

# Evolution and Psi<sup>1</sup>

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## I

It may seem curious to many of you that I have again been invited to talk on a topic which is widely felt to be without scientific merit. I am referring of course not to evolution but to psi phenomena, more widely known as telepathy, clairvoyance, psychokinesis, and the like. But many things that have ultimately proved worth while in science have had questionable beginnings, so I do not feel too apologetic in asking you once more to entertain provisionally the notion that it is possible for information to be conveyed and apprehended apart from any known physical means of so doing, which is what is meant when we talk about psi phenomena.

Let me remark right off that saying something of significance on the evolution of psi abilities (or at least of those that manifest themselves overtly) is much more difficult than saying something of interest about the possible role of psi in evolutionary processes. The reason is that we are shorter on hard data bearing upon the former than we are on theoretical considerations conceivably relevant to the latter.

To begin with, we know virtually nothing about the genetic aspects of psi abilities, despite the widespread notion that these seem to run in families. No valid studies have been made in this area and no such are likely to be made, when the tremendous difficulties encountered in getting reliable data on the heritability of even normal cognitive abilities are considered. Nor are there any artifacts or paleontological data to help us place psi abilities within the evolutionary scheme. Thus, although we have records of what today we would call psi occurrences for as long as there have been written records of man (which is anyway merely an instant on the scale of human evolution),

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we have nothing that gives us a hint on the question that seems to interest a great many people: which way are our psi abilities going? Are they, like our molars and body hair, likely to disappear in time, or are they, like our burgeoning cerebrums, likely to continue to increase in magnitude and complexity so long as nature and providence allows the human experiment to continue? If we could only say something definite about the relation between psi abilities, the enigma of consciousness, and the physical attributes of the central nervous system, we might be able to infer something about this question, but here too, unfortunately, hard data are lacking.

With such a paucity of data, and small possibility of performing pertinent experiments, one would think that the problem could be laid to rest as one of nature's great unsolved mysteries. But such is not the case. Forecasting trends in human evolution, including evolution of the psychic side of man, has long been one of the fringe benefits available to anyone who has had anything at all to say about the human condition. As far as the psychic side of man goes, two points of view may be said to sum up the situation: In one, psi abilities are seen as residua of archaic modes of functioning which will probably disappear as the brain becomes cleverer and consciousness expands; in the second, these abilities are forerunners of things to come and will probably become more important as the brain becomes cleverer and consciousness expands. The first point of view is apt to be held by those to whom the existence of psi processes is an embarrassment; the second by those to whom human depravity is an embarrassment. Neither point of view is supported by facts, and there is in any case no guarantee that were psi abilities to become more available they would be used for good and not for evil. However that be, all we seem to be left with in regard to the question of whence and whither psi abilities in evolution, after the smoke of much tendentious speculation has lifted, are man's ceaseless fears and fantasies about his own nature.

## II

But this does not end the question of the possible relation of psi to evolution. According to several biologists, if psi didn't exist something like it might well have to be invented to account for still outstanding puzzles in the field. The situation is this: No one quarrels with the importance of mutations (spontaneous random variations in the germ plasm) and natural selection (the selection by the environment of those features most favorable to reproductive superiority) in producing evolutionary changes. Doubts about the importance of these processes were laid conclusively to rest decades ago by brilliant experiments on protective coloration and countershading in moths,

butterflies, and fish, and by a variety of experiments with that stellar experimental performer, *Drosophila*, the little fruit fly. The only question that remains is whether mutation and selection is the whole picture.

Numerous biologists, exemplified by Nobel laureates Monod (1971) and Luria (1973), believe that these dual processes are quite adequate, given enough time and a sufficient number of chances in the mutational lottery, and aided perhaps by certain types of guiding pressures on selection which may develop (still by chance) en route. Others (Lillie, 1945; Koestler and Smythies, 1969; Polanyi, 1958; Whyte, 1965) feel, however, that it is not simply a matter of time and lottery tickets but basically a question of how and to what degree the lottery is rigged as, according to them, it necessarily has to be. These hold that the evolutionary development of complex structural and behavioral characteristics of different populations would seem to depend on the confluence of combinations of factors requiring a degree of ordering of events—at the very least some highly efficient feedback and control mechanisms—impossible to ascribe to pure chance.

But the problem, as seen by many who argue for something beyond simple mutation and selection, is not merely that of the enormous complexity of even the most elementary biological structures (let alone the marvels of design which characterize more advanced forms), but is one of how selection can work on behaviorisms and structures that have not yet arrived at the point where there can be anything like a clear payoff in terms of differential death and reproductive rates. The most frequently cited instance is that of the eye, where eons would have had to elapse before the light-sensitive spot or disc became an optical system with enough efficiency to sense food or predators. (The fact that eyes have developed independently in more than a dozen species doesn't make the problem any easier.) But examples can be given in the hundreds: almost any moderately complicated animal courtship or nest building or ritualized predatory activity (from protozoa up) will do, to say nothing of the delicately integrated behavior of conglomerates, from colonies of protozoa which carry out complicated building activities to the well-known group behavior of termites, bees, and ants. What happens during the hundreds of millions of years before these complex instinctual individual and group behaviorisms—that work, as the ethologists tell us, on an all-or-nothing basis—get to the point where they can work at all? Darwin himself was well aware of the difficulties that some of these points made for his theory of natural selection. (The eye and the instincts, both individual and conglomerate, particularly disturbed him.) If we add to problems of this sort questions as to how constancy of patterns as well as of species is maintained, the seemingly

contradictory question of why complexity of organization and structure so often proceeds to a point far beyond what is necessary for adaptation (again a headache to Darwin), the occurrence of virtually identical anatomical and biochemical structures (e.g., enzymes) from widely dissimilar gene pools, and finally, the development of structures when the genic factors responsible for them have been experimentally removed, as in the case of *Drosophila*, whose eyes reappeared after inbreeding 60 generations of an eyeless strain (T. H. Morgan, 1929), it would appear that a major theoretical mutation might indeed be required for all the facets of evolutionary fact to be satisfactorily accounted for.

One might imagine that a few comparatively simple probability computations would be able to show whether or not the biosphere could have evolved to its present state with mutation and selection operating purely on a chance basis. But mathematicians and biologists differ widely on just about every step of the way (Moorhead and Kaplan, 1967), resulting in a theoretical free-for-all that seems to allow every investigator to maintain the position he probably always had anyway. To some the very fact of life itself remains the height of improbability, to say nothing of everything that has happened since the first organic molecules learned the highly unlikely trick of replicating themselves; others seem ready to go to the stake with unshaken faith that simple dice casting, if carried out long enough, is equally capable of producing the marvels of sexual reproduction, where DNA is parceled out to various populations "after their kind" (as *Genesis* has it), and the highest distillation of human consciousness in a Shakespeare, a Mozart, or a book with the intriguing title *The Origin of Species*.

It isn't as if all investigators committed to a mechanistic approach fail to appreciate the magnitude of the problem on their hands. Attempts to deal with at least some of the difficulties mentioned go back to the end of the last century. Around this time Baldwin (1896) in America and C. L. Morgan (1896) in Britain introduced the notion of "organic selection," which they thought might provide a kind of shortcut to the evolution of certain characteristics. Their idea, then and subsequently hotly disputed, was that animals develop changes in habits in response to environmental changes (e.g., in climate or food supply) and then tend to seek out those environments where these changed features are more or less constant. Mutation would in time bring about the genic changes that, by selection, would tend to perpetuate the adaptive behavior. (This scheme was subsequently put on an up-to-date ethological basis by Thorpe, 1945.)

In 1957 C. H. Waddington, of Edinburgh University, introduced the notion of the tendency of genes and gene combinations to stabilize out by means of what he calls "creods," after the Greek

words *Chre*, meaning "it is fated or necessary," and *Horod*, meaning "path." A creod seems to be not unlike what our local farmers and ranchers call a gully which, once formed, tends to perpetuate a channel for runoff (and unfortunately for erosion too). Waddington holds that such gullies in the genescape, which he thinks can develop from purely random initial conditions, might go far in explaining outstanding puzzles like the explosive separation and fanning out of species in the mesozoic period, the resistance of species to change, once formed, and other problems. Waddington (1961) also invokes a principle he calls genetic assimilation, which states that genes which are favored in what amounts to the process of organic selection (for which he uses the term "canalization") are able then to stabilize those alterations in the creodic gullies that will further increase the chances of certain inherited characteristics persisting in the genetic structure.

Others see these amendments to the classic Darwinian scheme as not providing nearly enough of a catalyst to evolutionary development to account for problems of the magnitude of those mentioned earlier. Without more powerful shaping pressures, it is held, these dubious shortcuts provide at best merely a few more tickets in a gigantic lottery, increasing the chances of getting some of the prizes from virtually zero to near zero. The late great theoretical biologist Ludwig Bertalanffy (1952) saw the beginnings of an answer in General Systems Theory, a manifoldly derived discipline dealing with the properties and principles of hierarchial systems as wholes, irrespective of the nature of their components. L. L. Whyte (1965), also accepting the necessity for "internal factors in evolution," postulates a set of "coordinating conditions" by which a "St. Peter of internal selection" acts to pass or reject genes depending on the requirements of the evolutionary situation. And the mathematician Ulam (1967) sees organizing instructions and rules as conceivably carried in the gene itself. These and other questioners of classical Darwinism appear to feel, nevertheless, that although the laws and principles of the organizational forces required to shape evolution are insufficiently known, they are still ultimately rooted in (even if not wholly reducible to) the elementary forces known to physics.

A biologist who does not accept this article of faith is Sir Alister Hardy, of Oxford University. In his Presidential Address to the zoology section of the British Association (1949), he drew attention to the data of psychical research and their possible role in filling some of the still existing gaps in the modern synthetic, so-called neo-Darwinian theory of evolution. He further elaborated his ideas in *The Living Stream* (1965), a detailed, lucid, and provocative treatment of the types of data that present evolutionary theory seems unable satisfactorily to account for. Curiously (or perhaps not so curiously in

view of the earlier mentioned absence of a mathematical yardstick in these matters), Hardy accepts the classical hypotheses as adequate to account for such complex processes as camouflage and mimicry (his special area of expertise), and even for such a remarkable development as so-called coincident disruptive coloration, where a pattern (e.g., lateral stripes) that is carried across an animal's (e.g., frog's) limbs folded close to its body in the resting position (as if painted on) disintegrates when the animal extends its limbs in motion. What boggles him are the variegated data of homology—the development of similar structures in different species (like the fin and the limb) from totally different gene pools and, along somewhat different lines, the occurrence of virtually identical structures not only from widely dissimilar gene pools but from widely separated regions (e.g., the Tasmanian wolf, a pouched marsupial, and the Siberian wolf, a placental). To illustrate the difficulties involved for classical selection theory, Hardy gives extensive citations of the data of Sir D'Arcy Thompson, who had wrestled with these problems in his great work, *On Growth and Form* (1917/1961). Thompson demonstrated the morphological intertranslatability of disparate species and showed "that forms mathematically akin may belong to organisms biologically remote." In *The Living Stream*, after reviewing some of the data of psychical research, Hardy speculates on how extrasensory communication between animals might lead to some answers. The existence of telepathy, according to him, "may be a clue to a much more fundamental biological principle." Holding it "most unlikely that so remarkable a phenomenon should be confined to just a few individuals of one species of animal," he believes that the psychic side of animals, independent though it may be of the DNA code that governs the form of the physical frame, "may interact with the physical system in the evolutionary process." Postulating an unconscious telepathic communication between members of the same species of animals, he sees such a process as aiding organic selection ("or genetic assimilation—whichever term you prefer") by providing "psychic blueprints" that would stabilize common behavioral patterns until they gradually became converted through favorable genetic changes into well fixed instinctive patterns. Although a firm believer in organic selection in its own right, Hardy feels that instead of changes in behavior coming about solely through external selection acting separately in each individual animal (aided at the most, perhaps, by some imitative tendencies, or possibly the tendency of some animals to follow one another as they browse and graze and fall into similar habits through trial-and-error exploratory behavior) the changes would tend to spread through the population and be canalized by psychic sharing of experience on a telepathic basis. "There would [then] be two parallel streams of information—the

DNA code supplying the varying physical form of the organic stream to be acted on by selection—and the psychic stream of shared experience—the subconscious species 'blueprint'—which together with the environment would select those members in the population better able to carry on the race" (p. 258). Most instinctive behavior, he feels, ultimately comes about in this way—changes in behavior preceding changes in structure and ritualized function. Hardy also feels that the psychic blueprint idea might go far in explaining the secret of homology. It may be, he conjectures, "the group 'mind' which indirectly selects those gene complexes presenting (in development) its best expression."

Throughout *The Living Stream* Hardy carefully avoids any suggestion of direct psychic action on the gene or gene complex. Indirect selection comes about through changes of habit, and it is only this, which may later become structuralized through genetic changes which in themselves are purely fortuitous, that is facilitated through "psychic sharing" or the "psychic blueprint."

The possibility of direct action on the genetic material of a more broadly conceived psi factor was suggested in 1971 by another British biologist, John L. Randall, who sees in both the origin of life and in its subsequent evolution "a tremendous increase in information content which cannot be satisfactorily accounted for by any mechanistic theory." Citing the work of Grad (1967), Smith (1968), and others on the effect of psychic activity on cellular and enzymatic processes, Randall suggested that it "would be of the greatest interest to discover whether the same force which can promote wound healing in mice can also induce mutations in *Drosophila* or bacterial cultures..." (p. 163). It is obvious that successful results in such experiments, hardly less far reaching in importance than the production through psi means of self-replicating molecules in a medium simulating the primordial broth (which some of you may recall was mentioned as a possibility in my previous lecture in this forum [Eisenbud, 1975]), would immediately open up 'staggering vistas in biology and evolution.

### III

An area somewhat short of direct genic action of the psi factor that might profitably be explored would be that of psi communication not just among members of the same species, as Hardy has suggested, but among members of different species. Such a possibility was suggested some years ago by observations I made quite by chance (Eisenbud, 1966-67). The first of these, which was so seemingly odd as to immediately alert me to its possible implications, was simply the

higher rate of success of a nursing cat in catching mice from a mouse-hole in the floor than that of a perfectly functional cheese-baited mousetrap placed there. Presumably the cheese had given off a more inviting, less alarming odor than the cat, but the mouse population kept behaving as if just the opposite were true. "Sometimes days or weeks would go by without the trap being sprung by a venturesome mouse, but the cat, once it came into the picture, for some reason—it was nursing kittens at the time—never seemed to have to wait more than a couple of hours before it would be rewarded, and this would happen several times a day. At times the cat would grow impatient and screw her eye right down to the hole as if to see why nothing much was happening, but she would then settle back a few inches and resume her wait for the mouse that sooner or later would crawl out" (p.153[653]).

A conceivable key to this situation was provided some months later when I noticed that a peculiar game had begun to go on between the aforementioned cat's no longer nursing kittens and a several months old shepherd-husky pup that belonged to the ranch which was the scene of the game. Again and again, one or another of the kittens would not only allow itself to be pounced upon and shaken like a rag doll by the dog, who would grasp the kitten's neck or even its entire head in its maw, but it would repeatedly invite this behavior from the dog. Each time this was accompanied by the fiercest growls on the dog's part and the most piteous meows and squeals from the kitten, who would sound as if its very life were at stake. But every time the pup, tiring of the game, would drop the kitten and settle down indifferently a few feet away, the latter, instead of scampering to safety, would merely spend a few minutes licking itself back into shape and then begin again to disport itself seductively in front of the pup. This would, in short order, have the effect of rousing the pup to pounce upon it, whereupon the (to me) alarming spectacle would begin again, once more with the most fearsome sounds issuing from the pair. I soon found that there was no point in my trying to rescue the kitten from its tormentor, since both participants in what I finally recognized as some sort of highly stylized *pas de deux* would simply move out of my reach and start all over again, sometimes one kitten spelling another for a round or two. Thus it went on for weeks. One day two of the kittens were found torn to pieces, literally limb from limb, dead but not devoured.

No one around the place could imagine how this had come about. The dog's behavior, I learned, was largely an innate response called forth simply by the presence of something furry in its mouth. The puzzling thing from the beginning was not so much the dog's role, however, but the apparent need on the part of the kittens to reenact over and over again the role of prey animals about to lose the battle

for survival. Something of the sort is well known among members of the same species where the loser in a fight at one point signals its submission by ceasing its defensive maneuvers and exposing itself in a way that plainly announces that it will accept a technical knockout. The victor's aggression is immediately and automatically inhibited, and no kill takes place. This dovetailing inherited species-specific behavior pattern presumably acts in the service of the preservation of the species, and also establishes the animal's position in the pecking order (which functions to the same end). But if a submission pattern of this sort were to be used with an animal of another species, it would lead only to an immediate kill (and ultimately to the genetic extinction of the trait).

Nevertheless, the seemingly ritualistic behavior of the dog and the kittens, it seemed to me, must also in some way have been the expression of built-in inherited mechanisms. The highly stylized game, played over and over again in exactly the same manner (and which I have subsequently learned was not unique in the case of the particular animals I observed) could hardly have arisen spontaneously and *de novo* but must also have called upon latent behavior patterns of ancient lineage. And perhaps what had begun as a ritual for the discharge of tension, enabling two natural enemies to live in peace, got out of hand when the dog, growing older and functioning like a bomb ticking away toward an explosion, had simply got to the point where it could no longer inhibit the powerful impulses it was repeatedly required to hold in check. The question arises whether what was invoked in this repetitive reenactment of an age-old drama may not have been the shadow of a reciprocal predator-prey duality that exists behind the scenes through nature. If so, what part might psi play in such an interplay?

Taking first simply the possibility of covert predator-prey "cooperation" (we will come to the psi aspects of the matter presently), such a notion might at first appear to be in strong contradiction to one of the chief tenets of the theory of natural selection, that the primary drive of every animal is to survive, except perhaps where its death would serve the continuance of its own species. But examples are known where members of one species become prey to those of another in highly ritualized manners, as in the case of the tarantula spider which in a most complaisant but thoroughly prescribed way allows itself to be paralyzed by the sting of the Pepsis wasp and then becomes the incubator for the wasp's larvae (Petrunkovitch, 1955). How this sort of thing can be squared with classical selection theory is not entirely clear, but a somewhat revised theory could accommodate the possibility of such "arrangements" occurring in subtle form, if needed, throughout nature. Certainly if there were a degree of flexibility whereby every animal

were given the option to play the game or not, such a system would possess an unsurpassable efficiency and would present the ideal paradigm for all ecological relationships.

Unfortunately, gathering examples of more subtle, less obviously ritualized predator-prey "fixes" is difficult because few eyewitness accounts of capture and kill are made (most statistics are compiled from animal carcasses and stomach contents) and those that are tend almost automatically to be "normalized"—sometimes in most procrustean fashion—to fit the classical mold. Again and again we read descriptions of "inattentive" or "lagging" or "hesitant" prey, of confused prey which zigged when they should have zagged, of prey which just made the wrong decision about when to run, where to run, how to run. Some, inexplicably—and I myself have observed this—run right toward predators, even when they have definitely sensed them (Schaller, 1972). Generally it is assumed—and there is some evidence for this (Schaller, 1972)—that it is mostly prey animals handicapped by extreme youth or age or by disease that are the vulnerable ones; but there is good evidence that this is far from always the case and that healthy prey in their prime are often taken. One conservation officer remarked that such an animal, a deer whose capture and kill he witnessed, acted plain "stupid" (Mech, 1970).

Granting the impossibility of getting inside the head of an animal at the moment of decision, one can nevertheless sometimes come across what appear to be obvious indications of predator-prey cooperation that are passed over with little or no puzzlement simply because they are being viewed through the wrong end of the theoretical binoculars. It is known, for example, that many prey which are large enough and well enough equipped to defend themselves even when dragged down (water buffalo, zebra) do not do so and give up without a struggle; and several authors have noted that horns, hooves, and tusks are used primarily in fighting among members of the same species rather than in defense against predators (Mech, 1970; Schaller, 1970). Some of this would even appear to be a kind of almost ritualized submission behavior (rather than mere "shock," as is often supposed); but for some reason no one asks how it is that such behavior (even if it should happen to be a shock response) should have been selected "in" rather than "out."

A beautiful example of the paralyzing hold of classical selection theory may be seen in descriptions of wolf predation (Mech, 1970). It is known that if moose stand their ground when attacked by wolf packs their chances of being killed are slight because the wolves almost never go in on these dangerous animals and sooner or later, tiring of waiting, move off. In fact, the most effectual attacking behavior in the wolf is instinctually released only by the stimulus of a fleeing moose; at the same time, moose in flight are less able to

defend themselves. How is it, then, that "standing" has not been selected in and fleeing out? Would not the answer seem to be that the fleeing moose and the attacking wolf make one ecological (and evolutionary) unit, and that fleeing and chasing constitute interspecific cooperation just as effectively as the dovetailing behavior of the tarantula and the wasp? From the conventional point of view such a duet ought to appear the more paradoxical when it is realized that while fleeing obviously takes more energy than standing, it is often the very animals which can least afford such an expenditure, the old ones, that are most likely to flee. Since these happen also to be the animals which can run neither fast nor long, would it not seem that Nature has in this way arranged for these population units, classically expendable from the standpoint of procreative capability, to be expended? To the conventionally tutored eye these animals may appear to be fleeing just as fast as they can, but from Nature's point of view, judging from the final scores, they can only be said to be beating a terrified advance.

Let us assume for the moment, anyhow, that the moose situation is representative of a widespread, if subtly concealed (from ecologists, anyway), state of affairs in nature. Where would psi come into the picture? First, it could be a major determinant of behavior at the actual moment of encounter. "Just what makes certain moose stand their ground and others run is unknown," writes Mech (1970). It is insufficiently appreciated to what extent information that is conveyed and apprehended by means of psi means mediates decision of one sort or another and is not simply an inert registration in the mind of a percipient (Eisenbud, 1970, Chapter 14). And since decision, as Hardy (1965) pointed out, is necessarily a major factor in shaping evolution—decisions about mating, about seeking new habitats, about fighting or fleeing—any psi-mediated factor that could work in confluence with and complement normal determinants influencing behavior might just tip the balance in one direction or another.

The second point at which psi might affect the balance of adjustment, again by complementing normal mechanisms, would be by facilitating the coming into each other's range of those predator-prey pairs whose ultimate encounter would tend best to fulfill particular ecological requirements. The prototype of this would be the way in which human individuals may be presumed to be drawn through psi out of their normally expected paths to consummate the fulfillment of inner needs (Eisenbud, 1963b, 1970; Stanford, 1974), including needs for punishment (Eisenbud, 1952).

How would this work? Normally, an individual animal's role in a given ecological context is determined by a complex interplay of genetic and psychosocial factors. It has been experimentally demonstrated (Denenberg, 1963) that variations in individual animals' alert-

ness as well as passivity and aggressiveness in relation to other animals are conditioned by the accidents of early development, particularly the conditions of the neonatal and nursing period. And Wynne-Edwards (1962) has shown that animal populations themselves tend to sort out those marginal individuals in the pecking order who, by becoming social outcasts as it were, constitute a sort of roving reservoir of vulnerable prey. According to classical concepts, these are the individuals, along with the sick and the old, that make up the largest part of the vulnerable prey population. It would be precisely from such a reservoir that individuals (with relatively strong "death-need" predispositions, as it were) could be recruited for roles in psi-mediated pairings. A marginal animal might thus be drawn into position by psi to fulfill in a single act the population-limiting needs of its own species (Carr-Saunders, 1922) and the high priority survival needs (as in the case of my nursing cat) of a member of an ecologically competing species. Animals on the roam, according to this somewhat idealized paradigm, might thus be regarded as something like a fleet of radio-dispatched and radio-controlled taxicabs. As roving vehicles, they would have relative freedom to cruise and some exposure to "random" calls; but they would all the while remain subject to the requirements of their district control centers operating hierarchically in interlacing systems with mutually geared feedback mechanisms.

It should be noted, however, that psi might, if required, operate to keep prey away from potential predators, just as a psi-mediated decision on the part of a prey animal to be or not to be might go either way. Such nonrandom flexibility, as pointed out earlier, could be of the greatest importance in the highly complex food-chain calculus that operates in the biosphere. The mechanisms by which various populations are kept within bounds that seem imposed by Nature herself and are not allowed either to grow without limit or to die out are not wholly known (Errington, 1967). Still not entirely understood "intrinsic" compensating processes come into play long before population levels get too high or too dangerously low (just as a sensitive thermostat works long before a room gets too hot or too cold). And although predation levels do not seem to play as major a role in these processes as was at one time believed, even a slight complementation of pure chance in this area could provide the fine tuning necessary to keep things running smoothly. (All it takes, as every croupier knows, is a slight edge, like the double zero on the roulette wheel, to keep the house in business.)

In any case, and regardless of whether or not anything like psi-mediated predator-prey "fixes" play an appreciable part—or any part at all—in the balance of nature, the problem that arises in connection with whatever mechanisms do operate is that of overall

control. Here ecologists become somewhat vague. By way of accounting for various feedback and buffering mechanisms, they tend implicitly or explicitly to fall back upon physiological models of homeostasis (the living organism's ability to maintain its component systems in finely balanced equilibria). But what individual organisms possess that is critically lacking in the pictures drawn by ecologists are built-in mechanisms for some sort of central control, as well as, in higher animals, more or less fail-safe nervous and hormonal means of communication between component organs and systems. Conventional informational mechanisms cannot in themselves provide this control, no matter how extensive the catalogue of their various capabilities (Wilson, 1975; Wynne-Edwards, 1962) and however intricately they may seem to be woven into the manifold patterns of ecological interrelatedness, any more than the various intercommunicating bureaucracies that make up a government can govern.

## IV

And this, returning now to evolution (ecology is merely evolution on the wing), is precisely the problem here too. The hope of certain biologists that new branches of mathematics or of computer science will provide the answer is as doomed as the perpetual motion machine. For mathematics, however cleverly it describes and analyzes problems of order, organization, and control, is as ineffectual as a Greek chorus when it comes to *doing* anything; and if computers were ever able to create anything like stable self-perpetuating patterns out of purely random inputs, as Waddington (1969) claims may have happened, the only plausible inference would be that the "experimenter effect" occasionally manifests itself (presumably through PK) with otherwise fairly reliable computer hardware.

At all events, it is not simply a matter of pumping information or energy into the evolutionary system here or there in small doses by way of accounting for this or that highly improbable bit of order or organization, this pocket of anti-chance or that one; the problem is that of the overall interrelatedness of all the systems of nature—including the inanimate, when it comes to that (Eisenbud, 1956). For part solutions, like the organizing fields within which embryos manifest their "harmonious equipotential gradients" (Driesch, 1907-08; Spemann, 1933/1962) or the "autonomous centers of decision" of Polanyi (1958), which oppose the entropic push toward disorder, will not do, any more than Whyte's St. Peter at the genetic gate or any other version of Maxwell's ubiquitous demon (even that in the mind of a moose). Nor will general systems theory provide an answer that

doesn't immediately beg the next higher question; for you cannot go on indefinitely in ascending hierarchies without sooner or later getting to some ultimate ground of existence whose nature has been the perennial preoccupation of philosophers and theologians and which only a handful of mystics have claimed to have glimpsed in the raw. It may be doubted that there is a patriarchal (or matriarchal) figure sitting at a celestial desk pointing to a sign saying "The buck stops here"; but it is difficult to avoid the impression that it is frequently the dread of having to confront a bogey of this sort that is responsible for the curious contortions, evasions, and hysterical blindnesses of those who, with almost religious faith, nurture their own version of the resurrection—the notion that electrons, particles, atoms, molecules, genes, organisms, and events somehow order themselves.

Sir Alister Hardy does not have a trace of doubt as to how the problem of ultimate control must find its solution. An uncompromising theist, he totally rejects the tendentious arguments of Teilhard de Chardin (1959) in this regard (as does also psychologist Sir Cyril Burt, 1966, who provides a penetrating glimpse of how unsimplistic informed thinking in this area *can* be), but arrives at his position through an "inner certainty" that has nothing to do with biology or logic. Although this may seem to scientists to be a sad waste of both, there it is, this inner certainty, as much a fact of nature, according to Hardy, as evolution and just as deserving of scientific attention.

It is interesting to realize, at this late date in the history of evolution and its critics, that Darwin himself was not overly disturbed by such high-level enigmas. In *The Origin of Species* (1859/1909) he took it for granted (as did Newton before him) that there was a Creator, and he more than once, when examining some remarkable bit of evolution, alluded to how infinitely superior the mind of the Creator was to the mind of man. All he was attempting to do, he asserted, was to account for the mechanism of variations and diversity, not for life itself and everything that came with it. His neo-Darwinian followers have set themselves a larger task, and some (Brooks and Shaw, 1973) have even found an extraterrestrial substitute for special creation. This would not have budged Darwin one jot. The only thing it could possibly have meant to him was that God was alive and well on some other planet too.

# V

I cannot conclude without making some mention of precognition and its conceivable relation to evolution. Precognition is the process

(or whatever) whereby events that have yet to happen appear capable of being apprehended apart from any possibility of rational inference and any known means of information transfer. If such a phenomenon actually does occur—and there seems to be ample evidential reason to conclude that it does—would this necessarily mean that something larger and more inexorable than Waddington's creods—supercreods, perhaps—are at work guiding the entire show along a fated path? Would all seemingly random phenomena, including genetic mutations and the whole panel of behavioral responses and decisions going into the struggle for existence, then be merely so much stage direction and play acting from a script that has existed from beyond all time? Or would it still be possible to think of evolution, as did Bergson (1911), as a creative process with an indeterminate future?

You are of course aware that the basic issue here, whether or not the iron fist of necessity lies inside the velvet glove of appearance, has long been a prime philosophical puzzle even apart from the problem of precognition, and that to some—Einstein, for one (Schilpp, 1949)—this issue has enjoyed only a temporary and in fact only a pseudo-resolution in terms of the dogma of indeterminacy that currently rules quantum physics. Unfortunately, the data of precognition have not really advanced the problem beyond the point at which the stoics confronted it since these data can not as yet be fitted into any satisfactory theoretical framework; and it may be that the problem cannot be resolved in terms of present modes of thought, that something more radical even than the major theoretical mutation called for in evolution theory will be required to get us off dead center. Meanwhile we continue to sift through what data we can gather on this strange phenomenon for clues, insights, or anything at all that might provide a chink in what now appears to be an impenetrable wall.

Curiously, the results of some experimental work on precognition in animals, though doing little to further the problem from the point of view discussed above, cast an interesting light on the factors influencing decision-making in animals and on the flexibility of this process. These experiments indicated that rodents were able, to a statistically significant degree, to avoid a future traumatic event such as electric shock or death by making a correct choice (e.g., in maze-running) from among a number of alternative possibilities (Bestall, 1962; Craig, 1973; Duval and Montredon, 1968a, 1968b; Morris, 1970). If we assume that it is the animal and not the experimenter which is responsible for such effects, we must suppose that it is utilizing a latent ability ordinarily held in check, an ability that could hardly manifest itself in such a manner in natural situations (e.g., to avoid predators and other dangers) without there soon being a rodent population explosion of such magnitude as to

dwarf everything else in the biosphere. If, on the other hand, we assume that it is the experimenters who are responsible for part or all of these effects (an alternative impossible to rule out), then we must presume not only the same latent ability on the part of the rodents but also their capacity and readiness to respond to psi-mediated signals ("instructions," if you will) in essentially the manner that was postulated earlier for animals on the roam. The important point is that either way what occurred in the laboratory could only have been a temporary (quite temporary, to my mind [Eisenbud, 1963a]) suspension of the real rules of the game, the rules that apply in the field at large, as if another game entirely were being played, as indeed it was. But the very fact that this is possible reveals the leeway and the flexibility that allows whole systems in nature to adapt to each other. Such systemic rather than individual adaptation would no doubt require a certain percentage of those animals who might in the laboratory show a tendency successfully to avoid traumatic events to join the ranks of my covertly masochistic kitchen mice and the moose fleeing surely toward their capture and kill. For what is certain, whichever way the issue of predetermination is resolved (if ever it will be), is that all organisms in nature, insofar as they can exercise choice at all, must do so in accordance with overall requirements that transcend individual concerns. But if the great constants of nature have to be satisfied no matter what, if the ultimate boundary conditions (Polanyi, 1968) are as invisibly present as our persistent and multifarious background radiation, is it conceivable that this imposes on evolution a destiny and a design (homage to Alfred Russel Wallace, 1911) which the mechanics of random mutations and all kinds of psi-mediated intercommunications merely help to carry out? Conceivable perhaps, but it is unlikely that the question can ever be settled.

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