

# TAOISM AND BIOLOGICAL SCIENCE

*by Raymond J. Barnett*

*Abstract.* The seemingly disparate systems of philosophical Taoism and modern biological science are compared. A surprising degree of similarity is found in their views on death, reversion (cyclicity of phenomena), complementary interactions of dichotomous systems, and the place of humans in the universe. The thesis is advanced that these similarities arise quite naturally, since both systems base their knowledge upon objective observation of natural phenomena. Substantial differences between the two systems are recognized and examined regarding verbal argument, machinery, and experimentation. The Taoists' relationship to Chinese alchemy and the biologists' to technology are claimed to mitigate their attitudes toward experimentation.

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At first glance, one could hardly imagine two more disparate systems than Taoism and the biological sciences. The former arose in China and is ancient; the latter developed in the West and is modern. Taoism contained strong traces of mysticism; biological science is material and logical. The sages of the former spent their days in mountain retreats and disdained verbal communication; biologists spend their days in laboratories and crank out endless scientific papers.

Western discussions of Taoism emphasize its radical departure from Western approaches to reality. Huston Smith, for example, after tracing the ways in which "modern science and a penchant for the physical are only the most evident examples of the West's urge to posit objects everywhere, to confer on everything she encounters the form and existence of external entities," feels he must "cut out of Western civilization completely" to find in Taoism a viable alternative to the West's scientific "impersonal truth, objective knowledge, and its view of reason as dividing and controlling" (Smith 1972, 70, 72).

I wish to contest the notion that Taoism and the biological branch of modern science, at least, represent starkly contrasting and irrecon-

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cilable systems. My thesis shall be that Taoism and the modern biological sciences, for all their apparent differences, have a good deal in common. In fact, I will claim that they have independently arrived at views which are similar in their essential features and that this similarity is not coincidental but rather quite understandable. First, the two systems will be briefly defined and described. Then, several aspects of Taoism will be examined and their analogues in biological science considered. Next, an hypothesis as to why these similarities exist will be advanced. Finally, the similarities will be put in perspective by commenting upon the considerable differences between these two systems.

#### HISTORICAL OVERVIEW

Several lines of evidence indicate that Taoism developed during the Neolithic period in East Asia and survived into the historical era as a relict philosophy, doubtless undergoing considerable change in the process (Needham 1956, 2:100-5; von Gulik [1961] 1974, 3-9). The first written expositions of the Taoist philosophy are traditionally ascribed to the sixth century B.C., but modern scholarship prefers the fourth and third centuries B.C. as their most likely time of origin (Needham 1956, 2:33-38; Smith [1958] 1965, 197-216). These centuries were among the most chaotic and intellectually fertile in China's long history. With the disintegration of the central authority of the Zhou (Chou) "dynasty" in the seventh and sixth centuries B.C., warfare between the many small states became more and more frequent. The appearance in the early fourth century of low-grade steel weapons (able to take and hold fine cutting edges) and the crossbow (able to shoot heavy arrows "which would have made collanders of Greek or Macedonian shields"), along with the rise of standing armies commanded by professional soldiers, created a society in which "successive generations were decimated with methodical regularity, and war became a 'Fundamental Occupation'" (in the words of Long Shang, Prime Minister of the state of Ch'in, which would finally unite all of China) (Griffith 1963, 23-24). The incessant warfare, intrigue, and social change of these centuries brought forth one of the greatest flowerings of philosophy in human history: Confucianism, Mo-ism, Legalism, and the Taoism expressed in the *Tao Te Ching* and the *Chuang Tzu*. The discussion of Taoism in this essay will be based only on the contents of these two books and will focus on philosophical (or contemplative) Taoism (Creel 1970), which adheres more closely to the original formulation of Taoism contained in these two texts than do religious Taoism and esoteric Taoism.

Philosophical Taoism holds that an underlying pattern of harmony and order characterizes all of existence. This pattern is termed the Tao,

a cosmic principle which is inherent to all objects and processes in the universe and which confers upon them their distinctive features.<sup>1</sup> The flow of the Tao through the world can be seen in the distinctive patterns of nature. Human beings, by turning away from the Tao, bring suffering and chaos into their affairs. By being aware of the Tao's flow a person can link up with the underlying principle of the cosmos and achieve wholeness.

Taoism proffers a view of humans as inextricably natural beings, with the capacity, at least, to align themselves and their society with the natural force which pervades and structures the entire universe. The Taoist insistence that humans are part of the natural world gives rise, in Smith's words, to a "concentric vision, the vision of society set like a stone in nature, and nature set similarly in the deep repose of eternity" (Smith 1972, 77).

Modern biological science has coalesced in perhaps the last ten or twelve decades. The publication in 1859 of Charles Darwin's *Origin of Species* and in 1878 of the great French physiologist Claude Bernard's *Lectures on the Phenomena of Life* can arguably (albeit arbitrarily) be said to have ushered biology into the modern scientific mode. The distinguishing aspects of biological science, as indeed of modern science in general, are the material view of reality, mathematical models, the experimental method, and a skeptical attitude (Bronowski & Mazlish 1975, 186-89, 491-93). The goal of biological science is to understand how living systems work; the motivation is often curiosity. The biology in the discussion which follows is simplistic but not inaccurate.

#### THE PLACE OF HUMANS

What do Taoism and biological science have in common? To begin, consider their views of the place of humans in the world (and universe). Taoists consider humans to have arisen from natural processes and to have no particular importance or grandeur beyond that of other creatures. "You were born in a human form, and you find joy in it. Yet there are ten thousand other forms [creatures] endlessly transforming that are equally good, and the joy in these is untold" (*Chuang Tsu*, 123).<sup>2</sup> Taoists are said by Confucius to "consider the body as an accidental arrangement of different elements" (*Chuang Tsu*, 135). (Note here that this very same criticism is levelled by fundamentalist Christians against evolutionists some 2500 years later!) Human values and perspectives are placed in a relentlessly relative framework by Taoists.

Everything has its own nature and its own function. Nothing is without nature or function. Consider a small stalk or a great column, a leper or a beauty, things that are great or wicked, perverse, and strong. They are all one in Tao (*Chuang Tsu*, 30).

If a man sleeps in a damp place, his back will ache and he will be half-paralyzed. But does this happen to eels? If a man lives up in a tree, he will tremble with fright. But does this happen to monkeys? Of these three, who knows the right place to live? . . . Mao Chiang and Li Chi were considered beautiful by men. But if fish saw them, they would dive to the bottom of the river. If birds saw them, they would fly off. If deer saw them, they would run away. Of these four, who recognizes real beauty? (*Chuang Tsu*, 40).

When a carpenter thinks meanly of a misshapen tree, the tree appears to him in a dream and says, "You and I are both things. How can one thing judge another thing? What does a dying and worthless man like you know about a worthless tree?" (*Chuang Tsu*, 82).

This Taoist view of the place of humans in the universe is quite similar to the view arrived at by biologists. Fossil evidence, anatomical and biochemical homologies, and the discoveries of geneticists convince most biologists that humans are related to other apes quite closely and to all other living things in general. Studies of other animal societies reveal that we have no monopoly on tool use, complex social roles, learned behavior, or symbolic language.<sup>3</sup> Our physical and also mental forms and capabilities are largely the result of material forces of natural selection working through genetic change, according to biologists. Human values and capabilities make sense for humans, given our ecological and social setting, but other "values" and capabilities work best for other creatures in other ecological and social settings.

Just as the Taoist and biological views here are similar, so do both groups stand against similar opposing viewpoints in their respective societies. The Confucians of ancient China, and many religious and humanist groups today in the West, are convinced that humans are fundamentally different and inherently superior to other life forms. Values are not relative and are not present in spontaneous nature, according to these people; human values are the only values (certainly the only values that count).

The dynamic behind this perceived place of humans in the natural world is, of course, the process of organic evolution. Several of the major points of evolution are echoed by Taoists. The role of the environment in directing evolutionary change through the natural selection regimes it exerts on populations of living creatures is reflected in the Taoist assertion that "All things arise from Tao. They are nourished by virtue. They are formed from matter. They are shaped by environment" (*Lao Tsu*, 51). The grand procession of constant extinction and appearance of species which has characterized the array of life on this planet is suggested by the phrase quoted above which mentions the "ten thousand other forms [creatures] endlessly transforming" (*Chuang Tsu*, 123). The proliferation of life forms on the

planet from some ancient common ancestor is perhaps mirrored by the words "The Tao begot one; one begot two; two begot three; and three begot the ten thousand things" (*Lao Tzu*, 42).

#### REVERSION

A second Taoist view that is echoed in biological science is the concept of reversion (Needham 1956, 2:74-83). According to the Taoists, the world works in cycles with things returning (reverting) sooner or later to the beginning point. "The ten thousand things rise and fall while the self watches their return. They grow and flourish and then return to the source. Returning to the source is the way of stillness, which is the way of nature" (*Lao Tzu*, 16). "Returning is the motion of the Tao" (*Lao Tzu*, 40).

Two disciplines within biological science have arrived at views similar to reversion. Ecologists have determined that most elements in the world pass through a cyclic system of movements. Nitrogen, for example, passes from soil to plants to animals and, through decay, back to soil in a well-studied cycle (which is actually two linked cyclical processes, since the element may flow from the atmosphere into the soil, and then back to the atmosphere from the soil, due to the action of micro-organisms). This cycle operates relatively smoothly and functions by means of the activity of a host of living creatures (from bacteria to carnivores) and organic chemical processes (Krebs 1978, 579-82). (The Taoists were well aware of certain aspects of the nitrogen cycle, and its illustration of a common aspect of natural systems, for we read that "when the Tao is present in the Universe, the horses haul manure" [*Lao Tzu*, 46]. That is, humans are participating in the grand cycling movement typical of the Tao by loading manure [human and animal] onto carts in the city and having their horses haul it back to the countryside to be put into the fields and subsequently reincorporated into crops.)

Physiologists have established that a cardinal principle reflected in the functioning of organisms is the automatic return to a set point whenever conditions deviate a certain amount from that set point. The result of this recurring return to an optimal point (or, usually, optimal range) is termed homeostasis. Bernard first emphasized the centrality of homeostatic processes in the functioning of a healthy body. For example, a decline in blood pressure in the arteries is picked up by pressoreceptors located in the carotid sinus and the aortic sinus. These in turn are connected to the autonomic nervous system, which signals the heart to beat more rapidly and the smooth muscles in the walls of the arterioles to contract. Both these responses will raise the blood pressure back to the preferred point. An increase in blood pressure

above "normal" will trigger the opposite response, so that pressure is continually reverting back to the optimal point. Similar homeostatic systems exist for nutrients, respiratory gases, waste products, acidity, osmotic pressure, and temperature (Landau 1976, 7).

#### YIN-YANG COMPLEMENTARITY

Third, the Taoists thought nature operated largely through the complementary interaction of two suites of properties. Although the Taoists were not the only Chinese to use the concepts of Yin and Yang, it was central to the Taoist outlook and the development of the Taoist philosophy (Needham 1956, 2:273-78). The Taoists saw properties and objects such as heat, light, aggressiveness, sun, and masculinity as somehow associated in a grouping they termed Yang. On the other hand, they saw coolness, darkness, receptivity, earth, fecundity, and femininity as associated in a grouping termed Yin. The world works through the interaction of Yang and Yin properties in a complementary process, in which Yang and Yin wax and wane, contributing varying proportions in different times and in differing creatures. Yin and Yang are commonly pictured as contributing to a circular spectrum or continuum, as in the familiar Yin-Yang Symbol (see fig. 1). Note that the two are connected by a meandering curved line and that each contains the other within its own core. A key point here is that the Yin properties and Yang properties are *not opposites* of each other and are not contradictory or exclusive. They are, rather, *complementary*, and can and do coexist (in varying proportions) within a given creature or system. "Know the strength of man, but keep a woman's care. . . . Know the white, but keep the black. . . . Know honor, yet keep humility" (*Lao Tzu*, 28). "The ten thousand things carry yin and embrace yang. They achieve harmony by combining these forces" (*Lao Tzu*, 42).

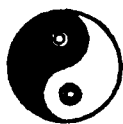


FIG. 1—The Yin-Yang symbol.

It is a mistake to view the Taoist view of Yin-Yang as anything more than a *model* of reality, a conceptual aid to understanding reality. Yin and Yang are concepts, not actual physical entities or processes. The Taoist would abhor any attempt to force a crude and literal meaning on these terms. Nor would a Taoist be comfortable with an insistence that certain objects or processes "are" Yin and others "are" Yang. Yin and Yang are parts of a spectrum, a continuity. Objects or processes that are

performing a Yin role today may perform a Yang role tomorrow. From reading the texts that use Yin and Yang, one is reminded of the way scientists describe the behavior of subatomic particles: you can say some things about these particles, but only if you realize that what is said is a statistical probability statement and that a certain modicum of uncertainty is a fundamental characteristic of talking about the system—and may indeed be a fundamental characteristic of the system itself. In a similar vein, the Taoists can speak of Yin attributes and Yang attributes, but they would never try to force all phenomena into either a box marked “Yin” or one marked “Yang.” Such an attempt would reveal to them a basic misunderstanding of how one goes about understanding reality as well as a basic misunderstanding of how reality in fact works.

The crux of the Yin-Yang model is not that there are two opposing “camps” to reality but rather that reality is structured by the complementary interplay of forces and objects and that these forces and objects can often be conceptually pictured as grouped in two assemblages called Yin and Yang.

Biologists often find they can best describe natural processes in terms of two interacting systems, which frequently possess similarities to the Yin-Yang model. The autonomic nervous system, an extremely complex association of neurons involved with (usually) involuntary control of bodily processes, is divided into the sympathetic and parasympathetic subsystems, each with its own circuitry, neurotransmitters, and types of effects on various organs (Landau 1976, 266-74). And like the Yin and Yang, both systems affect most organs, with the state of the organ being a function not of one system being totally “off” and the other totally “on” but rather of the current balance between the activity of both systems, with each able to change its input and alter the balance.

Ecologists speak of the evolution of organisms governed by r-selection or by k-selection, that is, selection for competitive ability or selection for productivity. Selection pressures may change, and a k-selected species may “switch” to an r-selected “strategy” (Pianka 1978, 267-68).

Biopsychologists have discovered that the human cerebrum functions as two interconnected halves. The left half specializes in sequential, analytical thought processes, language, time processing, and control of the right half of the rest of the body; the right half specializes in Gestalt-type, intuitive thought processes, art, music, spatial processing, and control of the left half of the rest of the body. Several psychologists, most notably Robert E. Ornstein, have commented on the remarkable parallels between this division of properties in the human brain and the division of properties in the Yin-Yang model (Springer & Deutsch 1981; Ornstein 1972).

The current biological understanding of sex is also congruent in many respects with the Taoist Yin-Yang concept. The division of organisms within a species into male and female individuals for purposes of reproduction is of course present throughout the plant and animal kingdoms (although there are certainly other forms of reproductive systems utilized by living creatures). The male sex has more mobile and active gametes and, in animals, generally displays more aggressive behavior. The female has more stationary, receptive gametes and, in animals, is generally less aggressive.

Cross-cultural studies indicate the presence within the human species of stereotypic average physical and mental differences between males and females. For example, relative to males, female humans on average exhibit lower infant mortality, less aggressive and far-ranging play behavior, smaller size, less muscle bulk, a cyclical (rather than tonic) reproductive physiology, higher voice level, more efficient energy utilization, earlier and richer development of language skills, more difficulties in learning mathematics, and higher longevity (Crook 1972; Benbow & Stanley 1983). As always, controversy exists as to what proportion of these differences are due to biological influences and what to cultural influences, but I will claim that as our understanding increases, our estimate of the sphere of influence of the biological factors is steadily increasing. We now know that the brains of males and females not only function differently in several respects but are also structured differently, so that a neuroanatomist has recourse to several criteria by which he can distinguish male and female brains.<sup>4</sup>

Just as the Taoist views Yin and Yang as complementary and as poles of a continuum, so modern biological science has come to understand that sexual identity (both biological and psychological) is also capable of a surprising and considerable amount of variation in between the typical male and female poles. Consider first the sex chromosomes. A typical female has two X sex chromosomes while a typical male has one X sex chromosome and one Y sex chromosome. Many variations on this pattern occur, however. Some humans have only one sex chromosome, the X; they are "female" but undergo no breast development, no widening of the hips, no pubic hair, and are sterile. Other humans have two X sex chromosomes plus a Y; they are "males" but undergo no development of the testes and are sterile. Other humans have an X and two Y sex chromosomes; they are "male," tend to be tall, have lower than average intelligence, and may be predisposed to develop violent behaviors in certain environments (Plotnick & Mollenauer 1978, 107-8). The X, XXY, and XYY sex chromosome patterns are, of course, "abnormal," but this term merely denotes that they (and the traits they engender) occur at much lower frequencies than the predominant ("normal") patterns.



Even with a “normal” sex chromosome pattern, the level of specific hormones in the developing fetus may lead to indeterminate sexual traits. For example, a genetic female (XX) may be born with male-like external genitalia if her adrenal cortex secretes an androgen-like hormone during fetal development—an “abnormal” occurrence that does occur sometimes (Plotnick & Mollenauer 1978, 110).

In the area of sexual preference it is particularly difficult to separate biological from cultural influences; undoubtedly both are present. Here, especially, there is a very considerable degree of variability between the “typical” poles of male and female heterosexuality, including functional asexuality, homosexuality, and bisexuality (Plotnick & Mollenauer 1978, 114).

Even the dot of Yin within the fullest expanse of Yang has its counterpart in human sexuality: witness the appreciation in many cultures for the touch of gentleness in the virile male, and the female whose femininity is enhanced by the ability to assert herself when the occasion demands it.

In many areas of biological research, scientists have learned how fruitless an “either-or” approach can be, in which one explanation must be correct to the exclusion of another. Instead, in the face of experimental evidence, they frequently have been forced to adopt the Yin-Yang sort of view, in which various explanations are viewed not as opposed and exclusive but rather as complementary. The “nature-nurture” debate is one good example, as is the controversy among ecologists whether competition or predation structures biological communities (Schoener 1982). Another, more specific example of the adoption of a complementary viewpoint is the study of long-distance navigational ability in birds. For decades researchers debated whether birds orient by the sun, by magnetism, or by some other undiscovered system. The new series of experiments led some researchers, including William T. Keeton, to wonder if complementarity in cues might be the key to understanding the phenomenon. In the words of a colleague of Keeton:

Such findings led toward a new philosophy of orientation research. Prior to such discoveries, workers had been seeking a unifying, single-cue theory to explain homing behavior. Keeton emphasized that birds can use multiple sources of information; that there is great redundancy in animal orientation systems. . . . Differing hypotheses about cues used in orientation came to be viewed not so much as conflicting, contradictory models—but more as mutually complimentary [*sic*] pieces in the same master jigsaw puzzle of navigation behavior. Attention began shifting away from arguments over the merits of one cue system versus another, and toward questions such as: Is there a hierarchical nature to the different components of orientation behavior? If so, does it change with the age and experience of the bird? Does it also change with changing meteorological conditions? Or at different geographic locations?

How do different cue systems come to be calibrated one against the others? And how do the different components of orientation behavior develop during the individual ontogeny of a given bird? (Emlen 1981, 169).

It should be noted here that the adoption of a complementary view, such as the Yin-Yang model espouses, has led to better science, that is, to an understanding of this specific phenomenon which appears to correspond better with what is actually happening. It should also be stressed that in all these examples—the autonomic nervous system, r- and k-selection, right and left brains, nature and nurture, competition and predation, and orientation behavior of birds—the elements in the phenomena seem to be interacting not in an antagonistic, either-or mode, but rather as complements of the other, as varying intercept points on a continuum, just as the Taoists pictured reality.

A common Western misunderstanding of the Yin-Yang model is that the model insists that reality is rigidly dichotomous. The misunderstanding perhaps reflects an approach to reality present in many phases of Western philosophy, the erection of antagonistic categories (e.g., good/evil, male/female, mind/matter, form/content, carnality/spirituality).<sup>5</sup> Such an approach is contrary to both philosophical Taoism and to modern biology. A Taoist would object to this approach on the grounds that Yin and Yang are not fixed, and indeed are not categories. All objects and processes are comprised of blends of Yin and Yang. And the objects and phenomena clustered under the rubric of Yin (or Yang) have no particular material commonality, no discrete distinguishing physical—much less causal—connections with each other. They merely all represent entities which can fruitfully be thought of as occupying one pole of the continuum of reality. The standard Yin-Yang representation of the circle with Yin and Yang curling against each other throughout the circle actually gives an excellent intuitive impression of the Taoist approach.

Biologists similarly recognize that biologic phenomena are not fruitfully thought of as falling into dichotomous sets of antagonistic categories. It will suffice to point out that, while many phenomena can be productively approached by conceptualizing them as the result of the *complementary* interaction between two aspects of the phenomena, clearly there are phenomena that are more fruitfully approached by thinking of more (or less) than two processes in conjunction. As a matter of fact, most phenomena are surely the result of a myriad of factors interacting in a variety of ways. Perhaps thinking in terms of two sets of factors interacting complementarily merely has the advantage of making many phenomena relatively easily understood by the human mind. I would think that neither the Taoist nor the biologist would object to this formulation. And I would suggest further that this con-

ceptual framework results in part from a compromise between the complexity inherent in reality and the complexity able to be contained within the human brain that is trying to make sense out of reality.

## DEATH

Fourth, the Taoists view death as an integral part of the natural process, not as an unnatural event or an enemy of life. "Life arises from death, and death from life" (*Chuang Tsu*, 29). Lao Tze advises a cripple who has just been rebuffed by Confucius, "Why don't you simply make him [Confucius] see that life and death are one thread, the same line viewed from different sides—and thus free him from his cuffs and fetters" (*Chuang Tsu*, 101).

Biologists too view death as an essential part of the process of organic change that includes life. Without death, new life and new life forms could not occur. Those who study biogeochemical cycles find that death and the subsequent decay of organisms are prerequisite to cycling the elements necessary for new life to arise. Nitrogen, for example, revolves from life to decay to the earth and back to life again in a perpetual cycle (Krebs 1978, 579-82). Life arises from death, and death from life.

This view of the role of death in natural processes of course affects one's view of human death. The Taoists refused to view death as a calamity, unlike the Confucians, or even to fear death. Death was simply another transformation. Some of the Taoist texts indicate plainly that they were not sure what happened after death but that they certainly were not going to dread it.

How can I tell if love of life is not a delusion? How can I tell whether a man who fears death is not like a man who has left home and dreads returning? Lady Li was the daughter of a border guard of Ai. When the Duke of Chin first took her captive, she wept until her dress was soaked with tears. But once she was living in the Duke's palace, sharing his bed, and eating delicious food, she wondered why she had ever cried. How can I tell whether the dead are not amazed that they ever clung to life? (*Chuang Tsu*, 45).

In other instances the Taoists simply seemed to accept death as the end of one's existence as a personality. Note that this calm acceptance of the cessation of one's existence is not predicated on an afterlife, as in the Christian or Muslim traditions. "The true man of old knew nothing about loving life or hating death. When he was born, he felt no elation. When he entered death, there was no sorrow. Carefree he went. Carefree he came. That was all. . . . He accepted what was given with delight, and when it was gone, he gave it no more thought" (*Chuang Tsu*, 114). When Lao Tze died, a friend came to the funeral, yelled three times, and left. When questioned whether this was properly somber

behavior for a funeral, the friend said, "The Master came because it was time. He left because he followed the natural flow. Be content with the moment, and be willing to follow the flow. . . . In the old days, this was called freedom from bondage" (*Chuang Tsu*, 59).

Although biologists likewise seem to be divided on their approach to human death, it is probably safe to say that the majority either accept death as the end of one's personality or simply confess ignorance as to what might happen. Most neurobiologists likewise would probably claim that the study of the human brain has yet to reveal any properties (such as a "soul") that cannot be ascribed to very complex interactions of suites of neurons, even though those interactions are as yet very imperfectly understood.

#### BASIS FOR SIMILARITIES

This brief survey has shown that in several important respects Taoism and biological science seem to have come to similar views. Why is this so? Several possibilities might account for this. For example, it may be that the classical texts of any philosophy or religion are simply so voluminous, so full of references to various phenomena, and so frequently obscure in their meaning that by picking and choosing adroitly one can cull phrases that seem to indicate similarities between that philosophy and nearly anything else, especially if the difference in definition of the same word as used in disparate disciplines is ignored. This criticism might be levelled, for example, against Fritjof Capra's *The Tao of Physics* (1976), in which he claims to show that modern physics is constructing a model of the universe which was independently arrived at several millennia earlier by many Eastern religious and mystical systems (including Taoism, hence the title).<sup>6</sup>

The situation I describe differs from Capra's in several respects. First, my scope is diminished: only one Eastern religion or philosophy is treated here, instead of a conglomeration of Hinduism, Buddhism, Chinese thought, Zen Buddhism, and Taoism. Second, only one aspect of that one philosophy is being considered: the original germ of the philosophy, philosophical Taoism. The later embellishments of this original stance are consciously excluded, as is the richly variegated popular religion which grew from it beginning in about the third century A.D. Third, the source texts of philosophical Taoism are marvelously few, terse, and abbreviated in stark contrast to the texts of Hinduism and Buddhism (and Christianity and Islam, for that matter). In particular, the four areas examined in some detail here represent the mainstream of thinking in philosophical Taoism and not minor sidelights of the philosophy. (This is not to claim that I have covered all

the key tenets of philosophical Taoism; I have omitted reference to *p'u*, *wu wei*, and *Tz'u*, all important to philosophical Taoism.)<sup>7</sup>

If the seemingly disparate systems of Taoism and modern biology exhibit many similarities, what factor has given rise to this curious phenomenon? Let us return to the source texts for the answer to the question, Why is this so? "How do I know the universe is like this?" asks Lao Tzu in the *Tao Te Ching*. The answer follows directly: "By looking!" (*Lao Tzu*, 54). Here we come to the basis for the remarkable similarities between Taoism and biological sciences: at root, their methods are the same. Biological science bases its knowledge upon careful observation of the biological elements of the world. Careful, empirical observation is the root of biological science. Even in the "experimental" method, what the biologist is doing is observing a situation in which (hopefully, only) one variable differs from the "control" situation he is also observing. But unbiased, objective observing is the crux of the matter. And the *Tao Te Ching* claims that this, too, is its method. "By looking." By looking with a clear, unfettered mind, at that: "There is nothing like using restraint. Restraint begins with giving up one's own ideas" (*Lao Tzu*, 59).

The Taoists were people of the woods and mountains, and the urban gardens and parks. They spent a great deal of time simply sitting by streams or wandering through forests. The Southern School of Chinese landscape painters, especially, have pictured them over many centuries of superb paintings quietly and attentively observing streams from a hut or walking with a sharp eye and ear among groves of trees or bamboo: in nature, and alert to its features. "The ancient masters were subtle, mysterious, profound, responsive. The depth of their knowledge is unfathomable. Because it is unfathomable, all we can do is describe their appearance. Watchful, like men crossing a winter stream. Alert, like men aware of danger" (*Lao Tzu*, 15). The Taoists knew the natural world intimately. Throughout the *Tao Te Ching* and the *Chuang Tzu* biological metaphors and allusions recur again and again.

A man is born gentle and weak. At his death he is hard and stiff. Green plants are tender and filled with sap. At their death they are withered and dry (*Lao Tzu*, 76).

Chuang Tze replied, "Have you ever watched a wildcat or a weasel? It crouches close to the ground and waits for its prey. Then it leaps up and down, first one way, then the other, until it catches and kills its prey" (*Chuang Tzu*, 17).

My dependence is like that of the snake on his skin or of the cicada on his wings. . . . Once upon a time, I, Chuang Tze, dreamed I was a butterfly flying happily here and there, enjoying life without knowing who I was. Suddenly I woke up and I was indeed Chuang Tze. Did Chuang Tze dream he was a butterfly, or did the butterfly dream he was Chuang Tze? (*Chuang Tzu*, 48).

Do you know the story of the praying mantis? . . . Do you know how a tiger trainer works? He knows when the tigers are hungry and when they are full; thereby he is touch with their fierce nature (*Chuang Tsu*, 78).

Just as Taoism and the biological sciences share a common mode of gathering information upon which to build a view of reality, so they also share a common ultimate source of knowledge. In cases of contrasting views, the deciding judgment comes not from a book, nor from a person, nor from a supernatural being. The final arbiter is the phenomenon itself. The biologist goes back to the field, or back to the bench, and looks at the phenomenon again, using perhaps a new stain or new experiment. The Taoist goes back to the natural world and patiently, calmly watches the flow of the stream and the steady progression of seasonal changes. Reality itself, carefully observed, is the source of knowledge and the final arbiter in both these systems.

In passing, it should be noted that the careful observation of natural phenomena pursued by Taoists and scientists implies an underlying philosophical stance of appreciation for an inherent value in the non-human world. This stance, which is expressed in Chinese gardens and landscape painting as well as by modern biologists in conservation groups, is in stark contrast to the typical anthropocentric attitude that "man is the measure of all things" and "the proper study of mankind is man." These considerations will not be adequately discussed here, however, inasmuch as a serious consideration of them would require another essay altogether.

#### DIFFERENCES

The thesis of this essay is that remarkable similarities exist between ancient Chinese Taoism and modern Western biological science and that these similarities are, upon reflection, not surprising, since both systems of thought rely heavily upon careful objective observations of the natural world. Having presented the evidence for these claims, it now remains to point out that Taoism and biological science are certainly not similar in all respects. Indeed, they differ markedly in some important ways.

*Verbal argument.* Taoists dislike argument and mistrust people with verbal facility. "Those who know do not talk. Those who talk do not know" (*Lao Tsu*, 56). "Truthful words are not beautiful. Beautiful words are not truthful. Good men do not argue. Those who argue are not good" (*Lao Tsu*, 81). Most scientists, on the other hand, relish spirited exchanges of opinions, either verbally or in print. They use the "peer review" system to judge grant requests and articles for publication. The most interesting section of scientific journals is the "Notes"

section containing critical comments on previously published articles. It is out of this climate of (sometimes unbridled) criticism of each other's ideas that scientific advances occur.

*Machines.* Beyond this dislike of words and those who use them well, Taoists also dislike machines and harbor deep suspicions of those who use machines. The *Tao Te Ching* describes the ideal country as follows. "A small country has fewer people. Though there are machines that can work ten to a hundred times faster than man, they are not needed. . . . Though there are boats and carriages, no one uses them. . . . Men return to the knotting of rope in place of writing" (*Lao Tzu*, 80). Needless to say, this aversion to machines is not found in the biological sciences where machines are seen as boons to expand our range of observations. Indeed, it is impossible to conceive of modern biology independent of the array of microscopes, oscilloscopes, spectrophotometers, centrifuges, analytical balances, calorimeters, and myriad other machines which have opened up worlds of observation and modes of quantification virtually closed without them. To a large degree, the story of modern biological science is the story of the invention of the machines used in its explorations.

*Simplicity.* The above quotation also illustrates the Taoist love of simplicity. Biological science adheres to Occam's Razor, the principle that, when several explanations adequately account for a phenomenon, the simplest is preferred. To that extent simplicity is preferred in biology. To "adequately account" for a phenomenon, however, often demands complex explanations. Indeed, as the structure and function of biological phenomena are explored further and further, we discover more and more complexity. Life itself, it appears, is an extremely complex phenomenon. Correspondingly, the description and testing of explanations of life have required more and more complex mathematical and statistical models. Indeed, much of the challenge and the pleasure in doing research in the biological sciences lie in uncovering and charting the complexity of life.

*Experiments.* Another very important difference between these two systems is in the area of experimentation. Although it is true that objective observation is the crux of biology, the most powerful use of this act is when the observation of one situation is compared with the observation of another situation identical to the first except in one respect—that one respect being the experimental variable. By thus manipulating the phenomenon under observation, the effect of the variable may be induced.

Experimentation is not synonymous with modern science, since other factors are also present (e.g., mathematical models, a material view, and a skeptical attitude). Thus some sciences (e.g., astronomy) and some branches of biology (e.g., taxonomy and systematics) make less use of the experimental method than they do of nonmanipulative observation. Yet it can be said that the experimental method is the most powerful use to which observation may be put in modern science and that the most dramatic breakthroughs in our understanding of the natural world have come about because of the experimental method of observation.

In philosophical Taoism, on the other hand, there is no mention of the experimental method, much less an expressed understanding of its power in the discernment of natural processes. Indeed, there is an unmistakable sense of distaste for human manipulation of the natural world. "Do you think you can take over the universe and improve it? I do not believe it can be done. The universe is sacred. You cannot improve it. If you try to change it, you will ruin it. If you try to hold it, you will lose it" (*Lao Tzu*, 29). When they expressed these sorts of strictures, the Taoists were not thinking only, or even primarily, of the efforts of evil, manipulative men to change and control the world for their own nefarious aggrandizement. The honest, sincere, goodly efforts of men to change and control the world were just as distasteful to the Taoists. To their way of viewing reality, the world was of consummate worth just as it was, and any attempts to wrench it into some other configuration would inevitably sully it, regardless of the motive behind the wrenching.

How does the experimental method of modern science relate to this Taoist view? The commonly accepted notion that the two are somehow at odds with each other is basically correct, I believe. Taoism sees the universe as sacred and attempts to change it as misconceived, whereas biology sees the world as material and manipulates it incessantly. Yet, it is important to realize that this contrast is not nearly so clear-cut or stark as may be believed. Close examination of the position of each system reveals that they contain mitigating factors pertinent to the supposedly opposed tenets of the other. Specifically, I will argue in the following two sections that experimental manipulations of biological science are concerned not with changing the world so much as discovering the natural laws governing the world (in *Science and Technology*) and, on the other hand, that the historical record reveals that Taoism was not as a matter of fact unalterably opposed to experimental manipulation (in *Alchemy in China*, although admittedly, perusal of the historical record of Taoism takes us beyond our hitherto strict concern with only the *Tao Te Ching* and the *Chuang Tzu*).



*Science and technology.* Every biologist has a different precise blend of motivations for doing science. Yet, in my experience, and based on the writings of other scientists, there is no question but that intellectual curiosity and esthetic pleasure rank very high among the reasons we “do biology.”<sup>8</sup> And while a desire to change the world for the better may be frequently cited in public, and especially when requesting funds to support research, this motivation is not actually an overriding one to most biologists, in my judgment. Science is a slow, incredibly tedious, usually penurious undertaking (see Blonston 1984). Most people zealously intent upon changing the world choose other fields, such as politics, social work, or, in unstable countries, the military. A sheer, at times rather childlike (although hopefully not childish) curiosity is the overwhelming motivation for doing biology; a desire to change the world is not really what brings scientists back to the lab late at night or back out into the field when it is wet and cold there.

It is not contestable that the world *has* changed because of science, with still more radical and deadly change an all-too-present possibility. These changes are not science, though, but a by-product of the application of scientific discoveries by the technological sphere. Lynn White, Jr. points out that it is only since circa 1850 that natural science and technology have joined forces (White 1967). And the extent of their “union,” in my judgment, is popularly exaggerated. Many scientists share Nobel laureate Salvador Luria’s “vaguely uneasy feelings about technology”: “I do believe in the potential beneficial uses of technology wisely applied but do not like the science-and-technology marriage celebrated by university presidents in search of funds and by technocrats in search of power. I recognize the need to sell science to the public through technology just as one must sell novels through advertisements, and yet I wish one could let science grow on its own momentum while carefully screening the technology that science makes possible” (Luria 1984).

*Alchemy in China.* Examining now the Taoist side in more detail, experimentation was a very important pastime of perhaps the most widespread and long-lived “school” of Taoism—the alchemists. The alchemical movement began in China in the first several centuries B.C. and was associated with the immortality cult which focused on the powers obtained by ingesting gold or even eating with gold utensils. Alchemy persisted as an active pursuit in China well over a thousand years, with the alchemists invariably being Taoists. The only extant collections of alchemical works, in fact, are found within the Taoist Patrology, the *Tao Tsang*. In the alchemical treatises it is clear that the practitioners’ motivations were twofold: to achieve immortality (or at

least to prolong youthful life) and to better understand the flow of the Tao as revealed in the chemical reactions. Nathan Sivin puts the matter as follows. "It is profoundly typical of Taoism that the alchemist did not seek control of process in order to change it, but merely to bring about material mutation at a rate so accelerated that he could observe it from start to finish. This is the point of an extraordinary passage in an early medieval work: 'Natural cyclically transformed elixir is formed when mercury, embracing lead, becomes gravid. Wherever there is cinnabar there are also lead and silver. In four thousand three hundred and twenty years the elixir is formed'" (Sivin 1968, 38).

Sometimes the Chinese alchemists sound surprisingly "scientific." Consider the skepticism toward accepted beliefs and the emphasis on personal, "hands-on" experimentation contained in the following excerpts from the *Tan Ching Yao Chueh*, an alchemical treatise of the prominent seventh-century Taoist physician Sun Ssu-mo.

I have personally tried the several alchemical formulas compiled here; there was not the slightest discrepancy in the results. I have furthermore given full directions. Following them will bring sure success. . . . The two-part reaction vessel must be plastered with six-one lute. . . . [Detailed directions follow.] This luting of the two-part reaction vessel with six-one lute is quite durable; what need is there to [further] plaster the vessel with earth? Admixture of sugar is the old method, but it has no practical effect. What if it be old? Not knowing something is a situation in which there is no distinction between modern and ancient times. That the ancients were worthy is quite true, but they were not rigorous in this matter, and in most cases were unable to understand its principles (quoted in Sivin 1968, 150, 167-68).

Thus, although it is certainly true that the Chinese alchemists had no firm grasp of the scientific method as it was developed in the West, it can nonetheless be claimed that an understanding and appreciation of the benefits of experimentation were present in Chinese alchemy and that the preconditions for this understanding were present in the philosophical Taoism from which Chinese alchemy developed and to which it steadfastly referred.

To summarize this digression concerning the experimental method, I have argued that the Taoist aversion to attempts to change the natural order is not as starkly contrasted to the biologist's penchant for experimental manipulations as it might appear. The biologist is by and large not seeking to *change* the natural order but rather to *understand* it. And the alchemical Taoist is not above engaging in experimentation, also in order to understand the natural order (as well as to prolong youthful vigor). Seen thusly, the deep cleft envisioned by some between Western "manipulative" science and Eastern "quietist" Taoism may be deceptively shallow (Smith 1972).

## THE SIMILARITIES IN PERSPECTIVE

Lastly, it should be emphasized that, even where similarities exist between these two very different systems, they are only similarities, not identities. This essay does not argue that Taoists knew two millennia ago everything that biologists are just now discovering. Taoists knew (from close and careful observations) that cycles were common and important in natural systems. They did not know that nitrogen occurs in the atmosphere, that it is fixed into nitrate by microorganisms in the soil, that plants take it up in this form and combine it with hydrogen and carbon atoms to form protein molecules, and so forth. Taoists knew that humans seem to possess two aspects to their personalities, one assertive, rational, and verbal, the other receptive, intuitive, and nonverbal. They did not know that the former sets of properties are primarily processed by the left cerebral hemisphere, the latter by the right; nor that the brain is composed of millions of neural cells which communicate with each other by means of chemicals crossing gaps between the cells. Taoists felt that life forms on this planet were endlessly transforming and had arisen from a common ancestral origin. They did not know that differential reproductive fitness resulting from natural selection powered these evolutionary changes, nor did they wonder whether the changes occurred mainly by the accumulation of gradual minor changes (*a la* neo-Darwinism) or by sudden major changes (*a la* punctuated equilibrium). When this essay claims "similarities" then, precisely that, and no more, is intended.

Even with these caveats in mind, it is nonetheless nothing short of remarkable to find, across a seemingly vast chasm of separating time, culture, and outlook, the sorts of essential similarities in these two disparate systems. This set of similarities argues strongly for a fundamental continuity of mental processes within the human mind as well as for a fundamental continuity in the structure of biological reality. The Taoists, lacking an appreciation for mathematical models, for the systematic use of experiments (except in alchemy), and not restricting themselves to a strictly material view of the universe, did nonetheless come a surprisingly long way toward certain aspects of modern biological science by adhering to the cornerstone of that science—careful, objective observation of the natural world.

These considerations are reflected in the findings of the noted English biochemist, Sinologist, and historian of science Joseph Needham, who has shown by careful (and voluminous) scholarship (1956; 1981) that Taoism was the fertile ground out of which early science arose in China (and led early science in the West for the first fourteen centuries A.D.—but that is another story). Scientists should not be sur-

prised that others can observe closely and arrive at general views similar to the general views that arise out of science. Nor, of course, should scientists jealously reject those views as unfounded, simply because they proceed from a rudimentary stage in the development of science.

The wonder of it all is how far the Taoists did come merely by observations. When generations hence look back at us today, they will doubtless wonder at our ignorance and the incompleteness of what we thought we knew. We can only hope that some few among them will be intelligent and fair enough to realize that, for all our shortcomings, we too like them are doing our best to make sense out of our existence in a strange and beautiful world, in a way that respects the integrity and reality of that world—as were the Taoists so long ago and so far away from us.

#### NOTES

1. The character 道 (pronounced *dow*, but spelled *tao* in the traditional Wade-Giles romanization system, currently *dao* in the Pinyin system) can be translated as *way*, *path*, or *road* in a literal or a symbolic sense. Based on conversations with a Taoist master in Hong Kong and on readings of Taoist sources, it appears that the term *tao* is often used rather loosely to denote both the patterns of things-as-they-are and the force which brings this pattern about. Strictly speaking however, the force whose workings structure the tao pattern is 氣, *qi* (*ch'i* in Wade-Giles), which can be translated as *air*, *breath*, *force*, or even *spirit* in certain contexts. See van Gulik ([1961] 1974, 12) for a precise distinction between *tao* and *ch'i*, and Needham (1981, 85-106) for a discussion of the *ch'i* of the human body as conceived by the acupuncture tradition.

2. As in Stines (1985), quotations from Lao Tsu's *Tao Te Ching* will be given as *Lao Tsu* together with the stanza number. The Feng and English translation (1972) is used. Quotations from Chuang Tsu's *Chuang Tsu* will be given as *Chuang Tsu* together with the page number in the Feng and English translation (1974).

3. See E. O. Wilson (1972) and R. M. Tullar (1977, 89-91). Only for "symbolic" language is an argument still made for human uniqueness with some merit, depending on the definition of *symbolic*.

4. For a review of the well-established differences in function of male and female brains, see McGlone (1980). Regarding differences in brain structure between the sexes see de LaCoste-Utamsing and Holloway (1982) and Gur et al. (1982).

5. For a succinct overview of the types of operations which Western philosophy habitually employs, which I would claim leads to the tendency to erect antagonistic pairwise categories, see Smith (1972, 65-70).

6. Examples of the criticism levelled at Capra's notions include Ferris (1982) and Morris (1983). Roger Sperry states that "changed views of subatomic events [in physics] have been very questionably extrapolated to the macroscopic realm as well by some writers, with analogies to Eastern religion and Taoism . . . it is not legitimate to extrapolate from the nature of subatomic events to the world at large" (Sperry 1985, 48-49).

7. See Needham (1956, 2:68-71, 2:107-15) for discussions of *p'u* and *wu wei*, and Stines (1985) for a discussion of *tz'u*.

8. Nobel laureate Salvador Luria, for example, writes that "What I have liked in 45 years as a practitioner [of science] has been the problem solving and the sense of order that this generates. I like seeing patterns emerge, answers dovetail to create an intellectually simple and satisfying picture" (Luria 1984).

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