

LIFE, HOPE, AND COSMIC EVOLUTION

by Harlow Shapley

CHEMICAL KINSHIP

Atoms of oxygen are sixteen times as heavy as the hydrogen atoms of which the material universe is largely built. Like all atoms, those of oxygen are very small—there are trillions in every breath we take. They are the fuel and fire of life. If we should cease taking in oxygen for a few minutes, we would be through. Composed of eight protons, eight neutrons, and eight electrons, the atom of oxygen is most sociable, forming chemical combinations with all sorts of atoms, such as carbon, sulphur, iron, titanium. We are two-thirds oxygen. The average adult embodies 100 pounds of this important constituent of oceans, rocks, and air. We eat oxygen, we drink it, and we breathe it. In lesser amounts, we contain atoms of carbon, hydrogen, nitrogen, calcium, and many others. They are the same kinds of chemical elements that make up the Rocky Mountains, the pine forests, and the seashores. We are indeed of the earth, earthy. Through chemical ties, we are kin of the glacial boulders and the thunderclouds, and close cousins of the fossil plants and beasts that in times past took a try, as also do we, at biological existence and persistence.

It is with this appreciation of our animate and inanimate brotherhood that I address you oxygen aggregates on the greatest theme I know—Cosmic Evolution.

MAN'S PLACE IN THE WORLD

Let us review the situation of mankind in the presently recognized physical universe. When our killer-ape ancestor, of a couple million

Harlow Shapley is an astronomer recognized for his pioneer exploration of the Milky Way and the other galaxies outside it. It was he who first discovered that our sun is far out from the center of our galaxy. For more than thirty years he was director of the Harvard College Observatory. But his bold imagination and scientific information have been mingled in a great humanitarian heart that has made him also a pioneer in many enterprises of science in the service of man, including the Institute on Religion in an Age of Science, of which he is a past president and perennial promoter. He edited and brought out a volume of its papers entitled *Science Ponders Religion* (New York: Appleton-Century-Crofts, 1960). The present paper was delivered at a recent conference of the Institute, and it overlaps in part with sections of his *The View from a Distant Star* (New York: Basic Books, 1963).

ZYGON

years ago, battered in the skulls of the baboons in the search for brains, and otherwise disported himself in African caves and jungles, it is reasonable to surmise that his philosophical thoughts rarely rose above the primal ponderings about food, shelter, and procreation. He had little need for ruminations concerning the meaning of life. His sense organs and the interpreting brain were not attuned to ethical systems of the kind we know. He lived an ape life, in an apo-centric universe.

The recent emergence of societies among the higher primates, however, has made meditation advisable for survival. Evolving man began to think co-operatively and defensively. He began to observe phenomena beyond the cave, the camp, and the village. He found that much of the universe lies beyond the immediate horizons. His cosmos was at first a lococentric universe with the home camp at or near the center. As the world population grew and the early philosophers resorted to thought and hypothesis, based on many strange observations, doubts naturally became widespread. There was some doubt that Athens, let us say, was really the center of the universe. The Geocentric Hypothesis emerged: the theory that the earth was the center of the observable universe.

This geocentrism was a natural deduction from observations of the motions of sun, stars, and planets. They clearly appeared to move from east to west across the sky around the earth, which itself seemed to be fixed, solid, and steady. But more and better observations gave trouble to this Geocentric Hypothesis. Many adjustments of the theory had to be made. A new theory of a rotating earth revolving annually around the central sun appealed to some of the more daring Greeks and others. Eventually, in the middle of the sixteenth century, the Copernican interpretation gained ascendancy. Geocentrism slowly died.

The relegation of earth to second place in the astronomical hierarchy was not fatal to human vanity. Our sun-centered family of planets seemed to have a central position in the universe of thousands of stars, and to man that was important. The sun sent light and heat to the precious planet earth. That operation naturally seemed to give both earth and sun high significance in the universe. Although it was soon found that the sun is just one of the stars, not impressively big or outstanding in its radiation power, the Heliocentric Hypothesis prevailed for nearly four centuries.

Human vanity, which had suffered a rather vigorous blow when the center of things was moved from earth to sun, received a greater

shock from the discovery a few decades ago that heliocentrism also had to be abandoned as a cosmology. The center of our wheel-shaped galaxy was found to be some one hundred and fifty million billion miles from the earth. The sun and its planets were found to be peripheral, far off center in a stellar organization in a galaxy that contains more than a hundred thousand million stars. An equally shattering discovery revealed that there are billions of other galaxies.

In view of these unquestioned discoveries about the universe, supplemented by knowledge that the over-all system of galaxies is expanding at a terrific rate, where shall we locate man? What is his place in the material universe?

Now that man's cosmic investigations have revealed a physical universe that dwarfs the one known a century ago, he has something of which to be proud, and before which to be humble. His reach outward has been multiplied a million-fold; and in the other direction, toward the amazingly minute, he has opened in the world of atoms a microcosmos of dazzling complexity. Should man not now abandon his primitive beliefs about his spot in space and time, his one-planet religion and one-planet deity? Should he not ask for a re-orientation—a religious philosophy that encompasses the newly known, and which is not continuously in retreat? Perhaps the traditional concept of deity should be abandoned entirely. In any case, should we not look deeply and sympathetically for religious beliefs that conform with scientific beliefs and that grow with science?

Truth and rationality in religion as well as in science will eventually prevail, I believe, if religion is to survive among thinking men. There must be an accelerated religious evolution or revolution to correspond with our accelerated scientific evolution. Creeds that are based only on the world picture of many centuries ago will no longer suffice. Are not many of our religious beliefs fossilized? Should we not continuously modernize? Here I put this matter as a simple but basic question—a rhetorical question. Continually our eyes are opened wider, our depth of vision is increased. We see that stars evolve, planetary surfaces like our own change with the flowing of time. We see that primitive plants and elemental animals develop through the ages into complicated organisms, including those with high sensitivity to the environment. Man, too, has evolved and so have his social organizations. Why, then—this is my question—why should we not expect the great growth urge that runs through the universe to include the growth of man's groping philosophies? The answer is that we do expect it. Even evolution itself evolves.

ZYGON

COSMIC EVOLUTION AND GOD

Before we proceed to further thoughts on cosmic evolution, I shall interpolate some brief but significant remarks about Tulsa, Oklahoma. In 1962, you may remember, there was a gathering in Oklahoma of several groups and unattached individuals of the Radical Right. Some were politically ardent; some religiously passionate. One individual was rich in oratory, and his fervid arguments were recorded and later repeated on a television program. He insisted that his ever present and eternal guide in all matters was the Almighty. Everything for him was referred to that high authority. He sought help in making all decisions. For example, should he make the long trip to Tulsa in Oklahoma? Naturally he asked God, and reported the result *verbatim*: "Charlie," God had said, "Charlie, go to Tulsa." Friendly, just like that, collaborative, sort of palsy-walsy with the Almighty.

Tulsa is symbolic. Should I go to Tulsa? What is my duty? How can I find out? Can I call upon a one-planet deity for a correct decision? Perhaps I should worry a little about the implications, about the multitudinous demands on the deity, not only demands from the two billion primates on this planet, but perhaps the demands from the billions of supplicants on each of a billion other planets. Perhaps the truth about reality and about duty requires some greater effort and responsibility on our part.

Good evidence that religious teaching can evolve from naïve to more sophisticated levels comes to us, for instance, from Rome. A few years ago the pope made an epochal address in opening a session of the Vatican Academy of Sciences. In that address, the pope went along with modern physical science in detail. He made a very good analysis of current atomic science. The age of the earth was noted as a few thousand million years. Atomic transmutations were described, scientific methodology was endorsed, and relativity theory accepted. This address seems to me to indicate an important adjustment of a great religion to the developing knowledge of the world and of man's place in it.

Cosmic evolution is my central theme. Anthropomorphism and anthropocentrism are false images of reality and man's place in it. If we could accept cosmic evolution, and could get away from the more primitive projections of our own images, religions and philosophies would be richer and truer. By anthropocentrism I mean the state of being personally blinded by a presumption of our own cosmic importance—a belief in the existence of a universe centered on the terrestrial genus *Homo*. Once we are free from that man-centered illusion, our minds

can roam over a universe that, in size, power, and meaning, puts our traditional vanities to modesty if not to shame.

This week in a thousand churches—perhaps ten thousand—solemn men have arisen in public to make or read prayers of a vain character—not simply expressions of gratitude for friends, health, and sunsets; not simply searching of the heart and mind for better pictures of the world and man's duty in it; but greedy supplications for special favors in support of unexamined wishes and prejudices. Fancy that! Asking, in the interest of a few feeble primates on one small planet, that the Lord of the Universe give special service to their preconceived and possibly misguided wishes.

Let us remember that the views of the world and the rulebooks (bibles) of most of the established religions were compiled at a time before we knew much about what we now know of the universe, or much about what we now know of the foibles and mental quirks of man. At that time we were quite uninformed in the field of psychology, as well as in physics, chemistry, geology, and anthropology. We are still not overwise in these fields, but our present knowledge is far advanced compared with that of the ancient tellers of the "holy tales" and the ancient writers of the "holy writs."

Although it may not seem to you to be a full definition of God, it is to many quite satisfying to equate Nature and God. My phrase, now too well known, that "All Nature is God and all God is Nature," is a pantheistic statement that is, I believe, completely operatable. A shorter version is "Nature is God and God is Nature." Still shorter, and deeply meaningful, is: "Nature is All." That last presents the essence of Natural Piety.

MEDITATIONS ON COSMIC EVOLUTION

Let us contemplate this Nature a bit more. The basic entities of the universe are commonly recognized to be space, time, matter, and energy: the first two can be linked together as space-time, and the others as mass-energy. It is difficult to think of any universal quality that is other than these four. Speed, weight, light, distance, momentum, and the like are all derivatives or combinations of these four, or are not universal like space, time, matter, energy. But is there not some additional entity, a fifth one that would be necessary if you had the assignment of creating a universe? How about vague abstractions like Drive, Direction, Original Breath of Life (administered by the Almighty), or Cosmic Evolution?

ZYGON

That last, Cosmic Evolution, may be a fifth entity which we would need for understanding a dynamic universe.

The word and idea Evolution commonly awakens thoughts only of evolving plants and animals, nothing else. It suggests changes in the biological world—for example, the wolf-to-dog ploy, the grass-to-grain development, the man-and-monkey business. For a century, however, scientists have been aware of an evolution beyond that concerned with the biological kingdoms. They have seen that volcanic action and the oxidizing of lava indicate that this planet's surface changes with time. The earth's atmosphere has evolved from hydrogen to oxygen abundance, and the variety among stars has indicated stellar evolution. For half a century, we have realized that the simple fact that our sun is shining is evidence that it is steadily losing mass-energy (a loss of four million tons a second), and therefore that it evolves. Similarly, starshine must mean stellar evolution—a much mightier operation than we can point to among the animals and vegetation of this small planet. It is only a short step from stellar evolution to galactic evolution.

For the present we shall accept Cosmic Evolution as a fifth entity, but we must not stop there. We shall lean toward metaphysics (that dangerous swamp) and reach for a most basic and permeating entity that is not co-ordinate with the other four, but should be regarded as an even more basic and permeating entity—the one without which all else is a vague nothing—that is: existence! We could go deeper than existence and ask, why does existence exist? But I believe the answer to that query is in the realm of the unknowables and will probably remain there because of the relatively poor equipment that man must use in his effort to comprehend the universe.

To those vague thoughts I shall return later. Meanwhile, I should report that the concept of an all-including Cosmic Evolution has had in recent years strong support from our new knowledge of the natural evolution of atoms. For thirty years we have been aware of the synthesis of helium from hydrogen, and the accompanying release of the energy that operates solar and stellar radiation.

Beyond the hydrogen-into-helium transformation is there further evolution of atoms? Evolution of the matter of the universe? The answer is affirmative. With the help of the gravitational shrinkage of stars which produces phenomenal heat, and with the contribution of the extremely high temperatures of the explosive novae and supernovae, we now have glimpsed the picture of how the hydrogen and helium evolve into the heavier elements—evolve into oxygen, calcium, iron, silver, gold, and uranium. *All* the chemical elements, all matter, we

now believe, has evolved, and is currently evolving, from the simplest and lightest of atoms—from hydrogen.

Thus we have evidence of a truly wide Cosmic Evolution from hydrogen to *Homo*, and probably somewhere an evolution beyond the *Homo* level of sentience. We have in Cosmic Evolution a fundamental principle of growth that affects the chemical atoms as well as plants and animals, the stars and nebulae, space-time and mass-energy. In brief, everything that we can name, everything material and non-material, is involved. It is around this Cosmic Evolution that we might build revised philosophies and religions.

There are many mysteries involved, unsolved problems along the way, but curious man may solve more and more. He may eventually learn, or guess, the parentage of the hydrogen that has as descendants atoms of all kinds, molecules of myriad varieties, organisms unlimited, and man. In our cosmographic survey, we start with the mystical hydrogen in space-time and finish with the hominid species that we vainly call *sapiens*. Yes, a deep mystery at the beginning, and lesser ones along the way up; but let us always remember that supernaturalism is not required, nor miracles, in the emergence of protoplasmic life. Cosmic Evolution naturally takes care of such matters as the origin of life. The progression is clear and rational throughout the whole course—atoms to stars to cells to man; *only* at the beginning and the end is there rather hopeless unclarity, for there still remain the aforesaid vagueness and mystery concerning the origin of hydrogen, the destiny of the universe, and the reason for its existence.

HUMAN DESTINY

The destiny of man is not a lightsome topic, for us at least. In the world of protoplasmic organisms, man is an outstanding performer. The civilized variety of man is forever looking back over its shoulder (history, we call it), and sometimes looking timidly far forward (hope). Man seems to be unique in this respect. The tree and flower apparently do not bother about ethical principles. The beast and the bug appear to have no far-distant goals that differ from those they had in the Pliocene. They live a routine pattern; their programs are clear. Individual survival through self-defense, physical continuity and growth through the ingestion of familiar foods, propagation of offspring in the interest of survival of the family and species—these are the facts and acts in the life struggle of the bees and flowers.

But man, while sharing with other organisms some vital drives, has got himself into a transcendence where eating, drinking, and scratch-

ing are not necessarily major inspirations. He sometimes seeks distant goals that involve more than his immediate bodily comfort. The enlarged frontal lobes of his brain have brought with them new variations on the character patterns we call charity, altruism, and mutual respect; and also brought new variations on the character patterns we call greed, mendacity, distrust, and similar less happy qualities. These are human qualities, or at least they are more strongly manifest in imaginative man than in the less thoughtful and less scheming animals.

But how far are we, the higher Hominidae, really superior beings? Let us again look toward some of the horizons that have been altered by the explosive advances of science and see if our new cosmic orientation supports *the superiority thesis*. The ants, bees, termites, and wasps are social animals of great antiquity that have developed many morphological and behavioral specialties, including the establishment of effective and co-operative societies some forty million years before man appeared on this planet. Then, as now, they practiced the higher social virtues and developed some of the most intricate technologies. Altruism, co-operation among individuals, and patriotism are natural to scores of different kinds of the hymenopterous insects. Some of them know and use community sanitation, air conditioning, anesthesia, birth control, fungus culture, and of course the making of wax, honey, and paper. They have long displayed numerous talents to which man has only recently attained.

These astonishing social developments, which came about long before nature devised the higher primates out of a humbler past, should be kept in mind when we contemplate the heights to which biological evolution may have gone on the livable planets scattered throughout the universe. And we must be open to the belief that high developments can occur elsewhere. They probably parallel the biological developments on this planet's surface, for we find the same chemistry in distant galaxies as in our own, the same responses to gravitation, the same relationships among matter, energy, space, and time. The nature and operations of physics and chemistry are apparently the same everywhere. Therefore, we expect to find, wherever our telescopes lead us, the same sort of biochemical reactions when the physical conditions permit the existence of organisms. Whatever life exists elsewhere should be similar to the life here—similar in pattern and quality. But elsewhere there may have been more time for some phases of biological evolution, or more propitious characteristics of life-giving, life-producing environment, to the end that high life could then go higher, perhaps much higher, than anything we know here.

Returning now to life on the earth, we should note that our effectively evolved social insects seem to be fixed in grooves, with little prospect of early escape from the rut of conformity to the goals laid out in the chemistry of their genetic structures. We Hominidae also seem to think in grooves. Although our brains and our cultures provide us with the possibility of exploring more rapidly outside our established grooves, the question is: Do we? Certainly human individuals and cultures change the grooves in which they operate much faster than do the ants. But, we might ask another important question: Do we always do it better?

On this planet we are now dominant and dominating among fellow creatures, but there is nothing to strut about in this situation. We are dominant only in this current Psychozoic era; the giant lizards were dominant in the Mesozoic era a hundred million years ago; the cockroaches, in the preceding Permian period; and the trilobites two hundred million years earlier.

These comparisons, moreover, orient mankind only with respect to the life forms on this one planet. We should broaden our views regarding life by forsaking for a few moments this earth and its thin superficial infection of protoplasm. We can then search for biological developments beyond our atmosphere. Acting as your agent in computation and analysis, I find the probabilities are extremely high that there is life elsewhere. Perhaps I say that too dogmatically, but it is with the same assurance that I say, without visual checking, that iron is in the middle of the earth, that hydrogen atoms are wandering in intergalactic space, and that there is snow on mountains of Tibet that I have never seen. Deduction is sometimes quite as convincing and reliable as ocular recording. Yes, life elsewhere, but specific primates like *Homo*, very unlikely.

It is getting to be common belief that there are numberless planets suitable for the emergence of life. Our sampling indicates that there are more than a hundred thousand million billion stars in the universe, and the number of planets may not be much less. If only one star in a trillion had a planet that harbors highly developed life, there would be a hundred million of them. Life is widespread and evolves out of the lifeless as a natural product of Cosmic Evolution. Evolution must have produced elsewhere forms that excel anything that this planet can show.

EARTH'S PSYCHOZOIC ERA

As every anatomist knows, man is physically primitive in many respects, and in other respects rather dangerously specialized. His physio-

logical oddities (brains, for example) may erase him suicidally from the earth. His clinging to the past keeps him, most of the time, at the animal level—food, fight, shelter, procreation. His present reaching for heaven and the stars may disconnect him from his animal sources of strength. He will need new sources adequate for his new ways of life.

We recognize in the animate world two kingdoms—animal and vegetable. Are they the only organic kingdoms that can be produced on this planet? On remote and more suitable planets, there may be life forms other than plant and animal—other major kingdoms of life. But have we not right here on earth the beginning of a third major category—the Psychozoic Kingdom? I know it is a weak vanity, almost anthropocentrism, to sort out *Homo sapiens* and say that he differs so much from oysters, spiders, and chimpanzees that he merits a kingdom of his own—that we can justly set up for him a separate set of natural laws, much as we can separate the rules for plants from the rules for animals. But vanity and hopeful wishing aside, the evidence is good that the fore-brain—our large time-binding cortex—is of high consequence in the animate world and perhaps justifies the separate classification.

We cannot draw a sharp boundary that separates man from fellow animal. Certainly we humans developed from simpler, less thoughtful organic forms. The series is continuous from lowest algae to highest primates. But what may be beyond? The future must be persistently exploited. Perhaps we are on the way to the establishment of a Psychozoic Kingdom, where brain overshadows brawn, and scientific rationality overshadows prescientific beliefs and animal instincts. As the free-moving animals outdo the anchored, sunshine-sucking plants so do we free-thinking humans outdo our ancestral animals, anchored to their instincts.

I have almost brought myself to the point of believing that man is important in the universe. But I hope you will keep in mind that this psychozoic development—this glorification of the human psyche, this rising dominance of mind, which seems now to be blossoming among the higher primates on this planet—that this development has probably long been attained in other inhabited worlds. To advance further toward hoped-for goals, it is clear that our emphasis in a program for life should turn away more and more from the animal—turn, shall I say, toward the angelic. If you are allergic to angels, turn then toward the spiritual—spiritual, broadly spoken.

Where and why does religion come into the cosmic picture? Is it one of the rewards and penalties of human societal organizations? Or is it

merely a product of the restless human mind? The anthropologists report that all tribes, including our own, have religions of some sort. Religion seems to evolve with questioning brains and new social requirements. Curiosity breeds explanatory hypotheses or beliefs. Human brains or minds require at least hypothetical answers to questions that concern them. Historical evidence suggests that religious beliefs came before scientific beliefs in providing hypotheses about the nature of the world and man's place in it. The beliefs about the customs or laws of the spirits and gods explained to earlier men what it is they are required to do to have the best of life.

But can we have better beliefs today? I have already suggested that the scientific pictures of Nature, the Nature which the sciences reveal, are the best or most reliable explanations that we have. I have suggested that even for the sciences there are many mysteries and unknowns at the frontiers of our hypothetical explorations and explanations. We do not yet know very much about our own nature and nearly nothing about the ultimates of existence; but we do and seemingly ever can know more about the inclusive Nature that produced us and presumably produces even higher patterns of life elsewhere in the evolving cosmos. For us higher primates at the forefront of living systems on earth, perhaps the best guide for the life we hold dear may come from a closer search for the potentialities which this inclusive Nature may hold for us. Perhaps it is to this larger Nature we should put our questions as to whether to go to Tulsa or elsewhere.

Reverence for life is the wide-ranging religion of Albert Schweitzer. Cosmic Evolution requires my reverence to include more than life: to include the whole natural world. Life arises out of the inanimate world; why not revere also the amino acids and the simple proteins from which life emerged? Or, why not go all the way and avow reverence for all things that exist, all that is inanimate as well as that which is animate, all that is touched by Cosmic Evolution, and reserve the greatest reverence for Existence itself?