Selfish Gene*, whose title itself tells the main part of the story. He talks of genes as being "replicators" and the organisms the genes produce through development as being the "survival machines" that are devices for keeping the replicators intact and functioning. We shall discuss this whole matter in detail further on. Here the point I wish

to make is that this is evolutionary reductionism in its extreme form, and, as we shall see, these basic ideas have already contributed to significant advances; they are the gateway to a new understanding of evolution and the social organization of animals.

If one looks at the criticisms of sociobiology by anthropologists and social scientists, they are almost entirely related to the idea that a reductionist approach will not be useful in the social sciences. The study of human societies occupies a separate hierarchical level and must be considered in its own terms and not in terms of the biological level lying below. In their view, human societies are too complex, too special, too different from anything found in the animal world to be interpreted in any meaningful way by biological analysis. Their position is largely or entirely holistic. For instance, their notion of culture is that it is an emergent property unique to man. According to M. Sahlins (1976), culture was developed in the hominid line about three million years ago. It is a new condition that came into being as a result of the complexity of the mind of early man. To that extent the cultural anthropologist would consider it biological, but once it came into being, it took on a life of its own, and its new properties cannot be understood in terms of the level below. It is, so to speak, self-propelled and, like a soul, has become detached from its body. More of this later; here I want only to stress that this is indeed a holistic bias. (The very same argument can be made by those, such as J. Jaynes [1977], who consider consciousness also to have arisen suddenly in the early history of man, although consciousness, according to Jaynes, arrived full-blown long after culture.)[1]

It has certainly been true for biology, as I previously illustrated, that when a field is able to make advances by a reductionist approach, the progress is most exciting and rapid. Furthermore it is obvious that the more complex the field, the slower it achieves a stage where it can make fast advances by reductionist methods. This statement is one of simple fact and applies not only to biology, but also to physics and chemistry. And from this I would suggest it is not inconceivable that the same process might occur in the social sciences at some time in the future. If it does, clearly the lower level will be biology. The sociobiologists have already claimed they have

[1] The contrary view is admirably set forth in a book by D. R. Griffin (1976), who with Darwin (1874) provides evidence for the idea that there might be a continuum between what we call consciousness and various manifestations of behavior in animals.

found a bridge connecting the two levels, but this has been stoutly resisted by many anthropologists and social scientists. Again, this is obviously a matter to which we shall return.

One final word on holism. I do not mean to imply holism is bad and reductionism is good, for they are both important. Often in a particular field at a particular stage in its development it is impossible to do anything other than examine the problems holistically. Furthermore a holistic approach has, in many cases, produced significant progress. It is probably true that it is a necessary stage without which the reductionist progress could not be made. Initially, it is the only way of describing the problems and grouping the facts. Were this not done the chaos would be complete. However, despite the strengths of a holistic approach, one should not fear reductionism as an evil. When it comes to a field, it should be greeted with caution, but also with pleasure. The caution is needed because there is a degree of oversimplification where the exceptions may accumulate to such an extent that clearly they no longer prove the rule, but prove the need for a more refined theoretical insight. The more traditional holism keeps the perspective in the field, even when reductionism is rushing forward at a dizzy pace.

It has always seemed strange to me that holism and reductionism should elicit such strong passions among scholars. They are, after all, only the philosophical methods characterizing different kinds of scientific progress. The reductionists tend to be contemptuous of all holists, for they feel they alone have the key to the universe. Holists know they have a broad perspective, a large insight, whereby they can see all the riches missed by the single-minded reductionist. In principle it would appear so easy to be both at once, but human nature is such that it enjoys taking positions on philosophical or political dichotomies, ignoring totally the possibility that some of these dichotomies are not genuine antitheses of the either-or category, but are complementary. In fact, I would go so far as to say that it is the holist who sees and understands the dimensions of the problem and it is the reductionist who in the long run will produce the most satisfying type of explanation. The one cannot do without the other.

A Definition of Culture

There are probably few words that have as many definitions as culture. I can remember when I was a student of Professor William Weston at Harvard, there was a large room across the hall from his

office where we made nutrient media to grow fungi and slime molds. It was there that I learned the now lost art of how to make potato agar from real potatoes. On the outside of the glass door to this communal room was one word inscribed in large gold letters: CULTURE.

At the other extreme there are those who use the word in a sense I associate with Matthew Arnold and the *Oxford English Dictionary*: culture is a refinement of tastes and artistic judgments; it is the ultimate in the purification and rarification of the intellect.

Fortunately, definitions in science are arbitrary, and I shall define the word in a sense somewhere in the middle of the great chasm between the two uses of the word mentioned above. By culture I mean the transfer of information by behavioral means, most particularly by the process of teaching and learning. It is used in a sense that contrasts with the transmission of genetic information passed by the direct inheritance of genes from one generation to the next. The information passed in a cultural fashion accumulates in the form of knowledge and tradition, but the stress of this definition is on the mode of transmission of the information, rather than its result.

In this simple definition I have taken great care not to limit it to man, for, as so defined, there are many well-known examples among other animals, especially among those that cooperate extensively such as primates. It would be easy to alter the definition and say arbitrarily that it applied only to man, and since any definition is fair game, there is nothing improper in such a procedure. But I want to emphasize that this is not the course I have taken.

There is a tendency to oppose the words biological and cultural, but Marion Levy has pointed out to me why this is unfortunate. Culture, as I have defined it, is a property achieved by living organisms. Therefore in this sense it is as biological as any other function of an organism, for instance, respiration or locomotion. Since I am stressing the way information is transmitted, we could call one *cultural evolution* and the other *genetical evolution* with the understanding that they are both biological in the sense they both involve living organisms.

Anthropomorphisms

The existence of anthropomorphisms is a problem to which there is no solution. Those interested in the similarities between man and animal have no fear of anthropomorphisms, while those who see

man as special in some major way feel that our whole man-oriented language is dangerous and misleading when applied to animals. Here is a clear instance where human culture interferes with our science.

Let us look at the prejudices of both sides of the argument. An anthropologist might find the use of words such as *slaves* or *castes* for ant colonies most undesirable. There are a number of reasons he finds this usage unfortunate. For instance, it implies that the most repugnant human morals are ascribed to the members of some species of ant who are clearly too stupid to be immoral. Much worse, it could imply that if ants have slavery, it is a natural thing to do and therefore quite justified in a human society. These arguments are not quite rational and can only be advanced under extreme fervor of one sort or another. A more reasoned objection would be that the motivations of ants and men might differ radically, but by using the same words this distinction is lost.

A biologist, on the other hand, feels that the points made above are too obvious to interfere with the dual use of the words. He does not see any problem: in both ant and human slavery individuals forcibly capture members of their own species or related species and cause their captives to do work for the benefit of the captors. It is unnecessary to drag in all the possible political, psychological, or strictly human nuances; a very simple definition of the word is sufficient. There is no need to be tyrannized by words. If a biologist may not use the common words, he will be forced to invent a whole new set of jargon terms for nonhuman societies, an unfortunate direction since there are too many jargon words in any science as it is. I hope it will be sufficient if I make it clear in the beginning that words either invented or frequently used for human societies will also be used for animal societies with the understanding that I am not implying anything human in their meaning; they are to be considered simple descriptions of conditions.

There nevertheless is a difficulty. It can be argued that no matter how excellent and pure our stated intentions might be, the words will unconsciously tend to make us interpret animal behavior in human terms. But surely this danger exists no matter what terms we use. It comes down to the very core of the problem of objectivity: we see the world only through our own eyes, our own minds. One might suppose it is easier to separate Newtonian mechanics from our psyche than courtship and altruism in the behavior of birds, but in fact they are both seen through our minds. If anything, in

the behavior of birds it is possible to see the pitfalls simply because they are more obvious. The difficulty of attributing human motives (correctly or incorrectly) exists and will continue to do so, no matter how cumbersome a vocabulary one invents. When the reader finds words of common usage in the pages that follow, he is urged to interpret them in a straightforward way. Even if he subconsciously fails in this task, no great harm is done for the question of what motivates other animals, as compared to ourselves, is not the central subject of this book.