Every Picture Tells a Story: Illustrations in E. O. Wilson's Sociobiology

Author(s): Greg Myers

Source: *Human Studies*, Vol. 11, No. 2/3, Representation in Scientific Practice (Apr. - Jul., 1988), pp. 235-269

Published by: Springer

Stable URL: http://www.jstor.org/stable/20009027

Accessed: 27-09-2016 16:24 UTC

Human Studies 11:235–269 (1988)

Every picture tells a story: Illustrations in E.O. Wilson's *Sociobiology*

GREG MYERS*
Modern Languages Centre, University of Bradford, Bradford, West Yorkshire BD7 1DP, UK

1. Introduction

If a child were to look into *Nature* and, say, *Sociology* or the *Journal of Linguistics*, the first thing that might strike him or her as important would be that the scientific journal had pictures, while the others just had print. Those of us who study scientific texts have, until recently, ignored these pictures.[1] But since Martin Rudwick commented on this lack of attention in 1976, a number of studies of scientific discourse have discussed the use of illustrations in scientists' communications with scientists (Latour, 1985; Shapin, 1984; Lynch, 1985c; Bastide, 1985). Illustrations are also important in communications between scientists and readers outside their specialties (Jacobi, 1985, 1986; Gilbert and Mulkay, 1984; Pickering, 1988). Indeed, the iconography of a science is more likely to have an impact on the public than the words or mathematics, which may be incomprehensible to them. If we ask, for instance, what most people would recognize from Watson and Crick's 1953 *Nature* article, it would not be the exact

* I thank the Harvard University Press for permission to reproduce illustrations from *Sociobiology*. I would also like to thank Trevor Pinch and the Sociology seminar at the University of York, Steve Woolgar and the Department of Human Sciences seminar at Brunel University, and Robert Fox and the seminar on popularization at the Centre de recherches en histoire des sciences et des techniques, La Villette, Paris, for allowing me to discuss earlier versions of this paper. I would also like to thank E.O. Wilson and Robin Dunbar for their comments.

phrasing of the claim, it would be the picture of the double helix, with the phosphate chains like flat ribbons, the base pairs as rods between them. So when the *New Scientist* illustrates an article (Maynard Smith, 1985) with a picture of double helices in the sky, with lines coming down from them to the hands and feet of a man and of various animals, the editors can assume that most readers, whatever their discipline, can interpret this rather complex message as a statement about genetic control of animal behavior. The double helix stands for the physical basis of heredity the way two intersecting ovals enclosing a circle stand for atomic energy.

E.O. Wilson's *Sociobiology: The New Synthesis* can provide some examples of how pictures work when an author wants to appeal to readers outside the immediate discipline in which the conventions for reading these pictures are well established. It did not introduce any one image as powerful as that of the double helix or the Bohr atom; indeed Holton (1978) asserted that the lack of such a master image could limit the theory's popular appeal. But it is a useful place to start looking at pictures because it contains such a large and heterogenous collection of them, with samples of almost every kind of figure currently used in evolutionary biology. It links the kinds of illustrations one would expect to find in *Scientific American* – photographs and elegant drawings – to the graphs and visualizations of models one would expect in the *Journal of Theoretical Biology*.

Wilson's book is not typical of any genre of scientific publication. It looks like a textbook, but it is also a scholarly review and an overview that brings together material that was not in one place before; it is addressed to other biologists, but it is also meant for social scientists and the general public. In this analysis, I am going to imagine the reader as a non-biologist who comes to the book as a work of natural history, the way one might read Darwin's *Journal of the Voyage of the Beagle* or watch David Attemborough's *Life on Earth* on the BBC. Of course there are other possible, and quite distinct, horizons of expectation that could just as easily be brought to the book – those of the reader of Wynne-Edwards on group selection, or of W.D. Hamilton on kin selection, or of Desmond Morris's popular works on animal behavior, or of Wilson's own earlier work on insects, or those of the reader of criticisms of sociobiology by Steven Rose, R.C. Lewontin, or Stephen Jay Gould. The genealogy one gives the work – as a textbook-like survey of behavioral ecology, as a new synthesis of population biology and ethology, or as the latest in a line of hereditarian manifestoes – is a crucial step in one's reading of it. I construct this non-biologist reader of natural history as my guide because I want to think about how such a reader might interpret the book's pictures, how its images carry over from the specialized literature of biology into public discourse.

When *Sociobiology* was published in 1975, it was a best seller; it was greeted with both extravagant praise and angry criticism, and the controversy still continues today, with a number of books and scores of articles devoted to analysis of the book, its methods, and its context (references in Myers, forthcoming). Though reviewers, pro and con, often commented on how lavishly illustrated and visually imposing the book is, there has been little discussion of how this museum-like collection of images contributes to the book's remarkable persuasiveness. The book links various sorts of pictures together in a sort of montage that parallels but does not simply reflect the book's verbal text. I want to show how some of these links between different kinds of pictures and different kinds of authority are made. First, I will distinguish several categories of pictures, to show how they differ in their conventions and their rhetorical effects. Then, I want to show how these pictures relate to the text, and how they are juxtaposed with each other. Finally I want to apply this analysis to some other popularizations of sociobiological ideas. Though I will describe the pictures, readers may want to look at a copy of the book to see some of the pictures I do not reproduce.

2. From photographs to graphs

Chapter 26 of *Sociobiology*, which deals with "The Nonhuman Primates," begins with a figure representing an evolutionary model; it is headed "The Primates" and shows arrows moving from top to bottom connecting various headings of "The Prime Movers" to various "Adaptive Social Traits," sometimes leading along the way through a network of other adaptive traits such as

"Increased Manipulative Skills." The chapter ends with two large black and white photographs of "Temporary resting parties of chimpanzees in the Gombe Stream National Park..." (Figure 26-8). The problem of the chapter, if it is seen as a set of images, is to establish a link between them, between highly abstract diagrams and apparently realistic photos, between an evolutionary hypothesis and the observations of ethology. I am going to treat the photograph and the pathway diagram as two extremes of a set of categories of pictures (my Figure 1).[2]

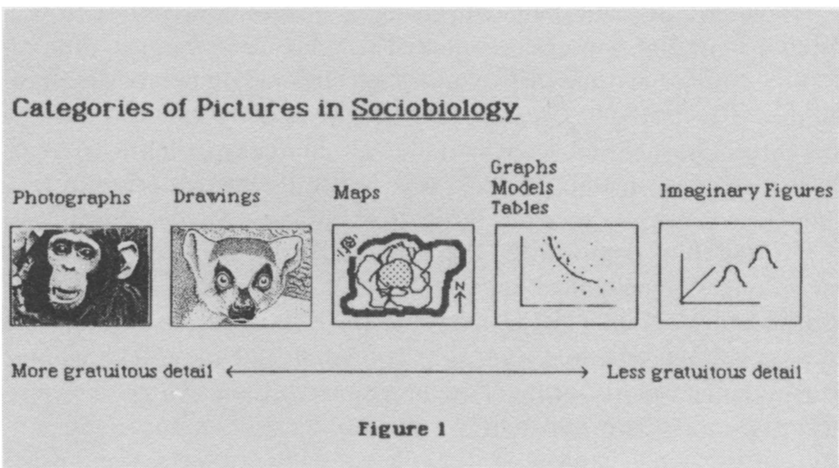

Figure 1. Categories of pictures in *Sociobiology*

One factor that distinguishes these categories is the presentation or elimination of gratuitous details. The squiggles and splotches that do not seem relevant to the claim the picture illustrates have their own significance, as part of the what makes the picture seem continuous with our own world. The elimination of these squiggles and splotches is part of the move from the particularity of one observation to the generality of a scientific claim.[3] I see a related change, from one category to the next, in the treatment of the background against which the object of the illustration is defined. At one end of this set of categories are *photographs*, which are full of gratuitous detail, and which present the background as a space continuous with our own. In *drawings* the artist gains the freedom to select and arrange details but loses the chaotic and arbitrary patterns of the photo; the background may recede in perspective or may be eliminated. *Maps* (of places or of bodies) are read as symbolic representations, rather than as images of the observed world. But in their backgrounds they still have some reference to the way we familiarly conceive of space, in the irregular outline of a waterhole, or the cutaway image of an ant's insides. In contrast, *Graphs, models*, and *tables* redefine space, wiping it clean of all irrelevant details and structuring it so that each mark has meaning only in relation to the presentation of the claim.

Photographs come with apparent self-evidence, because they are taken as mechanical reproductions of an image. As the film critic André Bazin (1945) has written, "Photography affects us like a phenomenon in nature, like a flower or a snowflake whose vegetable or earthly origins are an inseparable part of their beauty." But of course photographs are not part of nature, and are not entirely mechanical – the photographer selects the image and plays a part in defining it. To understand their effect, we must consider the way they are received, as well as the way they are produced. There has been enough written recently about photographs to make it clear that the interpretive process that turns dots into images is at least as complex as the optical and chemical processes that turn images into patterns of dots. Paradoxically, it is the limitations of photographs that make them such powerfully persuasive documents. The film theorist Rudolph Arnheim (1933) calls this a theory of "partial illusion"; the photographs cannot show time, space, or even images without our working on them. From the spotty grains of black and white, we reconstruct two-dimensional shapes and textures, and from the shapes and perspective we reconstruct volume and three-dimensional space, and from this reconstruction in space we reconstruct a moment in time.

First we must define some part of the photo as the image, usually setting it apart from the background. In Figure 26-8, the photos of the chimps (my Figure 2), our attention may go first to the pat-

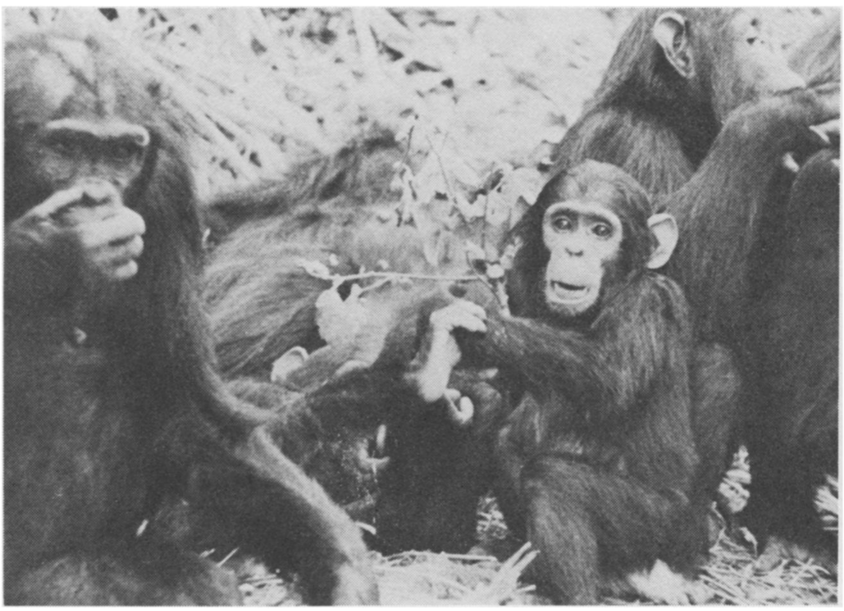

Figure 2. A photograph. The caption reads: "*Figure 26-8* Temporary resting parties of chimpanzees in the Gombe Stream National Park. Left: Three adult males on the left (Worzel, Charlie, and Hugo) are accompanied by two adult females (Sophie, with a female infant, and Melissa). Right: in a second group, two infants play in the middle, one with a typical 'play face,' while a juvenile grooms an adult. (Photographs by Peter Marler and Richard Zigmond)."

tern in the middle because it is a light patch surrounded by dark, because it is in the middle, and because we look for the pattern of two dots above a curve signifying a face. The pattern at the top and the bottom is background because it is lighter, is incoherent, is at the edges, and, at top, is out of focus. The image is not always so easy to find. For instance, in a photo showing "slavery in ants" (Figure 17-7), Wilson must intrude arrows to enable us to pick out the relevant shapes of the master and slave ants. (One game show on British television sometimes challenges naturalists to pick out the animals in photos that apparently show a tangle of vegetation. But the audience must be shown highlighting, zooms to closeups, and enhanced outlines to make the image emerge.)

If we assume light from the top, and the shading conventions of realist, paintings, we can give this flat image volume; that is, we see this shape we have picked out as a face, and not, say, as a flat mask or cut-out.[4] Conventions of perspective direct us to read one chimp as being in front of another chimp and not, say, inside it. Just as important, conventions of perspective define our own place just outside the picture, just as the gaze of the chimp does. We place ourselves at a few feet from the chimp, and would be surprised if it had been taken with a telephoto lens from hundreds of feet away. This specific point of view is part of what gives a photo, or a realist painting, its immediacy and self-evidence. This point of view is also defined by the rectilinear edges of the photo. Just as we assume that a chimp at left was chopped off in framing or cropping, and is not really a whole image of half a chimp, we assume that the rest of the world goes on beyond the edges of this photo; this is one slice of a world that is continuous with our world. Perhaps the most powerful effect of a photo like this one is the way that, by freezing time, it suggests a narrative of events before and after – here, according to the caption, "resting," "playing" and "grooming." It is one particular moment, just as it is one particular place.

All these processes of interpretation lead us through a thicket of irrelevant detail. There is a great deal of detail here besides what the caption tells us to look for, "Two infants play in the middle, one with a typical 'play-face,' while a juvenile grooms an adult" (Wilson, 1975:544). Hundreds of dots go into the ear of an irrelevant chimp, or into a blurry stalk, or into the shadow under an eyebrow. All this detail carries no relevant information, but it does have a function, making the photo seem to be a document recording an unmediated perception of a particular piece of nature. The book also includes some photos that do not have all these signs of realism. In a photograph in which termites cluster around a bar of iron (Figure 14-2, 303) a photo taken from directly overhead, lit from behind, and greatly enlarged, the lack of a background, of shading, and of perspective in all suggest an experimental situation, rather than observation in the field.

Some critics, like Bazin, have begun their consideration of the photograph with the fact that it is a mechanical recording of the image: "All the arts are based on the presence of man, only photography derives an advantage from his absence" (13). But the rhetorical power of the photograph does not extend to other forms of mechanical recording of reality, such as spectrograms.[5] A spectrogram of a whale song (Figure 9-7, 221) carries no apparently self-evident message. This may be partly because the readers of popular natural history are less familiar with reading inscriptions that record frequencies of sound than they are with reading inscriptions that record the effect of light on an array of crystals. But there is also an assumption that photographs are organized like our ordinary sight, while spectrograms are organized like graphs. We only become aware of our processes of interpretation with photographs when we are looking for some trick in them. What both kinds of inscription share is a wealth of gratuitous detail. In the spectrogram, as in some photos, the relevant patterns must be picked out from the irrelevant details that are here labeled "artifact" and "dynamite."

Some of Wilson's critics commented on the number and lavish presentation of drawings in *Sociobiology*. They might seem to be out of place in a scientific book; they are not mechanical records and do not suggest that the artist ever saw just this, or even that the artist was in the place represented. But, like photographs, they use gratuitous detail and particularity to suggest immediate contact with reality. The most striking of these drawings are a series of two-page spreads by Sarah Landry, illustrating the social systems of various animals, each drawing based on one study cited in the caption; an example is the drawing of lemurs based on the research of Allison Jolly (Figure 26-3; my Figure 3). As in a pho-

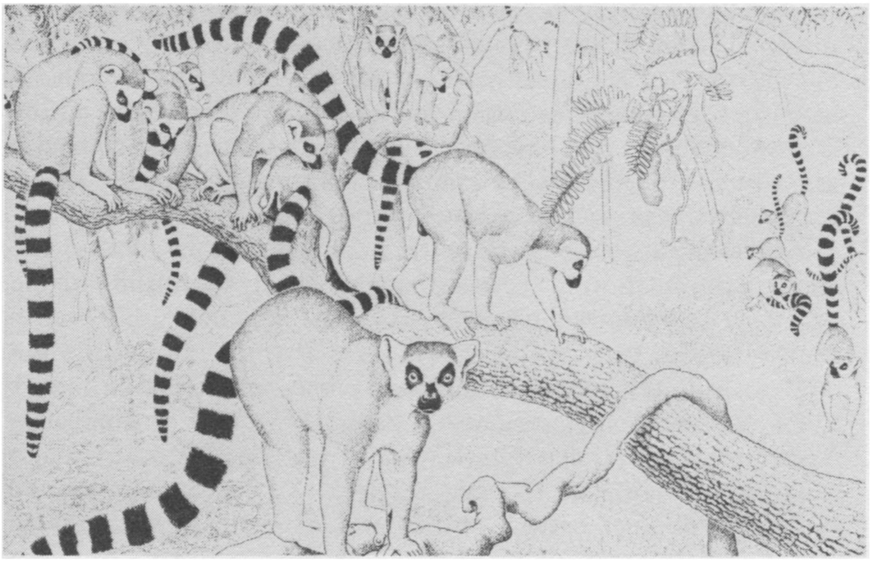

Figure 3. Part of a drawing by Sarah Landry. The caption reads: "Figure 26-3 The encounter of two ring-tailed lemur troops at the Berenty Reserve in Madagascar. The habitat is a riverside gallery forest, dominated in the foreground by a large tamarind tree (*Tamarindus indica*). The arboreal troop on the left is stirring into activity after a noontime siesta. One male faces the observer with a threat stare, his antebrachial gland visible on the inside of the left forearm. A second male behind him has begun to move down the tree trunk in the direction of the other troop directly to his rear, two adults engage in mutual grooming, while other members stay clumped together in rest or in the early moments of arousal. The troop on the ground has begun its afternoon progression to a feeding site. Two adults at the left and front have spotted the group in the tree and are staring and barking in their direction. One of these, a male, draws its tail over the antebrachial glands in preparation for a hostile display. He is ready for a stink fight, during which the tail will be jerked back and forth to waft the scent toward the opponents. Well to the rear and in the center of this picture, two subordinate males of the 'Drone's Club' trail the second group. (Drawing by Sarah Landry; based on data from Alison Jolly, 1966 and personal communication.)"

graph, the frame, with vegetation and parts of animals continuing off it, and the perspective, fading to the dim small animals in the background, all suggest that the world is supposed to continue and this is just a metonymic piece of it. It is the strategy of the realistic novel. The observer is made present in the drawing of lemurs by the gaze of the male in front. Several of Landry's drawings have such inquisitive animals; one of the lions "stares at an unidentified object past the observer." This sounds odd; of course in a photograph the object would be unidentified, but in a drawing it, like the animals themselves, is imaginary.

A drawing uses these conventions of photographs, but it also allows manipulation in ways a photo does not. One handbook on popularization for scientists makes this distinction:

> If realism is important, the best choice may well be photographs. Otherwise, diagrams, which allow you to emphasize certain features and eliminate the rest, are often the best medium. (Gastel, 1983:13)

All of Landry's pictures arrange their components in a way a photographer cannot, to make them typical. They include in the same frame several representative activities, usually conflict between animals, recognition of the observer, sexual behavior, and the search for food, and these activities are usually read by the caption from left to right, and foreground (bottom of the page) to background. The drawings are deliberately impressionistic, pointillist, in style, and the layout makes them more like museum diorama than photos.[6]

Wilson emphasizes the representative quality of these drawings in his account of how they were made.

> I planned the panoramic views of animal societies for a special reason: unlike many other behavioral and biological phenomena it is impossible to represent more than a tiny slice of social life of any species with an ordinary photograph or sketch. Accordingly, I extracted information on the key members and some of the important behaviors from the best monographs and laid out the arrangement in a (crude!) pencil sketch. My work gave the two of us a lot of amusement. I took care to

> make the representation demographically correct and provided Landry with the original research materials. Landry took it from there, and added her own unusual gifts for scholarship and design. In many cases she visited zoos and watched motion pictures to sketch the live animals. She invented new arrangements and postures, including the striking one of the staring lemur. She researched the botanical literature and consulted botanists (both abundant at Harvard) to get as exact as possible the vegetation where the societies naturally live, and her drawings of individual plants are meticulous. (personal communication)

Wilson is careful to give full credit to his collaborator. He is also careful to stress the way that her careful research brought her into various kinds of contact with reality so that we will not look upon the drawings as inventions, as interventions of the artist or scientist.

Drawings can be classified on a continuum from the conventions of photographs to the conventions of diagrams. For instance, there is a Landry drawing of primitively eusocial bees, taken from an earlier Wilson book (20-7) that marks with a cutaway that we are seeing the unseen, the inside of a stem. And the reader would further qualify its realism because the stem is arranged in white space; the gratuitous detail in the background is eliminated, and there is no implication that the image extends beyond the frame. But even with this cutaway, the effect of realism is given by the thorns on the outside of the stem, the woody lines of the grain where the stem was cut, the shading of light from above, and the bee crawling out of the cut end. Abstracting further, the setting of an object can be eliminated entirely, and the pictures arranged like specimens mounted in a glass case; so, for instance, Figure 11-2 shows two rows of larvae, arranged with their heads to the top to display their mandibles, labelled with letters and a key. The shading can be eliminated so that only an outline is left, as in a drawing of a parasitic ant strangling a host queen (Figure 17-4). Here we are reminded that the use of black and white lines is governed by the conventions of prints, not by reality; we interpret this picture as meaning, not that a queen shown as white is white and an invader shown as black is black, but that the two animals are shaded differently so that we can distinguish them more easily. From such outline drawings focusing our attention on only one or two specific features, it is only a step to symbolic figures standing for the animals. In these symbols even more gratuitous detail is removed, so that a fish is an oval with fins, a bird is a profile silhouette of a beak, talons, and tail, and herds of rubber stamp elephants roam a landscape of wavy lines. Even so, such rubber stamp elephants suggest a reference in the picture to a visible reality that would not be suggested by an *E* with an arrow on a map.

A different sort of abstraction occurs in maps and diagrams. Martin Rudwick (1975) has discussed the problems of makers of early geological maps trying to represent three dimensions in two, using symbols or colors to represent the world below the surface. The problem in zoogeography is showing a series of events on a page: the distribution of animals, and the changes in this pattern, must be created out of a series of individual observations by the researcher over a period of time. The background is now defined by a two-dimensional grid, rather than by perspective, and by a few landmarks, rather than details of scenery. In many of these maps the space of a territory is defined by the a number of places an animal has visited or has marked over a period of time. The underlying set of conventions seems to be drawn from political maps, except that the boundaries are not drawn by fiat, like those of Merseyside or Loire-Atlantique, but are drawn through a series of conflicts, like the boundaries of Poland. In one map, for instance, the "travels of a coati band on Barro Colorado Island" are shown as a tangled skein of a line (Figure 12-1). The territory is then a boundary drawn around this tangle, and there is another theoretical construction, the "core area" further marked by shading within this boundary. Here all that matters is that there is a boundary; the exact shape of the territory is incidental, as is the path taken by the animals, and the gratuitous detail of its outline is effective just as testimony to its being a real, if unfamiliar, place.

The map framework can also be applied to bodies, in diagrams of deer glands (10-6) or of human hormones (11-5) or of the waggle dance of bees (8-1). As in maps, the object is reorganized as a space in two dimensions, and processes and entities can be marked as lines or arrows and regions within this grid. The outline of a body or organ serves as a terrain on which points are mapped. The theoretical entities are foregrounded, but there is still an underlying background representation of some real-world object. So, in a diagram of the waggle dance, the sun and the destination are represented by stylized symbols, the angles x and the ellipses tracing the movements of the bee are seen as mathematical abstractions, but they are marked against the background of woodgrain or of a honeycomb, as in representational drawings.

Pater said that all art aspires to the condition of music: in *Sociobiology*, all art aspires to the condition of a graph. While in a diagram the background, at least, refers to something we take as real, in a graph, the background is a theoretical space.[7] But graphs that record data retain some of the authority of automatic inscriptions by including gratuitous information. For instance, a graph of "frequency-dependent sexual selection," (Figure 15-2), with proportion of the population bearing a gene as the ordinate, and coefficient of mating success as the abcissa, includes a scattering of points and vertical bars that presumably show ranges. The clean line through them is given more, not less, authority by the fact that the points do not all fall exactly on the line. The points suggest accuracy and the likelihood of statistical variation in a finite number of trials, while the curve through them holds out the hope of a simple mathematical relation. Other types of graphs can be arranged in a continuum from those that look like messy printouts of recording devices to the clean and highly abstract correlations of ratios with ratios.

The figures that aspire to be graphs are the tables and the models. The tables are data points looking for curves. This is true even when the tables consist almost entirely of words, not quantities, so they may seem more a part of the text than of the pictures. They are not part of the text because the clusters of words are not to be read sequentially, left to right and then to the next line and so on, but are each to be read as a unit of information that is related to the other units in its row and column. A table showing the evolutionary grades of primates (Table 26-2) is part of a search for a pattern, a way of arranging these clusters of words so that the intersections of columns ("evolutionary grades") and rows ("ecology and behavior") will show relationships in a consistent development as one moves across the page. Wilson is frankly dissatisfied with this table, and with his own table of mammals, because such clear relationships have not yet emerged. He is happier with a table like 24-1, analyzing the social systems of ungulates into 'a relatively simple pattern that can be transformed with minor distortion onto a single axis, or "sociocline"' (479).

At the other extreme from graphs are the optimization models, which can be seen as curves looking for data points. As Wilson points out in an article (1977), the form of these graphs is borrowed from economics. The model for castes in insects is one of the key parts of the book (14-4, my Figure 4). The animals here are not treated as individuals at all, but are considered in terms of their collective weights.[8] There are many events behind this graph, such tasks as defending the colony, or foraging, or caring for the eggs. But there they are not even quantities; they are abstracted a further step and analyzed in ratios. A series of such graphs shows mathematically how shifts in environment or tasks can affect the caste structure. Behavior here is completely reduced to a set of laws. All the particularities of a photograph have been eliminated, and the space of the picture is now an entirely theoretical and quantitative space. But while some details are lost, some information is gained; a model like this can do things that a graph recording data cannot. The movement of a curve from one position to another gives a prediction of the ratios of the castes to each other; in this sense the world of the model replaces the world of the ant colony, just as the colony in the laboratory replaces that in the jungle.

The graphs and diagrams have an effect, even when the data in them are subjective, qualitative, or imaginary. So, for instance, Figure 2-2 (my Figure 5) shows what "The age-size frequency distributions of three kinds of animal societies" would look like in three dimensions, but the caption says, "These examples are based on the known general properties of real species, but their details are imaginary" (15). Some reviewers are annoyed by these graphs without actual data, taking them for lazy attempts at demonstration when they are, in effect, thought experiments on the page. That Wilson included them shows how important it is for him to visualize even the most theoretical statements. To

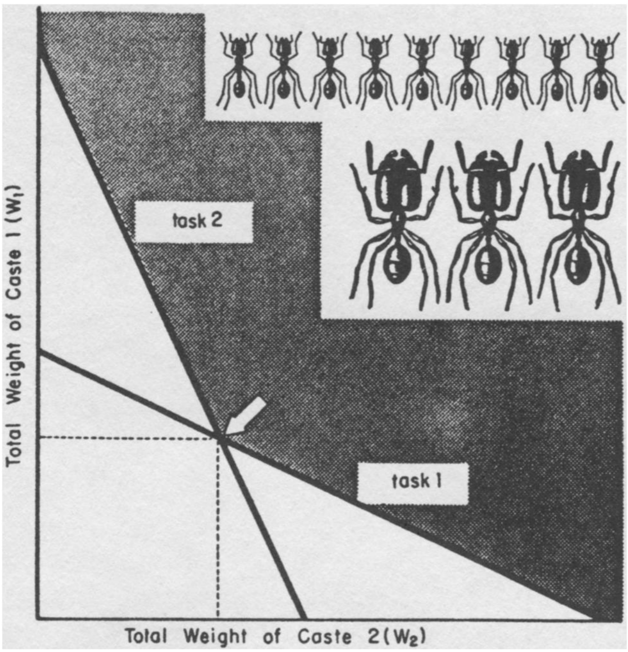

Figure 14-4 This diagram shows the general form of the solution to the optimal-mix problem in evolution. In this simplest possible case, two kinds of contingencies ("tasks") are dealt with by two castes. The optimal mix for the colony, measured in terms of the respective total weights of all the individuals in each caste, is given by the intersection of the two curves. Contingency curve 1, labeled "task 1," gives the combination of weights (W_1 and W_2) of the two castes required to hold losses in queen production to the threshold level due to contingencies of type 1; contingency curve 2, labeled "task 2," gives the combination with reference to contingencies of type 2. The intersection of the two contingency curves determines the minimum value of $W_1 + W_2$ that can hold the losses due to both kinds of contingencies to the threshold level. The basic model can now be modified to make predictions about the effects on the evolution of caste ratios of various kinds of environmental changes. (From Wilson, 1968a.)

Figure 4. A model

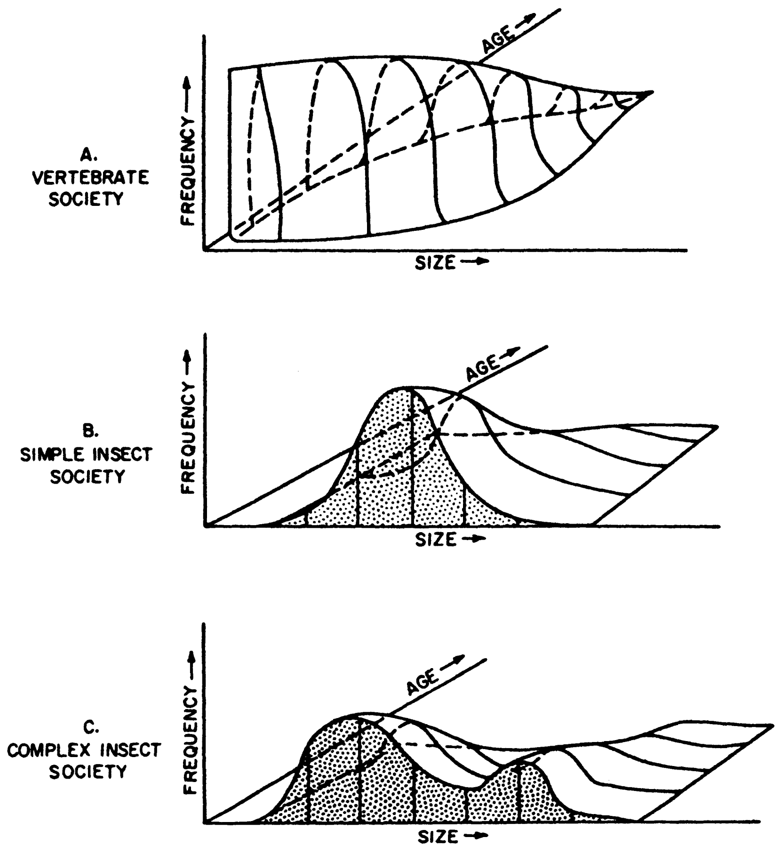

Figure 2-2 The age-size frequency distributions of three kinds of animal societies. These examples are based on the known general properties of real species but their details are imaginary. *A*: The distribution of the "vertebrate society" is nonadaptive at the group level and therefore is essentially the same as that found in local populations of otherwise similar, nonsocial species. In this particular case the individuals are shown to be growing continuously throughout their lives, and mortality rates change only slightly with age. *B*: The "simple insect society" may be subject to selection at the group level, but its age-size distribution does not yet show the effect and is therefore still close to the distribution of an otherwise similar but nonsocial population. The age shown is that of the imago, or adult instar, during which most or all of the labor is performed for the colony; and no further increase in size occurs. *C*: The "complex insect society" has a strongly adaptive demography reflected in its complex age-size curve: there are two distinct size classes, and the larger is longer lived.

Figure 5. An "imaginary figure"

do this, he draws on the same conventions of maps, grids, and curves he uses in showing data, but uses them here to create purely theoretical spaces. Of course Wilson was not the first to use such representations of evolutionary abstractions; Darwin's evolutionary tree is also a visualization of a model, and Wilson uses C.H. Waddington's "adaptive landscape" in 2-6. What intrigues me about this latter kind of illustration is that it seems to come full circle; the highly abstract concept of a surface area corresponding to genotypes and a vertical measure of a quality, fitness, comes out looking like a representation of a perspective on a real world.

Wilson's usual way of visualizing a theory is a sort of flowchart, like that showing the evolution of primate social behavior (Figure 26-1; my Figure 6) in which a series of causal connections is represented as a movement on the page. The background is blank, instead of being a grid, and there is not even a definite convention about the representation of time, which is generally left to right in graphs. Here, time is sometimes read from left to right (22-2), sometimes bottom to top (12-14), sometimes top to bottom (2-8), often both directions at once (15-11). All that matters are the connections of the arrows and the clusters of words to which their heads point; we can read them without an explicit caption just as we can read maps of Turner's first tour of Yorkshire.[9] One difference between the pathway diagrams and such tour maps is that the arrows in these theoretical narratives are causes, not events happening to one actor. So they are the furthest step of Wilson's argument: a table suggests a correlation, a graph shows it in quantitative terms, and the pathways make it a step in a series.

I have arranged these categories in terms of realism and abstraction. From one category to the next, gratuitous details are eliminated, and the background is transformed from a space continuous with that of our everyday worlds to grid. The elements of narrative events, time, space, and subject, are transformed. In photographs, the image becomes a narrative. In pathway diagrams and adaptive landscapes, the narrative of evolution becomes a two-dimensional image.[10]

The distribution of pictures from these categories through the

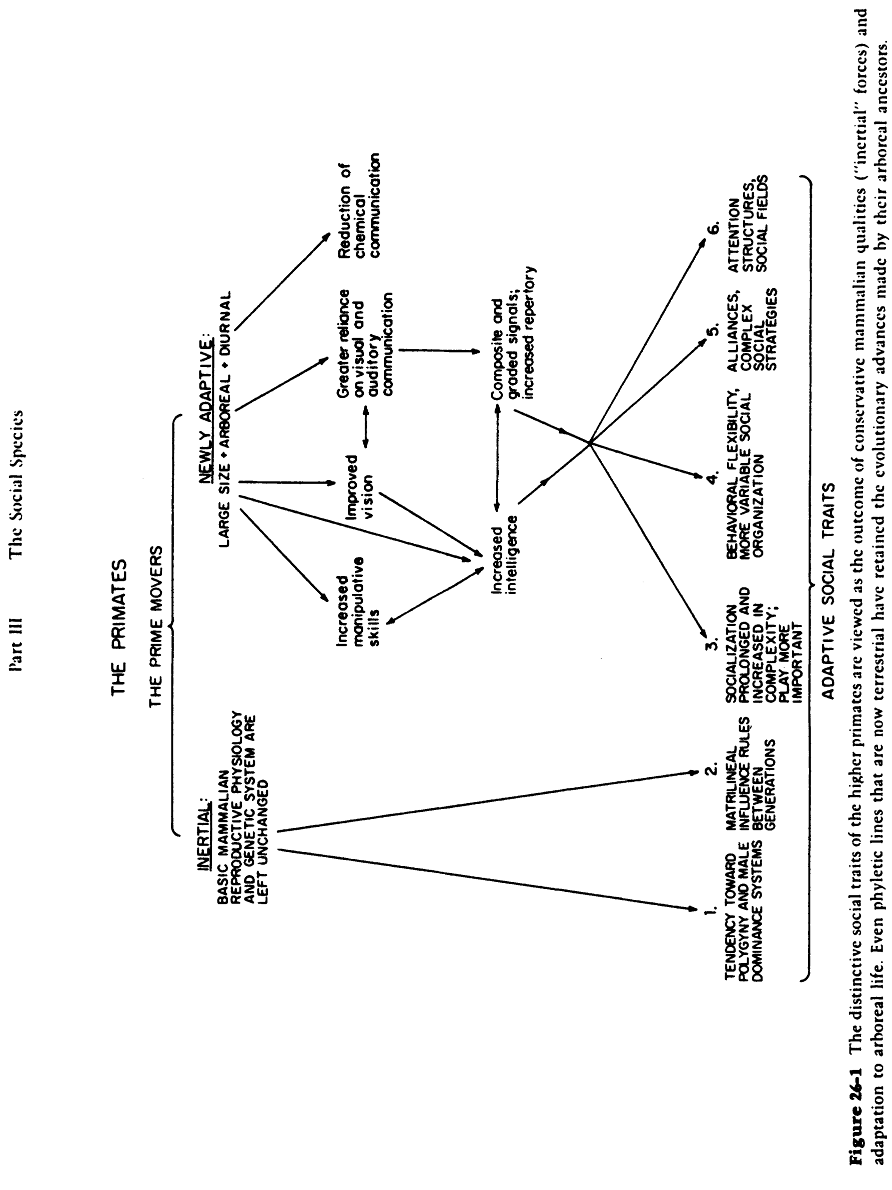
Part III The Social Species

Figure 26-1 The distinctive social traits of the higher primates are viewed as the outcome of conservative mammalian qualities ("inertial" forces) and adaptation to arboreal life. Even phyletic lines that are now terrestrial have retained the evolutionary advances made by their arboreal ancestors.

Figure 6. **A pathway diagram**

text can indicate the kind of argument going on. As we might expect, the theoretical opening chapters of the book are illustrated mainly with diagrams and graphs; for instance, Chapter 4, "The Relevant Principles of Population Biology," has 22 figures and two tables, but no photographs or drawings at all. Nearly all these pictures demonstrate some part of the argument, so, in Figure 4-1, a graph shows that a computer simulation of genetic drift does rapidly lead to fixation of one allele and loss of another. On the other hand, the pictures in the last nine chapters that survey the animal kingdom consist nearly entirely of tables that survey the part of the taxonomic system being discussed in the chapter, and of photos and drawings that simply illustrate statements in the text. It would seem that the more abstract figures go with the more abstract and difficult chapters. But Chapter 3, "The Prime Movers of Social Evolution," which one might expect to be as theoretical as the chapter on population bilogy, has only two of fourteen figures that don't have some photo, drawing, or symbolic representation as part. We need to look, not just at individual pictures, but also at how the picture fits into the text, and how one picture affects the reading of those before and after it.

3. Words and pictures

Of course the reader interpreting these pictures does not just rely on conventions associated with photographs, drawings, maps, and graphs. Every illustration in *Sociobiology* is associated with two passages in the text: the caption, which tells us what we are seeing, and the sentence in the text marked with the reference to the figure, which tells us how it fits into the verbal narrative. This is the caption for two pictures of chimpanzees, one of which is the photograph with which I began.

> *Figure 26-8* Temporary resting parties of chimpanzees in the Gombe Stream National Park. Left, three adult males on the left (Worzel, Charlie, and Hugo) are accompanied by two adult females (Sophie, with a female infant, and Melissa). Right: in a second group, two infants play in the middle, one with a typical "play face" while a juvenile grooms an adult. (Photographs by Peter Marler and Richard Zigmond)

Usually the first part of a caption, or in some cases the only part, is a long noun phrase, not a sentence, that functions as a sort of title. The caption leads us through the thicket of gratuitous details to the shapes that are supposed to be meaningful. So we look, for instance, at the face of the small chimp in the center, rather than at the chimp covering its mouth at left. Captions tell us what happened before, what will happen after, what usually happens; so, for instance, this caption tells us that both groups are only temporarily resting, and that the figure in the centre of the photo on the right is an infant that is playing. The caption helps link each picture to the next level of abstraction: here the caption in effect emphasizes and abstracts the "play face," in effect making a diagram of the photo. Other captions can make a drawing into a diagram by pointing to one specific movement, and bringing out the causal connections in the graphs and diagrams.[11] The caption also gives the authority for the image, so that all the photocaptions end with photographers' credits, and all Sarah Landry's panoramas end with a textual source, like the caption to the lemur drawing, which ends '(Drawing by Sarah Landry; based on data from Alison Jolly, 1966 and personal communication).'

In *Sociobiology*, as in most scientific books and articles, there is always another reference to the illustration in the text, as well as the caption. So, regardless of the demands of layout that may put an illustration on one page or the next, each illustration is formally inserted at an exact point in the text. It can be inserted there either to illustrate a point made in the text, or to demonstrate and extend the text. For instance, the reference in the text to the lemur illustration mentions this whole elaborate panorama only as a way of pointing to the position of an underarm gland: 'Brachial glands, which occur high on the male's chest, and conspicuous antebrachial organs on the forearms produce odorous substances (see Figure 26-3).' Here it is not even necessary to have the picture; it is a supplement to the text, adding details or specificity, or illustration of it. In contrast, the references to many of the graphs are not complete without a study of the graphs themselves. For instance, Wilson refers to his ergonomic model in the sentence, 'The general form of the solution to the optimal mix problem is given in Figure 14-4.' One way of distinguishing these two uses of pictures is in the form of the reference; a parenthetical figure number often implies an illustration, while demonstrations usually include the number in the structure of the sentence. So, syntactically, the demonstrations are part of the linear flow of the text, while the illustrations are parallel to it but set off from it.

Some textual explication is necessary even for pictures that seem to carry a self-evident meaning. Two photos in Figure 3-13 demonstrate that fire ant workers respond to evaporated trail substances; the difference between the photos before and after trail substance is blown over the ants is to be taken as proof of the claim. In the top photo, there is a dish on the left with black specks in it, and on the right a watch in the background and in front of it a block of wood with a glass rod on it. The bottom is the same except that the hands of the watch have moved and there are black specks to the right of the dish. The insertion of the watch, an otherwise odd element, adds to the effect of self-evidence by giving apparently undeniable evidence that the two photos are separated only by "a short time." But to see what claim being proved, one needs to be directed by the caption, and informed about what these black specks are and what was done between the two pictures.

> *Figure 3-13* The response of fire ant workers to evaporated trail substance. Above: before the start of the experiment, air is being drawn into the nest (by suction tubing inserted to the left) from the direction of the still untreated glass rod. Below: within a short time after the glass rod has been dipped into Dufour's gland concentrate and replaced, a large fraction of the worker force leaves the nest and moves in the direction of the rod. (From Wilson, 1962a:56)

Without these instructions from the caption, one might see the pair of photos as demonstrating that iron fillings are attracted by a bar magnet, or that ants are attracted to stopwatches.

4. Pictures into stories

In a book with so many pictures, or in a lecture, a popular article, or a television show, part of our interpretation of each picture depends on how it relates to those we have already seen. One picture can be related to others when it is part of a pair or a series, or when it has the same form or subject matter as another picture. The photos of the experiment with the stopwatch are meaningful only as a pair, and the series of graphs of the ergonomic model of castes makes sense only as a series. One set of six drawings (Figure 8-3) show, from left to right, three stages of the aggressive display of a rhesus monkey, and below that, three stages of the aggressive display of a green heron, each with arrows showing the movements of the head or the tail feathers. The individual drawings are as realistic as any in the book, but they are placed here in an abstract space, in which time passes from left to right, so each row forms a narrative, while comparison of the top and bottom rows suggests similarities in behaviors across species. The abstraction is a crucial move, for some comparative psychologists would deny that this kind of comparison can be meaningful. Any series of pictures makes a theoretical statement by bringing out selected features from the innumerable details of the pictures, and putting them in narrative order.

Juxtapositions between different sorts of figures that are not obviously part of the same sequence can also be significant. The drawing and photos are often linked to graphs or pathways, when one type of illustration immediately follows another or has the same stated topic as another, or has a similar form. Many of the graphs include some symbolic representation of the animal involved; even Wilson's highly abstract ergonomic models of ant castes have symbolic ants in the upper right corners. The figure then brings together the more representational and more abstract pictures, the illustrations and the demonstrations. For instance, Figure 2-4, shows, at bottom, bar graphs of the percentages of time various species of monkeys devote to such behaviors as grooming and observing, while at top it has line drawings of monkeys performing these behaviors.

The famous diagram illustrating "altruism," "selfishness" and "spite" in their sociobiological senses (5-9; my Figure 7) and the graph that follows it show how two figures on the same stated topic can support each other. In the diagram the concepts are reduced to black and white circles with circular happy faces or

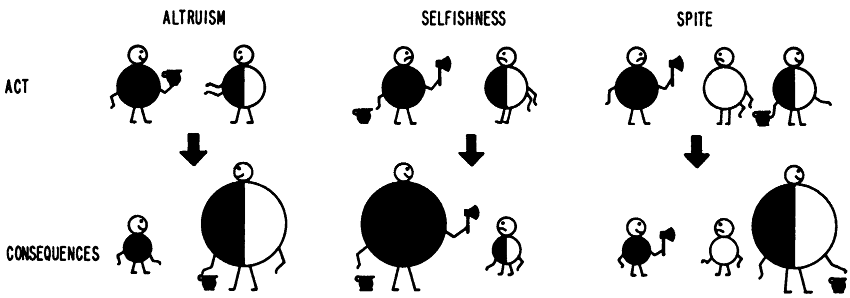

Figure 5-9 The basic conditions required for the evolution of altruism, selfishness, and spite by means of kin selection. The family has been reduced to an individual and his brother; the fraction of genes in the brother shared by common descent ($r = \frac{1}{2}$) is indicated by the shaded half of the body. A requisite of the environment (food, shelter, access to mate, and so on) is indicated by a vessel, and harmful behavior to another by an axe. *Altruism*: the altruist diminishes his own genetic fitness but raises his brother's fitness to the extent that the shared genes are actually increased in the next generation. *Selfishness*: the selfish individual reduces his brother's fitness but enlarges his own to an extent that more than compensates. *Spite*: the spiteful individual lowers the fitness of an unrelated competitor (the unshaded figure) while reducing that of his own or at least not improving it; however, the act increases the fitness of the brother to a degree that more than compensates.

Figure 7. The diagram of altruism, selfishness and spite

unhappy faces. They carry either a jug, representing some resource, or an axe, representing harm. The oddity is that the figures are so abstract, but the illustration still appeals to our common sense definitions of the words and categorization of everyday objects. This figure of apparently naive simplicity is followed by a graph (5-10) that attempts to quantify the level at which an altruist gene would become fixed. It is an example of the most abstract kind of graph, in which neither axis is a quantity like time or number of organisms; instead, both are proportions of 1, and the equlibrium point is a critical point on one of these proportions in relation to the other. The two illustrations play off each other, one pointing in the direction of daily experience, the other pointing in the direction of mathematical abstraction.

The chapter on territory shows the alternation of more realistic and more abstract figures, in which photographs and maps lend particularity to the graphs and pathway diagrams. For instance, Figure 12-8 shows "territories of the dunlin, a species of sandpiper that breeds in Alaska," on a conventional map. The empirical nature of the figure, the fact that these maps refer to real places, Kolomak and Barrow, and to real observations, in 1966 and 1962, is suggested by the way the lines of territories cross the edges of a grid, extending beyond the frame. These maps are related by the narrative of the chapter to an even more empirical figure, a photo showing fish in their own territories (12-9), taken from overhead so that the boundaries of heaped-up sand that the fish have made show in the pattern of light and shadow as an array of hexagons. This photo is crucial to the iconography of the chapter, for it shows a map of territories that is an inscription of the animals themselves, suggesting that "territory" is not a theoretical concept created by biologists in interpreting their observations, but is a fact that can be directly observed, a disk of sand with walls around it created by the fish.

These and the other territory diagrams in this chapter help us understand one of the most controversial illustrations in the book, the territory diagram of disciplines in the first chapter (1-2). In that diagram, Wilson shows, "A subjective conception of the relative number of ideas in various disciplines in and adjacent to behavioral biology to the present time and as it might be in the future." In this conception, sociobiology expands at the expense of neighboring disciplines; the picture is a bit baffling to nonbiologists beginning the book because it is hard to see what these rounded, bread-dough-like forms on two different planes are supposed to represent. It becomes clearer when we come later to a figure like 12-15, "Territorial exclusion in two species of blackbird." The parallel in visual conventions suggests that scientific specialties (in 1-2), like birds (in 12-15), compete for limited resources, and that what one gains must be taken from another – an assumption that is defensible, but is by no means universally accepted.

5. Pictures as icons

I have argued, in discussing the controversy over *Sociobiology*, that quotation is always quotation out of context (Myers, 1986). In the same way, the re-use of an illustration, even if the source is an earlier work of Wilson's, changes the meaning of that illustration. Sarah Landry's illustrations to Wilson's own *Insect Societies*, reproduced in *Sociobiology*, now illustrate the nature of social systems while before they just illustrated observations of insects. When Wilson reproduces a detail from Sarah Landry's *Sociobiology* illustration of the wild dogs in his own article in the *New York Times Magazine*, 'Human Decency is Animal,' (1973b), he alters the context and the caption. In the book, it is introduced with the phrase, 'The "super beasts of prey" and most highly social canids: a pack of wild dogs on the Serengeti Plains of Tanzania ...' (510). In the article, it is introduced with the phrase, 'Responsibility: In Tanzania, a wild dog, home from the hunt ...'. The change of context turns the picture from an illustration of one type of nomadic carnivore society, built around maternal care, into a general moral fable about the need for community if the species is to survive.

Similarly, Wilson's illustrations are appropriated in reviews and comments on the book. These uses can be allusive or ironic, but can never be straight. So, for instance, the drawings by Sarah Landry selected for reproduction in reviews in *Nature* (Wynne-Edwards, 1976), *La Recherche* (Hopkins, 1977), and the *New York Times Book Review* (Pfeiffer, 1975), and the first news report in the *New York Times* (Rensberger, 1975), all carry a meaning besides what they were illustrating in the book. The illustration used on page 1 of the *New York Times*, showing porpoises lifting a wounded comrade, connects *Sociobiology* to popular books (which Wilson criticizes severely) that suggest porpoises have a culture parallel to our own. The gorillas in *Nature* (and other gorillas in the *New Scientist*) make the connection between sociobiology and the Descent of Man. The lemur in the *Book Review*, and in *La Recherche*, as we have seen, attracts attention with its goggle-eyed animal staring out at us, and with its appearance of a cartoon figure. So all these illustrations stress the relation to man that is the most controversial aspect of *Sociobiology*.

Other photos and drawings seem to be quoted in reviews and in commentary to represent the public image of the field of sociobiology. The most obvious way of doing this, as with any science, is to provide a photograph of the scientist; on the front page of the *Times*, next to the porpoises, he is seen as a thin, middle-aged man in horn-rimmed glasses with a half smile, the epitome of the academic. The jacket photo on the back flap of *Sociobiology* (Figure 8) portrays him with arms folded, in front

Figure 8. **The jacket photograph of E.O. Wilson. (Photo by Chris Morrow)**

of a display case containing, I think, a gibbon and an orangutan. A *New Scientist* article has a picture of Wilson in front of a (presumably stuffed) gorilla. When the *New Scientist* editors fished this picture out of their files for a retrospective, they mischievously labelled it "E.O. Wilson, foreground." Now Wilson studies ants, but he is never shown with ants, and he has little to say about orangutans, or about any apes but the chimpanzees. But the pose seems appropriate because of the nineteenth-century iconography of Darwin confronting his "ancestor" the ape (Figure 9).

Figure 9. **A Victorian cartoon of Darwin and the ape**

Quoted illustrations can be used ironically, even in apparently straight quotations. So, for instance, Joe Crocker's *Radical Science Journal* critique of sociobiology (1983) reproduces the diagram and caption defining altruism, selfishness, and spite. In *Sociobiology*, this was meant to illustrate and distinguish the three sorts of behavior with an abstract example, but in its new context it is meant to demonstrate the absurd anthropomorphism of sociobiology, the cartoon-like happy faces suggesting a naive simplicity. The same illustration is used without apparent irony in *La Recherche*; but here the words are not quoted directly (or even translated literally, though the translation is fairly close). Since the intention in *La Recherche* is not ironic, the exact words of the caption are not essential. The figure illustrates a concept, instead of demonstrating a flaw.

Some later references to *Sociobiology* use caricatures rather than direct quotations. *New Scientist* illustrates an attack on *Sociobiology* by the Science as Ideology Group with a caricature of ants as Nazis. This alludes to Wilson's specialty, and to the authors' argument that he sees reactionary tendencies in animal societies by projecting human societies onto them. Two recent retrospective articles also make a comment on *Sociobiology* in their cartoon illustrations. I have mentioned the *New Scientist* illustration of double helices dangling by marionette strings, a lizard, a man in a business suit, a bird, an ant, and an elephant. This is used even though Maynard Smith's article is cautious about the applications of sociobiology to humans. Critics of sociobiology have referred to a similar cover picture on the issue of *Time* that reported on sociobiology. (Similarly, the cover of a French popularization of sociobiology [Christen, 1979] shows computer graphics contour represention of a man, woman, and child, suggesting that sociobiology leads to technical control and standardization of human life.) The cartoon in another retrospective article, by John Krebs, shows two fish drawing their strategies on blackboards like football captains. The joke is in the juxtaposition of the abstract representation of strategies in game-theory approaches to the evolution of behavior with the realistic image of fish acting as conscious strategists in characteristically human roles.

The article by Joe Crocker in the *Radical Science Journal*, to which I have already referred, has a cartoon of three monkeys wearing hats that, in England, are taken as upper class, middle class, and working class symbols. This is a parody of Figure 13-3 in *Sociobiology*, a photograph showing rank order of rhesus monkeys, as indicated by direction of grooming. Such parodies make us aware of the conventional nature of interpretations that are otherwise accepted as natural. Here the parody plays with the social reading of the hats, and the ethological reading of the grooming, and with the representation of dominance, which can be observed only in terms of social behavior and interactions, as if it were a hierarchy fixed in space. The cartoon, like the article, suggests that ethological readings have an origin in taken-for-granted assumptions about class in human society.

6. Pictures tell a story

In many ways *Sociobiology*, as a lavishly illustrated survey for biologists that is also aimed at the general academic reader, is an anomaly in a world of texts divided between the popular and the professional. But even if there are no exactly comparable texts, its anthology of illustrations makes it a useful starting point in a discussion of illustrations in popularizations of evolutionary ideas. While more popular presentations do not use the battery of graphs and tables found in *Sociobiology*, they do select their images from a range of categories, each of which carries its own conventions of interpretation, and they do juxtapose several kinds of images. In many popularizations, as in *Sociobiology*, the juxtaposition links pictures that have the authority of our everyday experience of the world to pictures that carry the authority of science.

In future research on the uses of illustrations on the popularization of science, it might be useful to compare this analysis to that of popularizations in other media or other periods. As the recurrence of the image of Darwin and the apes shows, the iconography of popular science is remarkably persistent, so we might expect to find some of the same images in the famous nineteenth-century popular science lectures and in popularizations of sociobiology. On the other hand, new technologies of reproduction of images change the sorts of images that can be used, so *Sociobiology* is a different sort of book from any in the nineteenth century, and it is different from presentations of the same ideas on television.

Nineteenth-century lectures, like *Sociobiology*, often use images of an apparently real world to lead to theoretical narratives, so, for instance, T.H. Huxley starts his most famous lecture with a piece of chalk as a prop, and Louis Agassiz starts one of his *Geological Sketches* with a description of a particular landscape. Both take this solid point of departure for their very different visions of the geological past. The formats of more experimental lectures, like those by John Tyndall on *Heat as a Mode of Motion*, are often built around the problems of making the large audience see the phenomenon, often through projected or enlarged displays; in the published versions all the paraphernalia survive only in the crowded engravings of equipment in the plates. A comparison of Michael Faraday's 1861 lectures on *The Chemical History of a Candle* with this year's televised Royal Institution Christmas Lectures might make one think that technological changes were relatively unimportant in the presentation of popular science, for Lewis Wolpert used the same sort of play with objects and models that his predecessor used. Yet it could be argued that, even in such a conservative genre as the Christmas Lectures, everything has changed. Television, showing a representation of a lecture rather than a lecture, makes the lecturer another of the objects to be watched, like the candles or tubes full of ping-pong balls.

Richard Dawkins' recent program *The Blind Watchmaker*, part of the BBC's Horizon series, is comparable to *Sociobiology* in presenting an argument for adaptation that combines pictures of animals with attempts to visualize an abstract model, so it may suggest some of the possibilities and difficulties of extending this sort of analysis to television.[12] One sequence, for instance, alternates images of animal eyes with images of the scientist and of designed objects. As Dawkins summarizes Paley's argument that the intricacies of the eye prove design in nature and the existence of an intelligent creator, we see him inside a gothic window at Oxford, looking in an antique microscope; in effect he is the modern scientist playing for a moment the eighteenth-century natural theologian. Then we see closeups of a fish's eye, and of a moth's eye, and then several shots of Dawkins holding and using a computer disk (the disk, in a joke, has the first verses of Genesis on it). An electron micrograph of the moth's eye is followed by electron micrographs of the computer disk, to show how the surface of the disk imitates the surface of the moth's eye. The use of gratuitous details is like that in *Sociobiology*, but on television the details that lend a sense of realism to these images can be on the soundtrack as well as in the pictures (and the sounds were presumably recorded after the pictures); the soft splashes of the fish, the beating of the moth's wings, even the noise of the holes being punched in the computer disks. As with the photos in *Sociobiology*, there are too many details for viewers to perceive them all. But the voice and presence of Dawkins guides us like a caption to what we are supposed to look at. The techniques of montage also have some of the functions of the captions in a text; the alternation of medium shots, close-ups, and microscopic images links the visible eye and the visible disk, apparently so little alike, through their similar images under the electron microscope. These microscopic images are linked through a peculiarly cinematic technique of panning in the same direction across their surfaces.

But television is not limited to the presentation of natural history photographs, to the first of the categories of pictures I described, as one might think. Later in the program, Dawkins goes on to present a fairly abstract model of Darwinian evolution by natural selection, through a computer simulation of "biomorphs" controlled by "genes" that vary within given limits and are selected by the operators' preferences.[13] At the end of the program, Dawkins' "selfish gene" is illustrated with a close-up view through an animated DNA double helix spinning in space like a starship in a science fiction movie, which then draws back and wraps itself around histones and coils into a chromosome, which recedes into a spot on the screen, which turns into a fish and then into a dinosaur. This kind of fluid juxtaposition is possible only with computer animation, but the idea is the same as that of the cartoons using the double helix for Maynard Smith's *New Scientist* article. Here the world of visible organisms (if one can include dinosaurs in that world) and the unseen structures of information proposed in the theoretical model are seamlessly linked, literally in one line.

Sociobiology does not have color, pans, sound effects, voice-over, or computer animation. But it achieves some of the same effects with the juxtaposition of the sober black and white of its photographs, the impressionistic dots of its drawings, and the severity of its graphs. I have paralleled the effect of this juxtaposition to cinematic montage, and this parallel should remind us that the effect of realism does not depend on the complete reproduction of the world, but on the viewer's perception of the narrative and perceptual order. Arnheim comments that one can edit together images only because they are not recreations of real life. "If film photographs gave a very strong spatial impression, montage would be impossible. It is the partial unreality of the film picture that makes it possible" (28). In the same way, the partial unreality of the images in *Sociobiology* (or in any printed popularization), requires us to reconstruct the space within them, and allows us to link photos to maps or drawings to graphs and to produce stories out of pictures. Paradoxically, for popular readers at least, the work we must do to put all those pictures together is what makes the story they tell seem so powerful.[14]

Notes

1. Martin Rudwick, in his pioneering study of the visual language of nineteenth-century geology (1976), attributes this oversight to the lack of a tradition of using visual communication in historical research – history is an overwhelmingly verbal discipline, as are sociology and linguistics.
2. François Bastide (1985) has categorized scientific illustrations in terms of the increasing intervention of the authors in the image and the increasing complexity of the information contained. In the same volume Mike Lynch has related electronmicrographs to graphs through different kinds of images in a process he calls *mathematicization*. I am going to present similar categories, but will discuss them in terms of some formal features of the images and their rhetorical effects on my imagined reader.
3. This would seem to be the opposite of Bastide's reading, in which the more abstract presentations can contain more semiotic dimensions. I think we are describing the same categories, but she is talking about what is added, and I am talking about what is taken away.
4. Bastide (1985) discusses the ambiguity of this convention.

5. A mechanical record of the head-bobbing patterns of a lizard (8-11), or even a lifelike electron micrograph (14-3), are other records that suggest reality because of the apparent exclusion of manipulation (on electron-micrographs, see Lynch, 1985b).
6. But oddly, even when there are these signs to the contrary, a reader takes these texts as showing what really is. Two of Landry's drawings are clearly labelled "speculative" in their captions; one shows dinosaurs roaming the plains and the other shows a group of early men (and no women) fighting off rival carnivores and tucking into a dead mammoth (27-5, 570-1). Some reviewers object to the portrayal of early man in terms of hunting (see, for instance, Pfeiffer, 1975). Despite the clear disclaimer in the caption, the effect of the drawing is to suggest that men were evidently carnivores. This effect is supported by the caption that gives warrants for everything else in the drawing: the plants, the volcanoes in the background, the prey, the competitors, the tools in their hands, even the shape of the saber tooth cats. But most of all it is supported by the conventions of representation in drawing. As Gilbert and Mulkay (1984) have pointed out, it is very difficult to mark a realistic drawing as speculative.
7. Laura Tilling (1975) traces early graphs to the inscriptions of recording devices like thermometers and barometers. I am arguing that we read machine inscriptions and graphs differently, even though they look the same. Even a graph that takes time as its ordinate, like a recording machine printout, treats that time as a quantity rather than as a continuing process.
8. Michael Lynch (1985a), in his studies of a neurobiology laboratory, describes the transformation of "animals" from individual organisms into dated and labelled experimental units.
9. The arrows themselves may be altered to carry various kinds of significance. In a flowchart of grasshopper behavior (9-6), different thicknesses of arrows indicate the number of observations of each transition between states. In one diagram, Figure 10-3, the original author, van Hoof, tried to suggest the indefiniteness of some evolutionary connections with shady bands that look like swarms of bees. Wilson sometimes uses dotted arrows, or two different arrows, to suggest alternate interpretations. The problem here is finding the visual equivalent of hypothesis, as in the drawing mentioned in note 5.
10. Françoise Bastide (1985:144), makes a similar point about the relation between graphs and photographs.
11. Some of the maps and graphs just have the first long noun phrase of the caption, as a sort of title, but usually they go on in an independent clause to explain just how we are supposed to interpret the graph. The only illustrations that just get a title phrase are some pathway diagrams (10-3) and tables. This lends support to the idea that captions are necessary to enable the readers to find their way through the thicket of details; only in the final stage of abstraction or the first stage of sort-

ing out data are the intended meanings clear enough.
13. If some confused viewers take this to mean that Dawkins does accept Paley's argument from design, but believes that God has changed his profession from watch-making to computer programming, that only shows that a sequence of images can always carry meanings beyond those intended.

References

Arnheim, R. (1933). Film and reality, trans. in *The Film as Art* (1957). Berkeley: University of California Press.

Bastide, F. (1985). Iconographie des textes scientifiques: Principes d'analyse. In B. Latour and J. de Noblet (Eds.), *Les "vues" de l'esprit*. Special issue of *Culture Technique* 14 (June).

Bazin, A. (1945). The ontology of the photographic image, trans. in *What is Cinema* (1967). Berkeley: University of California Press.

Christen, Y. (1979). *L'heure de la sociobiologie*. Paris: Albin Michel.

Crocker, J. (1983). Sociobiology: The capitalist synthesis. *Radical Science Journal*.

Gastel, B. (1983). *Presenting science to the public*. Philadelphia: ISI Press.

Gilbert, G.N., and Mulkay, M. (1984). *Opening Pandora's box: A sociological analysis of scientists' discourse*. Cambridge: Cambridge University Press.

Holton, G. (1978). The new synthesis? In M. Gregory, A. Silvers and D. Sutch (Eds.), *Sociobiology and Human Nature*, 75–97. San Francisco: Jodssey-Bass.

Hopkins, P.O. (1977). La sociobiologie. *La Recherche* 8 (75):134–142.

Jacobi, D. (1985a). La Visualisation des concepts dans la vulgarisation scientifique. In B. Latour and J. de Noblet (Eds.), *Les "vues" de l'esprit*. Special issue of *Culture Technique* 14 (June).

Jacobi, D. (1985b). References iconiques et modèles analogiques dans des discours de vulgarisation scientifique. *Information sur les Sciences Sociales/Social Science Information* 24:847–867.

Krebs, J. (1985). Sociobiology ten years on. *New Scientist* (3 October): 40–43.

Latour, B. (1985). Les "vues" de l'esprit, in B. Latour and J. de Noblet, trans. Visualization and cognition. In H. Kuclick (Ed.), *Knowledge and society: Studies in the sociology of culture, past and present* 6:1–40. Greenwich, CT: Jai Press.

Latour, B., and de Noblet, J., Eds. (1985). *Les "vues" de l'esprit*. Special issue of *Culture Technique* 14 (June).

Lynch, M. (1985a). Discipline and the material form of images: An analysis of scientific visibility, *Social Studies of Science* 15(1):37–66.

Lynch, M. (1985b). *Art and artifact in laboratory science: A study of shop* *work and shop talk in a research laboratory*. London: Routledge and Kegan Paul.

Lynch, M. (1985c). La rétine extériorisée: Sélection et mathématisation des documents visuels. In B. Latour and J. de Noblet (Eds.), *Les "vues" de l'esprit*. Special issue of *Culture Technique* 14 (June).

Maynard Smith, J. (1985). The Birth of sociobiology. *New Scientist* (26 September):48–50.

Myers, G. (1986). *Narrative and interpretation in the sociobiology controversy*. Paper presented at the History and Philosophy of Science Seminar, University of Leeds, October.

Myers, G. (Forthcoming). *Writing biology: Texts in the social construction of science.*

Pfeiffer, J. (1975). Review of *Sociobiology. The New York Times Book Review* (27 July):15–16.

Pickering, A. (1988). Editing and epistemology: Three accounts of the discovery of the weak neutral current. In L. Hargens, R.A. Jones, and A. Pickering (Eds.), *Knowledge and society: Studies in the sociology of science, past and present*, Vol. 8.

Rensberger, B. (1975). Sociobiology: Updating Darwin on behavior. *New York Times* (28 May):1.

Rudwick, M. (1976). The emergence of a visual language for geological science, 1760–1840. *History of Science* 14:149–195.

Schiele, B. (1986). Vulgarisation et télévision. *Information sur les Sciences Sociales/Social Science Information* 25:189–206.

Silverstone, R. (1985). Framing science: The making of a BBC documentary. London: BFI.

Tilling, L. (1975). Early experimental graphs. *British Journal for the History of Science* 8:193–213.

Wilson, E. (1975a). *Sociobiology: The new synthesis*. Cambridge, MA: Harvard University Press.

Wilson, E. (1975b). Human decency is animal. *New York Times Magazine* (12 October)38–50.

Wilson, D.O. (1977). Biology and the social sciences. *Daedalus* 106(4):127–140.

Wynne-Edwards, V.C. (1976). Bull's-eye of sociality. *Nature* 259 (22 January):253–254.