

JACQUES MONOD AND THE CURE OF SOULS

by John A. Miles, Jr.

PART I

Jacques Monod, French biologist, professor at the Collège de France, founder of the Institut Pasteur, Nobel laureate in physiology and medicine, published in the summer of 1970 a philosophical essay, *Le hasard et la nécessité: essai sur la philosophie naturelle de la biologie moderne*. The essay was the publishing success of the year, running right behind the French translation of Erich Segal's *Love Story*. In 1971 it appeared in English translation as *Chance and Necessity* and was widely reviewed in the United States. The reflections which follow are suggested as much by the popular success of *Chance and Necessity* as by the work itself. They are a comment on what might be called the *Chance and Necessity* phenomenon.

A SUMMARY OF "CHANCE AND NECESSITY"

The popularity of *Chance and Necessity* was a surprise, for the greater part of it is an extremely dense, if also lucid, résumé of recent work in biology, especially biochemistry. As George Steiner wrote in the *New York Times Book Review*: "The standards of 'literacy' set by Monod honor us all but may be a little unrealistic."¹ Perhaps partly for this reason, partly because the biology is, after all, only a review of previous discoveries, Steiner and all other English reviewers jumped immediately to Monod's ethical conclusions, criticizing them without reference to their alleged basis in biology. Though this approach is reasonable enough in a brief review, another approach is indicated here. If Monod intends to derive his ethics from his biology, then this biology deserves at least the courtesy of a brief summary.

Chapter 1. Strange Objects. The basic postulate of the scientific method is that nature is objective and not projective; that is, nature betrays no overriding purpose, it is a fact and not a plan. What is science then to do when it encounters objects—namely, living beings

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—which do appear to be projective, that is, which do have teleonomy (purpose), autonomous morphogenesis (growth), and reproductive invariance?

Chapter 2. Vitalism and Animism. Is teleonomy prior to reproductive invariance, or vice versa? Having set aside autonomous morphogenesis as a mechanism occurring within both teleonomy and reproductive invariance, biology has maintained the priority of invariance, thus escaping its epistemological dilemma: teleonomy exists in living beings, but these beings are themselves accidents within a larger process which is without teleonomy. Philosophy and religion maintain the priority of teleonomy only at the price of a growing sense of intellectual isolation.

Chapter 3. Maxwell's Demons. Consideration of the relationship of reproductive invariance to teleonomy begins with the study of proteins. The teleonomic effect of proteins derives from their *stereospecificity*, that is, their ability to recognize other molecules (including other proteins) by their *shape* in a kind of microscopic cognition. So, for example, enzymes (a class of protein) trigger certain teleonomic reactions within a metabolism by bonding themselves to their substrata in stereospecific complexes; that is, literally, in groups of proteins that "fit together." The bond is not covalent—no electrons are exchanged—and consequently may be formed and broken with little consumption of energy and in very great numbers. Stereospecificity and noncovalent bonding make it possible for the enzyme to function like the demon who, in Maxwell's imaginary experiment, stood in the neck joining two retorts and sent some molecules one way and others another.

Chapter 4. Microscopic Cybernetics. The reactions catalyzed by the enzymes are regulated and harmonized by another class of proteins, the allosteric or shape-changing proteins. Limited neither to bodies with which they might exchange electrons nor to bodies of a particular shape, the allosterics make interaction possible between bodies deprived completely of chemical affinity. The gratuity of allosteric bonding, inasmuch as it removes the obstacles to purely physiological organization, is "the ultimate source of the autodetermination which characterizes living beings in their behavior."²

Chapter 5. Molecular Ontogenesis. The spontaneous reassociation of artificially dissociated protein components in oligomeres, ribosomes, and bacteriophages proves that even at such higher levels of complexity, the organization and teleonomic behavior of organisms rests on the properties of stereospecific recognition in protein. Just as the information necessary to cover a floor in a hexagonal pattern is entirely present in one hexagonal tile, so the information necessary

to develop an organism is present in the shape of its proteins. "The epigenetic construction of a structure is not a creation but a revelation."³

If so much depends on stereospecificity, how do proteins become stereospecific; that is, how is it that they have *different* shapes? The core of protein is a chain of amino acids (the polypeptide chain) joined by *covalent* bonding. Since the bonding is covalent, the chain is strong. Since it is in the form of a chain, it can tangle itself into various kinds of ball, the acid links in the chain forming new *noncovalent* bonds among themselves, like rust in a tangle of abandoned anchor line. The tangling begins because certain of the amino acids are hydrophobic, recoiling from water as oil does, in a pattern which is determined in detail by the number and position of hydrophobes in the chain and by the temperature, etc., of the water vehicle in which the process normally occurs.

Since the shape of a protein defines its recognitional function and its potential for organizing larger structures, and since the polypeptide chain defines this shape, "the *ultima ratio* of all the teleonomic structures and behavior of living beings is . . . enclosed in the sequences of radicals in the polypeptide strands."⁴

And how are these sequences determined?

They are determined by chance.

Once a particular sequence occurs, it will—because of the nearly total reliability of the genetic transmission process—maintain itself almost perfectly. However, the initial arrangement is unpredictable, *essentially* unpredictable. That is to say that there is no further insight to be anticipated in its regard. If 199 amino acids in a chain of two hundred are known, it is totally impossible to predict the two hundredth.

Chapter 6. Invariance and Disturbance. Given the extreme fidelity of the genetic transmission process, the diversity among living beings can only be explained by quantic disturbances. The genetic copying mechanism is no exception to the laws of physics; that is, it is not immune to accidental variation. What makes its accidents interesting is that they are accidents in a *copying* mechanism. Once the mistake is made and a "false" chain occurs, that chain reproduces itself perfectly unless and until another accident takes place. DNA is "as deaf to the noise as to the music."⁵ It must be kept clearly in mind that quantic accidents are not the sort that could ever be controlled the way, for example, one might control dice to make their tumbling predictable. These accidents inhere in the structure of matter itself and affect any controller as much as they affect that which he would wish to control.

Chapter 7. Evolution. Though chance is the source of mutation, an organism regulates evolutionary pressure for or against the survival of a given mutation by moving into different environments. The primitive fish that clambered onto land made a fateful "choice": it willed to its descendants an environment that made the selection of powerful limbs more likely. The first crude act of symbolic communication, because of the radically new possibilities which it offered, was a similar "choice." The brain of the proto-man who made the choice is to the brain of man as the fins of the clambering fish are to the legs of a horse; but once the choice was made, an environment favoring such a brain was created. The further evolution of brain and language was conjoined, and the two remain in the strictest symbiosis.

Chapter 8. The Frontiers. The frontiers of the study of invariance and teleonomy stand at the extremes of time: first, the origin of the process in the distant past and, second, its present complexity in the human brain.

The formation of the chemical constituents of life (nucleotides and amino acids) is not implausible in a "prebiotic soup" of methane, simple carbon compounds, ammonia, and water. Equally plausible is the development of protein-like macromolecules containing a polypeptide chain. What is most implausible is the spontaneous occurrence of even a single actual replication. DNA, essential for the transmission of a genetic code, is itself transmitted. *Omne vivum ex ovo.*

The solution again can only be sought in the development of DNA or some substance with similar code-transmitting properties by chance. Though the a priori likelihood of this was infinitesimal, it had only to happen once.

On the other frontier, investigation focuses on the synapses of the brain and the mechanics of memory. What little is known in this area is more than sufficient to vanquish pure empiricism. A frog does not "know" a fly at rest, only a fly in flight. Similar a priori categories in human perception are gradually being isolated. They derive from experience only in the sense that their selection is connected with the past experience of the species. Scientists like Einstein have marveled at the correspondence between experimental observation and mathematical systems constructed without reference to experience. But when one recalls that thought developed gradually over millennia as a way to deal concretely with nature, the marvel is less marvelous. Man and the world are a single thing, however inescapable dualism may be as a logical tool.

Chapter 9. Darkness and the Kingdom. The specific environmental

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dangers which the development of brain and language in man has produced are warfare and, more recently, the complete dissociation of cultural and genetic evolution. The weak and handicapped now survive long enough to reproduce. Intelligence, imagination, courage, etc., are factors in personal success but do not affect the likelihood of reproduction. There is, in fact, a negative correlation here which, over ten or fifteen generations, could begin significantly to affect the species.

A much more proximate danger is the *mal de l'âme* of modern man as he discovers a radical conflict between what his culture teaches and what his genetic program requires him to believe. For millennia, the pressure of evolutionary selection favored whatever favored social cohesion. Consequently, the modern need not only for law but also for a mythic explanation grounding law has the force of evolution behind it. The brain requires this harmony. Unfortunately, the scientific postulate of objectivity, asserting that nature has no intentionality, goes directly counter to this need, severing man from his world, destroying their "old covenant." It is possible to use the products of science without adopting the viewpoint of science, but not indefinitely and not without a growing sense of disorientation.

It may be possible, however, to respond to this crisis by forging a "new covenant" in which a new harmony will result from the very authenticity required to live in the new situation. The ethics of this "new covenant" would be an "ethics of knowledge," of the new knowledge, namely, that while man (by chance) is projective, nature as a whole is not. Ethical, authentic man, accordingly, would never claim that nature either commanded or supported his goals, or conversely that he was ever obedient to nature or grateful to it. Nor would the man of the "new covenant" claim that his decision to practice such an ethic was, any more than any other decision, dictated by nature.

If the "ethics of knowledge" were widely adopted, the *mal de l'âme* of modern man might abate as action and thought were again brought into harmony. In the "old covenant," it was knowledge of being which grounded and guaranteed ethical decisions. In the "new covenant," the direction is reversed: the starting point is an ethical decision to regard only objective knowledge as valid; the decision is gratuitous, difficult, and without obvious promise of reward. However, quoting Camus, "*Il faut imaginer Sisyphe heureux.*"⁶

ASSUMPTIONS OF SCIENCE AND THE COMMON SENSE OF MAN

Though Monod opens his essay with the discussion of an epistemological contradiction in modern biology, there is scarcely a real question

in his mind about the epistemological validity of his science. Rather, the discussion is a staged debate in which Monod refutes philosophy and religion as “holistic” biology in order to refute them *tout court*. It would be a mistake, however, to construe Monod’s strategy negatively, as nothing more than an attack on philosophy and religion. In fact, it is not an attack but a defense and even an apology. Speaking of the “holistic” biologists, Monod writes: “According to such schools of thought . . . , the analytic approach, labeled ‘reductionist,’ is doomed to sterility for presuming to trace the properties of a complex organism back to the pure and simple sum of those of its parts. A vile and moronic dispute this, and one which proves only the depth of the ‘holist’ misconception of the scientific method and the essential role of analysis within it.”⁷ In this passage, Monod is responding with appropriate force to an insulting charge. To call an investigator “reductionist” is to accuse him of nothing less than falsification of the facts in the interests of his theory. And if the charge that scientists like Monod reduce man to the sum of his chemical parts is only rarely made by other scientists, it is commonly made by the man on the street. I read both the frequent lyricism and the occasional scorn of *Chance and Necessity* as a defense against that charge. Monod is saying, in effect: “We too treasure the beauty of man. We too are sensitive to his sorrow. But we know the subtlety and power of his chemistry as you do not. If you knew it, you would know that when we translate man into his chemistry, we do not reduce him at all.”

Monod presents the rupture of his “old covenant” as, on the intellectual level, more a problem for the layman than for the scientist, and yet on the social level it is a problem for the scientist as well. From Carl Jung’s comments on the “mad scientist” of popular literature to C. P. Snow’s dissection of the “problem of the two cultures,” sensitive observers have drawn attention to an alienation of the scientist from the common man which, though it may be discussed dispassionately as a difference in methods and interests, is experienced by both sides as, in the first instance, an estrangement among men. In this context, the “ethics of knowledge” proposed in Monod’s last chapter reads as a burning desire to see the operating assumptions of science become the common sense of man so that scientists can rejoin the race. That this desire won a warm popular response in France can hardly be without significance. The layman is evidently eager to recognize himself and his concerns in the scientist and to do so not just when the latter takes time out “to be human,” playing with his children, going to the cinema, etc., but even as he toils in the laboratory.

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AN IMAGINARY DIALOGUE

The attitudes against which Monod implicitly argues are perhaps best presented in an imaginary dialogue between Monod and the voice of *les âmes modernes*, those souls in which science has yet to win its rightful place.

[Spotlight downstage. Seated in shirtsleeves, facing the audience across a cluttered desk, JACQUES MONOD, obviously deep in concentration, writes rapidly, occasionally glancing up to find the right word, then eagerly scribbling it down.]

Midstage, LES ÂMES MODERNES, a mixed chorus including children, stand in heavy shadows, huddled, as it were, but without the hunched posture which that word implies, and swaying slightly as they speak.

Upstage and overhead, part of the context more than of the place, dark suggestions of gothic windows, the grotesque silhouette of a huge crucifix, the flicker of a candle.]

ÂMES MODERNES [with the merest touch of wail]: Monod, Monod, you reduce us to our parts. Chemical parts, the sum of chemicals. Monod, it cannot be.

MONOD [absently, without looking up; he has dealt with LES ÂMES before]: Come, come. I speak not of a sum but of a structure.

ÂMES MODERNES [a troubled murmur behind one clear, female voice]: A sum, a structure. A structure, a sum. Many combinations, but finally a limit. And what of us? [Murmur deepens among LES ÂMES.] We are without any limit. We are an endless surprise. [Murmur grows deeper, then stills, expectantly.]

MONOD [continues to write, answers abstractedly]: The, uh, contrast you suggest between the limitless possibilities of man and the, uh, limited possible combinations of elements might be, uh, valid were it not for noncovalent bonding. As I pointed out, this is bonding without exchange of electrons. The atomic number plays no part. The, uh, table of elements represents no limitation. It is the shape of the bonding proteins that acts as principle of selection. [Silence among LES ÂMES. An ARCHBISHOP steps quietly out from among them. He is a portly, ruddy Anglican, rather like the late Archbishop of Canterbury. He waits for a moment—MONOD has not seen him—then takes a few challenging steps downstage, red-slippered feet darting from beneath his robes.] No [MONOD, still unaware of the ARCHBISHOP, repeats himself absently], the table of elements represents no limitation at all.

ARCHBISHOP [loudly, rather splendidly]: I disagree. What matter that the principle of selection is shape? [MONOD, startled, swivels in his chair.] The number of possible shapes is still limited. And even if it weren't, a more important point is that all your stereospecific interactions take place automatically. If they can take place, they must take place. Put the reagents in the tube with the proper catalyst [spoken in a tone of disdain, as if the ARCHBISHOP had something against catalysts] and they have no choice. But we do have a choice [gestures upstage: LES ÂMES are his flock]. We can inhibit, to some extent, even our most basic mechanisms: witness Hatha Yoga. [Waves upstage. Two altar boys detach themselves from LES ÂMES, pulling a yogi in a coaster wagon. They cross in front of Monod's desk and return to the shadows of LES ÂMES.]

MONOD [resigned now to a real, if tiresome, discussion, puts down his pen]: Well, to answer your first objection, the number of protein shapes may be eventually limited, but it is also incalculably great. The number of discrete acts on the macroscopic level which a man—your yogi, for instance [gestures

upstage—performs during a lifetime is also incalculable. If you will permit me to chop logic with you, between two incommensurables no comparison is possible. As for your second objection, regarding the automatic character of chemical reaction, if I may say so, this cookbook picture of the scientist is responsible for much needless suspicion of him and his work. Chemical reaction is not so simple as that. The very point of my discussion of allosteric bonding—you do seem to have read my book—was that certain reactions occur and fail to occur in a manner which is chemically gratuitous.

ARCHBISHOP: But when you speak of reactions occurring *gratuitously*, are you not documenting *our* contention? Are you not confessing that the microscopic level reveals something which cannot be explained in terms of itself? Isn't the *obvious* hypothesis a higher principle or purpose in terms of which these gratuitous reactions might not be so gratuitous?

MONOD [*more accommodating*]: I understand the objection. When organization becomes physiological rather than merely chemical, one can, in a way, speak of a higher principle. However, the fact that the information for the operation of the higher principle is implicit not just in the lower level but actually in the components of the lower level makes it impossible to make the emergence of your higher principle depend on its introduction from without.

ARCHBISHOP: But my dear man, this is surely to reduce—

MONOD [*sharply*]: No! [*Pauses momentarily.*] It is not. And you must permit me a further comment. My point in discussing the allosterics was to indicate that there is no point beyond which complexity at microscopic levels cannot keep pace with complexity at macroscopic levels. Computers have become a byword for complexity, but an electronic relay weighs a million billion times as much as an enzyme with the same cybernetic properties. When one hears this technology routinely described as “refined,” one might expect that the recognition of a refinement a million billion times finer might not be so brusquely dismissed as “reduction.” We cannot know until *after* our investigations what constitutes “reduction” and what, so to speak, constitutes terminological “inflation.”

ARCHBISHOP [*mollified*]: Very well. Perhaps we should be more circumspect. And yet as successively more complex principles of organization are imposed on their substrata—

MONOD [*thumping the desk*]: Nothing is “imposed.” In the biochemical completion of the theory of evolution, new complexity develops accidentally *within* the level of complexity already reached and is preserved by the reproductive process.

ARCHBISHOP [*dejectedly, as if to himself*]: Supposing the reproductive process already to have developed [MONOD *nods, the ARCHBISHOP seems not to notice*] and to have developed by chance. [*Turns, begins to trudge upstage to rejoice LES AMES.*]

MONOD: Monsignor, wait. [*The ARCHBISHOP stops, turns.*] When I was a child [*Monod is struggling now not for the correct formulation but for the persuasive one*], I loved to imagine Aladdin and the lamp. Aladdin had three wishes. I would have needed only one. The jinni would have had only one mistake to make with me, and he would have been my slave forever, for my wish was the wish to have all my wishes granted. Nature made the jinni's mistake in the first crude self-replicating mechanism. Everything followed on that.

ARCHBISHOP [*sighs, uncomforted*]: Perhaps. I concede that you have an

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answer for everything. And yet—pardon my presumption—you don't have an answer for us. [*Gestures upstage. For an instant LES ÂMES are fully lit. Plumbers in overalls, mini-skirted waitresses, bankers with attaché cases, schoolchildren, and an assortment of furniture—the sort of mélange occasionally seen in an insurance ad. They wave hats, handkerchiefs, small flags. Darkness descends again.*] What do you, armed only with biochemistry, say to a man who knows he is going to die in an hour. [*Altar boys reemerge from the shadows, pushing a hospital bed with an enormous clock suspended over its head. On the bed, a gaunt man in a hospital gown stares vacantly about. The clock moves slowly toward five o'clock. The altar boys position the bed alongside MONOD's desk and return to the shadows, accompanied by the ARCHBISHOP.*]

MONOD [*reflectively*]: Do you fear death? [*The patient lifts his head, stares at MONOD—or is he looking past him?—and sinks back on the pillows.*] Do you question death? [*Patient seems to nod.*] Your time is running out. Why wouldn't you question death? But I [*rises from his chair, circles to the front of the desk, begins to speak more energetically*], I am a scientist. As a scientist, I must question life, not death. It is life which is the scientific anomaly. It is now 4:45 P.M. You have fifteen minutes to live. All the clocks in this city are edging toward 4:46. What would you say, what would I say, if your clock started edging toward 4:44? [*Clock moves. Patient stirs.*] We should regard this as exceptional, should we not? And if it edged all the way back to 4:15? [*Clock snaps back to 4:15. Patient suddenly sits upright and begins rocking weakly but excitedly, like a child in a crib.*] Most exceptional indeed, would we not agree? But if, after edging its way back to 4:10 [*clock does so as he speaks*], your clock suddenly slipped and, in a rush, rejoined the rest of the clocks at 4:59 [*clock obeys, patient collapses like a puppet*], our hearts would grieve that the wonder was over, would they not, but our minds would know that the exception had simply dropped back into the norm. The universe is clockwork winding down. All the clocks are plugged into a single power source. If one draws extra power to run backward, the others wind down that much faster, and all, all eventually stop.

It is entropy, my dear. Entropy is the determinism which contains freedom. Lives and deaths are ripples in a pond that will eventually settle to a mirror stillness. Are you listening? A mirror stillness. [*Notices the clock, now stopped at 5:00, crosses to the patient, bends over the bed, as if listening for a breath, closes the patient's eyes, straightens the bedclothes, kisses him once on the forehead, and exits left. Lights hold for a moment, then black out.*]

PART II

In Part I we argued that a major motivation in Jacques Monod's *Chance and Necessity* was the author's perhaps unconscious desire to overcome the psychosocial estrangement of scientific from lay society. The popularity of the work, however, is by no means to be attributed to this desire alone or to its reflex among laymen. *Chance and Necessity* responds as well to an alienation *within* lay society, an alienation of conduct from thought. Monod may exaggerate when he writes that “in three centuries, science, founded on the postulate

of objectivity, has won a place in human society but not in the human soul,"⁸ but it is at least true that science has not taken over the soul of man as completely as it has taken over the practical conduct of human affairs. The resulting disarticulation may be considered from various vantage points. However, if we hold with Clifford Geertz that "the heart . . . of the religious perspective . . . is the conviction that the values one holds are grounded in the inherent structure of reality, that between the way one ought to live and the way things really are there is an unbreakable inner conviction [that] what sacred symbols do for those to whom they are sacred is to formulate an image of the world's construction and a program for human conduct that are mere reflexes of one another,"⁹ then we may consider it a religious problem. In his attempt to make modern man's general ethical and philosophical thinking more perfectly the reflex of his scientific practice, Monod would then be responding to the same impulse which in every age has created religion.

MONOD'S SOCIORELIGIOUS POSTULATE

Monod recognizes the reflexive structure of traditional religions: "In an animist system, the interpenetration of ethics and knowledge creates no conflict, since animism avoids any radical distinction between the two categories: it considers them two aspects of a single reality."¹⁰ However, he does not recognize the same structure in the relationship of his science to his ethics. He maintains that what modern science has discovered is that the world's construction is not such that any program for human conduct could be derived from it, that this is the ethical import of its lack of teleonomy. However, Monod cancels his own point by saying that man must now act accordingly. In such wise does the religious instinct reassert itself. Monod wishes to end man's doomed attempt to bend his will to the will of an involuntary universe. But Monod fails, for the fact that there is no cosmic Will to obey is religiously irrelevant: there is a cosmic Fact to yield to, and from that act of surrender, religion is reborn.

One might object that not every impulse toward harmony is religious. May we not rather characterize as religious only those responses to the impulse which are based on incomplete evidence? In them, deficiencies in knowledge are supplied by faith, while science derives its image of the world's construction from objective knowledge alone. Its ethics, then, is rightly called an ethics of knowledge, and not a religion.

This objection founders on the fact that within biology, the postulate of objectivity is postulated *ad hoc*; it is a working hypothesis, intended for work within biology. At the moment when its application

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is universalized, it ceases to be a biological principle and becomes a philosophical principle, and, as such, its truth is not proven by its usefulness within biology.

Monod is aware of this:

It is plain that to make the postulate of objectivity a condition for true knowledge constitutes an ethical choice and not a knowledge judgment inasmuch as according to the postulate itself, there can be no "true" knowledge before this arbitrary choice. The postulate of objectivity, in order to establish a norm for knowledge, defines a value which is objective knowledge itself. To accept the postulate of objectivity then is to articulate the basic proposition of an ethics: the ethics of knowledge.¹¹

However, Monod seems unaware that when an ethical postulate is used to accord universal validity to a postulate of limited demonstrable applicability, the result is ordinarily called religion and not philosophy.¹² That is, the decision to regard a statement as true because, prescinding from logical proof, it is morally right to do so, or wrong not to, is what is ordinarily meant by faith. Conversely, even such ordinarily religious concepts as prayer and the afterlife cease to be religious when (as recently in parapsychology) they are taken as hypotheses to be used only when, and to the extent that, they are applicable. When Monod, having established the distinction between the objective universe and projective man as absolutely and irrefragably true, proceeds to derive further ethical consequences of an equally absolutist complexion, in which, for example, "in order to remain true to the principle, we shall judge that no speech (or action) may be considered significant or *authentic* unless (and to the extent that) it makes explicit and preserves the distinction between the two categories,"¹³ we see very plainly that, as Geertz would have it, the image of the world's construction and the program for human conduct are once again reflexes of each other.

Monod betrays little interest in the earlier philosophical history of the notions he espouses. His title is a quote from Democritus and reappears in an epigraph: "Everything which exists in the universe is the result of chance and necessity." However, the fact that the Democritean physics were incorporated without revision in Epicureanism (from 300 B.C.) and as such never quite disappeared as a philosophical option seems to have escaped his notice. Cicero (106-43 B.C.), a good Epicurean, compared philosophers who explained natural events theologically to bad dramatists who had to introduce the *deus ex machina* to end the action. In late pre-Christian and early Christian times, under Epicurean influence, the gods of the Hellenistic pantheon were increasingly identified with *tyche*, "Chance," to the point that in A.D. 79 Pliny the Elder could write: "In the whole world, indeed in all places

and at all times, Fortuna [i.e., *tyche*, *chance*] is invoked and celebrated. . . . And we are so subject to chance that chance takes the place of god, whom she proves to be unreliable."¹⁴ The Talmud (final redaction, sixth century A.D.) regularly brings up the *'apikor*, or Epicurean atheist, for refutation. The Arabs inherited Epicureanism from the Byzantines; the Spanish, from the Arabs; and the scholastics, from Spain. After the Renaissance, of course, all the proscribed classics won a new lease on life; and in 1747 we find de la Mettrie, whom Toulmin and Goodfield call "a conscious Epicurean," writing in *Man a Machine*: "Only one [substance] is to be seen in the World, and Man is the most perfect [form] of it."¹⁵ That de la Mettrie, an Epicurean in all senses, died of digestive complications after eating pheasant *paté*, that Jacques Monod is described as elegantly groomed, an accomplished musician, and a gracious host, whose image for the condition of man is breaking the bank at Monte Carlo¹⁶—these may be only piquant details. The survival and influence of Epicurean atheism is a fact.

Monod therefore claims too much when he says that "the prodigious development of knowledge over the last three centuries today forces man to a rude uprooting of a conception of himself and his relation with the universe which he has held for tens of thousands of years."¹⁷ The projective view of the universe is not a plant that has been growing undisturbed for "tens of thousands of years." It has been challenged repeatedly, most recently by twentieth-century logical positivism, a movement which Monod nowhere acknowledges.

No purpose is served, however, by belaboring Monod's failure to protect his philosophical flanks. My thesis is that, despite its subtitle, his work is not philosophical in intent but religious. His key postulate is not the postulate of objectivity but the socioreligious postulate that, in Emile Durkheim's words, "a human institution cannot rest upon an error and a lie. . . . If it were not founded in the nature of things, it would have encountered in the facts a resistance over which it could never have triumphed."¹⁸ Monod stands before the scientific (and implicitly also the technological) achievement of the past three hundred years as before a temple, and asks, "Can you doubt?" If you cannot, then the rest of the book has the excitement of theology: it is *fides quaerens intellectum*.

AWAKENING MEN TO THEIR ISOLATION

Though in some circles the *reductio ad absurdum* and the *reductio ad religionem* are equated, the equation obviously relies on definitions of terms. But, if religion is regarded as, for better or worse, an inevitable concomitant of human existence—as, namely, the unbreakable habit by which we make some practical sense of the whole even when

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no logical sense can be made—then the discovery of a religious purpose in a scientific or philosophical work only raises a new set of questions: how effective is it as religion? how likely to become a mass religion? how comparable with other past and present religions? etc.

It has well been said that the first question to ask in analyzing a religion is not whether it believes in a/the deity but what, if anything, it regards as holy. The holy in *Chance and Necessity* is patently chance itself. Consider the following stately passage:

It follows necessarily that chance alone is at the source of every innovation, of every creation in the realm of life. Pure chance, chance alone, a liberty absolute but blind, at the very root of the towering edifice of evolution: today this central notion of modern biology is no longer a hypothesis among others possible or at least conceivable. It is the *only* one conceivable, the only one consistent with the facts of observation and research. And nothing allows us to think (or to hope) that our ideas on this point should or even could be revised.¹⁹

In emotional tone, is the preceding passage not a hymn to chance worthy of comparison with the following lines from Pharaoh Ikhnaton's famous "Hymn to Aton" (fourteenth century B.C.)?

How manifold it is, what thou hast made.
They are hidden from the face (of man)
O sole god, like whom there is no other.
Thou didst create the world according to thy desire,
Whilst thou wert alone:
All men, cattle, and wild beasts,
Whatever is on earth, going upon (its) feet,
And what is on high, flying with its wings.²⁰

Aton, to be sure, is "thou," and chance is not. However, chance—like Aton—is the unique source of all that exists; and the excited, numinous feeling that comes from holding oneself mentally in the presence of that hidden source does not seem milder in Monod than in Ikhnaton.

Holiness, of course, stands only as a quality of the deity. It is the experiential, not the logical, starting point. The logical equivalent of the deity within modern science is matter, to which, in Monod's vision, chance relates as the will of God relates to God himself. As the concept of matter grows physically more problematical, receding down an endless *via negativa* before the finest scientific hypotheses of the age, it takes on—even without the note of personality—the contours of divinity. One recalls that even in Christianity, whose strongly personal God Monod must have frequently in mind, the

personal appellative "God" and the impersonal "heaven" are often interchangeable: "God only knows," "Heaven only knows"; "It was the will of God," "It was the will of heaven"; "He has gone home to God," "He has gone home to heaven." The notion that heaven is the impersonal abode of the personal deity is a secondary harmonization frequently absent from the actual sentiment. Monod, of course, never speaks of matter qua philosophical category. However, as he conducts the reader through the dazzling intricacies of biochemistry, matter is so constantly in the background that when he borrows from Mauriac, "Ce que dit ce professeur est bien plus incroyable encore que ce que nous croyons, nous autres pauvres chrétiens,"²¹ one senses that it is the incredibility of matter itself to which he refers.

A further, key question must ask how man relates to the deity. At the end of chapter 8, Monod comments, almost in passing, that dualism is psychologically inescapable: man will inevitably open a gap between the world and himself.²² Monod might as easily have written—to have done so would have accorded better with many of his own observations—that man will close a gap between himself and the world at almost any cost. If in the past he was able to close the gap by regarding the world as a person like himself, or as controlled by a person or endowed with a quasi-personal purpose, and if he must now regard the world as one impersonal thing, then we may expect that before long he will begin to regard himself as part of that thing. And so we find Monod, in a revealing aside, admitting that on occasion, concentrating on his work, he has caught himself identifying with a protein molecule. Neither the total personality nor the total impersonality of the world is painful. What is painful is the unevenness in a world which is partly personal and partly not. The elimination of that unevenness, albeit in the direction of impersonality, is a mystical liberation.

Gunther Stent, writing on Monod in the *Atlantic*, ties the development of Tao mysticism to a kind of climacteric in Chinese science:

I suspect that the Chinese knew all about the principle of objectivity when two millennia ago they reached the highest level of civilization, cultural as well as technological, seen until then on the face of the Earth. Once the Chinese had attained that pinnacle they weighed and found (and for the first time in history could *afford* to find) the principle of objectivity wanting. While the Dark Ages were setting on the West, China turned toward Taoism, a kind of animism in reverse that projects nature into man, rather than man into nature.²³

Commenting on the indifference of the Taoist mystics to the question of personal immortality, R. B. Blakney quotes the Tao Te Ching:

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In this world,
Compare those of the Way
To torrents that flow
Into river and sea.²⁴

For the Taoists, water is water: nothing changes but the direction of flow. Man is located in a unity which death cannot shatter. For Monod, matter is matter: nothing changes but by transitory combinations.

Entropy serves much the same function in Monod's religion that Providence serves in Christianity or Karma in Hinduism. It is the universal, inexorable Law, which reasserts itself after every apparent violation. The evil may prosper in this life, but God will punish them in hell. The Brahmin may disregard the laws of his caste, but he will be reborn as a Kshatriya. Living organisms may violate the second law of thermodynamics, but the rest of the universe cools faster as a result of their warmth, and so entropy proceeds apace.

There is no physical asceticism in Monod's religion, but his choice of Sisyphus as the type of the man of objective knowledge reveals that he regards his ethics of knowledge as a merciless discipline. Simply maintaining the distinction between projective fantasy and objective knowledge requires unremitting effort.²⁵ It may be, however, that the ethical discipline of Monod's religion is insufficiently articulated. What other behavior might logically accompany the conviction that man's reflection is nowhere to be found in the universe?

According to Stent, "this development—the dissolution of the covenant—presages the end of science, since there is little use in continuing to push the limits of our knowledge further and further if the results have less and less meaning for man's psyche."²⁶ In other words, when science reaches maturity, it loses interest in itself. One is reminded of a passage in the Bhagavad-Gita:

Every action is really performed by the *gunas* (elements). Man, deluded by his egoism, thinks "I am the doer." But he who has the true insight into the operations of the *gunas* and their various functions, knows that when senses attach themselves to objects, *gunas* are merely attaching themselves to *gunas*. Knowing this, he does not become attached to his actions.²⁷

In its way, this sort of epistemology is heaven on earth, freedom now. It is welcome relief from the too present sense of responsibility for one's own daily behavior and especially one's own eventual success or failure. It is, above all, liberation from the burden of unending further investigation. Like other actions, thought is merely *gunas* attaching themselves to *gunas*. The process has no completion in and of itself. Its only termination is subjective withdrawal.

Holiness, deity, providence, asceticism—these notions are among those most common to acknowledged religions, but there are in Monod's message additional elements which parallel Christianity in a special way. There is, for example, messianism, the awaited culmination of a long and laborious process of revelation in one climactic event. Compare the Letter to the Hebrews (New Testament): "At various times in the past and in various ways, God spoke to our ancestors through the prophets; but in our own time, the last days, he has spoken to us through his Son, the Son that he has appointed to inherit everything and through whom he made everything there is," with the following from Monod: "It has taken millenia for the idea of objective knowledge as the *sole* [*sic*] source of authentic truth to appear in the kingdom of ideas."²⁸ There is no question here of the sort of unconscious borrowing that may link Monod to de la Mettrie and the Epicurean tradition. However, if the mood of culmination contributed to the appeal of early Christianity, the same mood may contribute to Monod's appeal.

Equally Christian in contour is Monod's strict connection of salvation with doctrine. One will find a cure for his soul when he believes that certain clearly formulable statements are true and others false. Although talk of redemption and the forgiveness of sin is lacking in *Chance and Necessity*, its equivalent may be seen in the monistic elimination of accountability. Monism has the capacity to moot not only, as we have seen, the question of mortality and immortality but also that of guilt and innocence. Compare Nietzsche:

*We invented the concept 'purpose': in reality purpose is lacking. . . . One is necessary, one is a piece of fate, one belongs to the whole, one is in the whole—there exists nothing which could judge, measure, compare, condemn our being, for that would be to judge, measure, compare, condemn the whole. . . . But nothing exists apart from the whole. That no one is any longer made accountable . . . this alone is the great liberation—thus alone is the innocence of becoming restored. . . . We deny God; in denying God, we deny accountability: only by doing that do we redeem the world.*²⁹

Nietzsche, of course, is the archetypal raving philosopher, while Monod, as a Nobel prize winner, is the certified world leader. However, if the similarity in their thought at this point can be granted, then we may see more clearly in Nietzsche the potential within main-line science to bring a troubled mind to the emotional equivalent of "I am washed in the blood of the lamb, I am released."

In order that he be saved, man must first recognize and confess that he is lost; and, in this sense, the basic doctrine of Christianity is the doctrine of sin. Evangelistic preaching—often called "revival" or "reawakening"—aims first to produce an acute sense of guilt and

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then to offer an ecstatic release from it. Monod, in a parallel way, notes that many men do not suffer their isolation as purposeful beings in a world without purpose acutely enough: "If he is to accept this message in its full significance, man must at last awaken from his primeval dream to discover his total solitude, his radical strangeness. He knows now that, like a Gypsy, he must live at the edge of the universe, a universe deaf to his music, as indifferent to his hopes as to his sorrows and his crimes."³⁰ Monod would have men awaken to their somber isolation, even though he can offer them no easy release. For him, man is not a pilgrim but a gypsy. And yet, as we saw in Nietzsche's passionate outburst, there is a sort of homecoming, a sort of release in the awakening to a knowledge that this is, once and for all, it. If this is despair, it is not desperation.

AMBIVALENT POTENTIAL

Monod's title phrase, *Chance and Necessity*, has meaning on several levels. There was, to begin with, the necessity, the inevitability, that all evolutionary development be by chance and the specific chance that within that necessity a self-replicating genetic mechanism (DNA) might develop. The odds against this were incalculable, but a single chance occurrence was enough to create the necessity of continuing replication. Within that necessary process of replication, there were further chances that man would evolve, would discover the postulate of objectivity, and would in time apply it to himself. Finally, there was the chance that man, having perceived the necessity of his condition, would have the courage not to retreat from it.

The sweep of Monod's conception is undeniably stunning, and yet there is one matching of chance and necessity which he fails to explore; namely, the chance that his own best perception of the universe—his natural philosophy—may be radically inadequate, *alongside the necessity that he act as if it were adequate*.

The perceptions of all living beings are characterized by the phenomenon of threshold: sound above a certain pitch cannot be heard by the ear of a given species, touch below a certain weight cannot be felt, etc. That the human brain is subject to similar limitations must be regarded as likely a priori, though not demonstrable except by analogy. A genius perceives the intelligence of ordinary men straining at its limits. A zoologist perceives that sensors and cameras, though not concealed, are not comprehended by the chimpanzee she is observing. Moreover, the genius cannot explain to his ordinary friend, nor can the zoologist explain to the chimpanzee, *why* they do not understand, for to appreciate the difference, the limited would have to transcend his limits, mooting the original problem.

The logical response to a situation in which the serious possibility of inadequate perception can itself be perceived is to wait, to remand all activities other than the struggle for perception to such time as an adequate perception may be possible. Unfortunately, the body is not a logical but a physical proposition. The chimpanzee can only spare a few moments to scratch his head and gaze at the sensor. At the end of those brief moments, he fits the sensor into the best available perceptual category and scurries off to hunt for food. The situation of the human brain *may* be radically different, and yet great thinkers invariably have spoken as though they had had to turn to bananas before the answer came. In one sense, then, the necessity which hampers perception is simply the pressure of physical existence. More exactly, however, the necessity is the felt need to make some practical sense of the whole even when no logical sense can be made. We may name religion any response to this need.

Monod's "chance" then must be not only *le hasard* of his science but also *le pari*, "the gamble," of Pascal's religion. Pascal gambled on Catholicism, but it would be inaccurate to say that he chose to play the Catholic game. Catholicism was not the game but only one of the moves, a play within the game. The game was the game of complete rationalizations on the basis of incomplete perceptions, and *everyone* was playing, even those who would "bracket" every assertion and make their daily practical choices on purely aesthetic criteria; theirs too is a complete rationalization. Pascal would have won his gamble not only if, after death, he "woke up" to find the redeemer awaiting him but also if, still alive but dying, he could judge in retrospect that his choice had been the best one possible for living out his years. The skeptical aesthete could validate his decision in the same way. And of course, either could remorsefully conclude that he had been mistaken, as a starving chimpanzee might feel remorse as he watched another starving chimpanzee steal a few more days of life by eating the sensor that the first had categorized as inedible. To put it another way, religion is not absurd but a response to the absurd. Everyone of necessity makes some kind of response, and there is never more than a chance that it is the right one.

Monod seems to have a constant implicit awareness of these exigencies and yet to resist making them explicit. Explicitly, he regards religion—or the tendency to make religion—as an essentially temporary social expedient which, however, by natural selection has become part of the genetic code:

The invention of myths and religions, the construction of vast philosophical systems are the price man has had to pay to survive as a social animal without succumbing to pure automatism. However, no purely cultural heritage would be sure or potent enough in itself to hold up the social structure. That heri-

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tage required a genetic ally which would turn it into the nourishment required by the spirit. . . . The need for total explanation is innate.³¹

As a geneticist, Monod cannot expect that any mere discovery about man's genetic heritage could enable man in short order to disregard it. The capability of *Homo sapiens* to mate at any time may also, like religion, be the result of natural selection and, like religion, may now be contraindicated by changing circumstances; and yet its refusal to be overruled was the hard lesson of the Victorian era.

Short of genetic engineering, no response to changing circumstances can hope to fly in the face of the genetic code. It may have been in his awareness of this that Monod attempted to derive a complete "natural philosophy" from his biology, to forge a "new covenant" to replace the old. Unfortunately, the bias of the scientific tradition against the word "religion" ("covenant" is evidently less offensive) seems to have prevented him from quite taking charge of his own task.

It was perhaps the chief contribution of Freud to point out how the unconscious repression of sexuality had distorted the pattern of European civilization and maximized rather than minimized sexual discontent. There was no escaping a good measure of sexual repression, he conceded, but taking thought, men could contrive to manage the sad matter as humanely as possible. They had first, however, to stop acting as if sex were a nastiness and an embarrassment that might eventually disappear if only the well-educated would persevere in their refusal to speak of it.

During the past three hundred years, a parallel expectation grew up that religion would disappear, replaced by a logically positivist science that would be in fact what the various religions had only been in inspiration. During this lengthy period, science gained converts whose "image of the world's construction" was outstandingly the image of a world comprehensible by objective observation, that is, by observation which sought correlations rather than explanations based on cause and purpose. They did not yet understand the world, but they confidently expected they would. Like Jews awaiting the messiah, they had little but the belief that one day they would have everything. Their program for conduct was the perfect reflex of their image of the world: perseverance in research. However, neither their image of the world as finally comprehensible nor their determination to persevere in research could be described as proven or provable on their own terms, nor did the multiplying marvels of technology offer more than rhetorical grounds for its defense. These were, like the miracles of Jesus, not proof of claims but only "signs" of a greater

miracle still to come; for the worshippers of Jesus, this was the apocalyptic "Second Coming"; for the devotees of science, the definitive rationalization of human life by objective observation.

It is the inherent fragility of science qua religious vision which explains the hostility toward religion (as distinct from the mere rejection of it) on the part of many natural scientists. To invoke an old religion was, by implication, to revoke the promise of the new. Saint Paul was scandalized that his Christians were bringing suit against one another in the civil courts when the Second Coming and the Final Judgment were just around the corner. In their action, they abandoned their own faith and threatened his. It may be that recourse to religion is to the promise of science as recourse to the Roman courts was to the promise of Christianity. The older institution in either case was expected to pass away as a great promise was fulfilled. Neither promise was fulfilled, and both institutions survived.

In itself, neither of these apostasies was subjectively beyond enduring, but neither was, for that matter, altogether inevitable. The recognition of faith as faith and the loss of faith are, potentially, the same act, but they are not necessarily the same. There are many who still await the Second Coming, and there may be many whose faith in the promise of science is equally unshakable.

Chance and Necessity has therefore an ambivalent potential. By bringing the religious, gratuitous character of science as a total vision of life so close to full consciousness, Monod will—as a Kierkegaard to this new faith—destroy it in some adherents. In others he will, again like Kierkegaard, strengthen it. Either way, the magnitude of the task in hand and the extent to which it has been discharged appear best when the new religion is compared without embarrassment to the old.

NOTES

1. George Steiner, review of Jacques Monod's *Chance and Necessity: An Essay on the Natural Philosophy of Modern Biology*, trans. Austryn Wainhouse (New York: Alfred A. Knopf, Inc., 1971), *New York Times Book Review*, November 21, 1971, p. 5.

2. Jacques Monod, *Le hasard et la nécessité* (Paris: Editions du Seuil, 1970), p. 92. Though I have translated cited passages, page references are to the French edition. Where I judged the rhetorical force relevant to the point under consideration, I have included the original in a note.

3. *Ibid.*, p. 102.

4. *Ibid.*, p. 110.

5. *Ibid.*, p. 131.

6. *Ibid.*, epigraph, quoting Camus, *Le myth de Sisyphe*.

7. *Ibid.*, pp. 92-93.

8. *Ibid.*, p. 92.

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9. Clifford Geertz, *Islam Observed* (New Haven, Conn.: Yale University Press, 1968), p. 96.

10. Monod, p. 189.

11. *Ibid.*, p. 191.

12. Some would prefer to say that the result is existentialist philosophy, and the choice is obviously made simply by defining terms. However, in regarding "religion" as the plainer term and "existentialism" as a kind of veil, I have the support of Sartre in the honesty of his old age. He writes in his autobiography, *The Words*: "As I was both Protestant and Catholic, my double religious affiliation kept me from believing in the Saints, the Virgin, and finally in God Himself as long as they were called by their names. But a tremendous collective power had entered me. Lodged in my heart, it lay in wait. It was the Faith of others. All that was needed was to rename its customary object and to modify it superficially" ([New York: George Braziller, 1964], p. 250; emphasis added).

13. Monod, p. 190.

14. As quoted in Robert H. Pfeiffer, *A History of New Testament Times* (1949; reprint ed., Westport, Conn.: Greenwood Press, 1972), p. 133.

15. Stephen Toulmin and June Goodfield, *The Architecture of Matter* (New York: Harper & Row, 1962), p. 315.

16. Monod, p. 161. Empirically, the metaphor has something in common with Heidegger's famous *Verworfenheit*, but how different is the mood!

17. *Ibid.*, p. 181.

18. Émile Durkheim, *The Elementary Forms of the Religious Life*, trans. Joseph Ward Swain (London: George Allen & Unwin, 1915), p. 2.

19. Monod, p. 127: "Il s'ensuit nécessairement que le hasard seul est à la source de toute nouveauté, de toute création dans la biosphère. Le hasard pur, le seul hasard, liberté absolue mais aveugle, à la racine même du prodigieux édifice de l'évolution: cette notion centrale de la biologie moderne n'est plus aujourd'hui une hypothèse, parmi d'autres possibles ou au moins concevables. Elle est la seule concevable, comme seule compatible avec les faits d'observation et d'expérience. Et rien ne permet de supposer (ou d'espérer) que nos conceptions sur ce point devront ou même pourront être révisées."

20. Translation by James Wilson in James B. Pritchard, ed., *The Ancient Near East: An Anthology of Texts and Pictures* (Princeton, N.J.: Princeton University Press, 1958), p. 229. Reprinted by permission of Princeton University Press.

21. Monod, p. 155.

22. *Ibid.*, p. 173.

23. Gunther Stent, "An Ode to Objectivity: Does God Play at Dice?" *Atlantic* (November 1971), p. 130.

24. Lao Tzu, *The Way of Life: A New Translation of the Tao Te Ching*, by R. B. Blakney (New York: New American Library, 1955), p. 47.

25. Sisyphus pushing his stone up the hill of Hades parallels Christ carrying his cross up the hill of Calvary at least to the extent that neither complains. One who is finally convinced that there is no divinity that shapes his ends, no world soul, no just purpose within the universe, cannot logically complain: there is no one to receive the complaint. Starting from very different premises—namely, from Jesus' command that his disciples bear the cross as he would—the Christian also loses the right to complain. Joseph Campbell, understanding religion as the celebration of heroism, defines the hero as "the man of self-achieved submission." Though narrower than Geertz's definition, Campbell's self-achieved submission seems to cover not only *Sisyphus heureux* and Jesus the Lamb of God but also Monod and Buddha. It is least adequate, however, for Judaism; for Judaism has made complaint—whether in the Lamentations of Jeremiah, the impatience of Job, or the irony of Tevye—a central religious category. It is this category which most massively resists incorporation into a scientific restatement of religion, not only because for science no one exists to receive such complaints but also because the ideal which stimulates a protest or a project can never be objectively known. The knowledge, for example, that the human brain is an evolutionary exag-

generation of the sort which in documented parallel cases has proven fatal to the species does not, scientifically, generate anything more than an estimate as to how long the human species is likely to last. To go beyond that to a program of eugenics or genetic engineering requires a value judgment that the death of man should not take place. Such a refusal to live with the facts as they are, such an ambition to change them, though not necessarily antiscientific, is surely unscientific. If it is not tampering with the evidence, it is at least longing for different evidence. Since a similar refusal and a similar ambition within a religion of submission would be judged morally wrong, one suspects that Western civilization has developed its prodigious technology not because Western religion was more worldly or world accepting than Eastern religion but precisely for the opposite reason. Technology then would be the marriage of the objective knowledge of the Enlightenment to the complaining attitude of Judaism as it survived in Jews, Christians, and Muslims.

26. Stent (n. 23 above).

27. *The Song of God: The Bhagavad-Gita*, trans. Swami Prabhavananda and Christopher Isherwood (New York: New American Library, 1951), pp. 47–48.

28. Monod, p. 185: "On comprend alors pourquoi il fallut tant de millénaires pour que paraisse dans le royaume des idées celles de la connaissance objective comme seule source de vérité authentique."

29. Friedrich Nietzsche, *Twilight of the Idols*, trans. R. J. Hollingdale (Baltimore: Penguin Books, 1968), p. 54.

30. Monod, pp. 187–88: "S'il accepte ce message dans son entière signification, il faut bien que l'homme enfin se réveille de son rêve millénaire pour découvrir sa totale solitude, son étrangeté radicale. Il sait maintenant que, comme un Tzigane, il est en marge de l'univers ou il doit vivre. Univers sourd à sa musique, indifférent à ses espoirs comme à ses souffrances ou à ses crimes."

31. *Ibid.*, p. 183.