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MONISM, ATHEISM, AND THE NATURALIST WORLD-VIEW: PERSPECTIVES FROM EVOLUTIONARY BIOLOGY

A Dissertation

Presented to the Faculty of the Graduate School

Of Cornell University

in Partial Fulfillment of the Requirements for the Degree of

Doctor of Philosophy

by

Gregory W. Graffin

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BIOGRAPHICAL SKETCH

Gregory Walter Graffin was born November 6, 1964 in Madison, Wisconsin. Greg attended grade school in Wisconsin, but relocated to Los Angeles with his mother and brother in 1976 to start 7th grade. His father remained in Wisconsin, and Greg spent his summers there with his dad, brother, and grade-school friends. To this day, Greg cherishes his Wisconsin roots.

As a teenager in High School in Los Angeles' San Fernando Valley, Greg founded the seminal punk rock band Bad Religion, which, after twenty years, continues to experience widespread success and is influential to many of the most popular bands in music today.

Coinciding with his musical endeavors, Greg entered the University of California, Los Angeles in 1984 and graduated with a B.A. in Anthropology in March, 1987. Thereafter, he was hired by the Los Angeles County Natural History Museum to collect birds and mammals on an expedition to lowland rain forest in Bolivia. Greg's undergraduate work, much of it consisting of fieldwork in biology and geology in the southwestern United States, served as training for his budding interest in evolution and paleontology. On returning from Bolivia, Greg entered graduate school at UCLA. He taught comparative anatomy to pre-med students, and spent his summers in the field in Colorado, mapping geological strata and collecting fossils, which contributed to his Master's degree in Geology in 1990.

Greg's interest in evolution was challenged at a higher level when he entered the Cornell University graduate Zoology program in 1990. Greg began work toward a lab-centered research project on the Histology of Acellular Bone Tissue, using the fossils he discovered during his Master's degree fieldwork. From1994-99, Greg took a leave-of-absence from Cornell to tend to the unexpected popularity of his musical career and the demands of family life.

In 2000, Greg returned to Cornell with a new direction and renewed enthusiasm for the social implications of biology. Under the guidance of William B. Provine, his dissertation is the result of three years of research. Portions of it were

completed while touring the world with his band.

Greg currently lives in Ithaca, NY with his children, Graham and Ella, and continues to pursue his interests in music and science. After completing his dissertation, Greg plans to publish his results as a book for the general public.

To Graham and Ella,
the greatest gifts of nature in my life

ACKNOWLEDGMENTS

I took a long, circuitous academic route to the completion of this project, and I still maintain that it is merely the first part of a much larger intellectual pursuit. I thank my academic Special Committee, whose knowledge will guide me for years to come, even after this version of the manuscript is filed away in a university archive: William B. Provine, Warren Allmon, and Yervant Terzian.

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My brother Grant was the first person to suggest that I consider the infinitude of the universe, when we were very young boys. I thank him for being the first person to inspire my interest in natural science.

Finally, I thank the best teachers I have ever had, Mom and Dad. Every year I come to discover more and more of their wisdom in my own handiwork, and I realize how lucky I am to have parents of such high intelligence and deep concern for goodness.

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INTRODUCTION

Evolutionary biology has been a field divided by controversy since the publication of Darwin's theory in 1859. Historically, evolutionary biologists disagreed about the primary processes of evolution (Mayr and Provine,1980; Provine, 1985). A perpetual source of disagreement is the social implications of Darwinian theory (Segerstrale, 2000), one aspect of which, religious implications, is addressed in the current project. My study illustrates the unity of belief on religious matters among the most prominent living evolutionary biologists and hints at a common world-view to which they subscribe. The project reveals my intention to test the possibility that religion and evolution are not at war with one another, and yet they are not totally compatible; one serves as a replacement for the other.

Evolutionary thought since the time of Darwin has been a mixture of monist and dualist perspectives. The dualist tradition, stated in simple form, sees the natural world as understood by two truths: truth by revelation and truth by reason (concepts introduced in the 13th century by the Dominican theologian, Thomas Aquinas). Descartes adopted this view in the 17th century and used it to construct his famous mind-body dualism which ascribed two properties to the human brain, material properties (the physical substance of the brain) and non-material properties (the substance of the mind). According to Descartes, the substance of the brain (matter) is not causally related to the substance of the mind (mysterious, invisible stuff); the two entities have their own separate existence. In his view, the truth about the mind is supernatural while the truth about the brain/body can be determined by observing its material properties. This corresponds to Aquinas' theological conceptualization that the supernatural truths emanating from revelation (such as the "mind," or "soul") are off limits for scientific study because they are beyond reason; for they exist as

permanent mystery in the mind of god. Dualism does not prevent the study of the material world, it merely invokes the supernatural to explain what is beyond the scope of science. In the 17th century, the Cartesian mechanical philosophy (1644; Principia Philosophiae), conceived from a dualistic world-view, helped to broker a new era in western civilization, the dawn of natural history.

Dualistic reasoning became the dominant tradition in natural theology, a field originating with *Wisdom of God in the Creation* by John Ray in 1691 (Greene, 1959). This work, and the intellectual tradition it created, assumes that all natural phenomena are available for discovery, but the wisdom of an organism's design is not subject to questioning. The design is Revelation, which is the mind of God and therefore is beyond reasoning, according to natural theologians. The classic work on natural theology came roughly 112 years later, William Paley's *Natural Theology: or Evidences of the Existence and Attributes of the Deity collected from the Appearances of Nature* (1802). Paley asks us, in the opening paragraphs, to imagine discovering a watch in a field and observing it closely:

> . . . metaphysical [questions at that moment] have no place; for, in the watch which we are examining, are seen contrivance, design; an end, a purpose; means for the end, adaptation to the purpose. And the question which irresistibly presses upon our thoughts is, Whence this contrivance and design? The thing required is the intending mind, the adapted hand, the intelligence by which that hand was directed (Paley, 1846 ed. p.8).

Next, Paley, one of the great naturalists of his time, explains that nature is far more complexly designed than the most sophisticated watch, and if we examine nature closely:

> It is only by the display of contrivance, that the existence, the agency, the wisdom of the Deity, could be testified to his rational creatures. This is the scale by which we ascend to all

> the knowledge of our Creator which we possess, so far as it depends upon the phenomena, or the works of nature. Take away this, and you take away from us every subject of observation, and ground of reasoning . . . Whatever is done, God could have done without the intervention of instruments or means; but it is in the construction of instruments, in the choice and adaptation of means, that a creative intelligence is seen (Paley, 1846 ed. p.20).

The early works in natural history, typified by Paley, demonstrate the dualistic world-view in action. The material phenomena of nature are seen by dualists as the product of an underlying supernatural plan that can be neither directly studied nor ever understood.

Historically, as a philosophical position, dualism allowed theology to peacefully coexist with science. The dualist easily segregated knowledge into natural and supernatural without the challenges of unifying the two spheres. Problems arose when scientific pursuits revealed verifiable truths that conflicted entirely with traditional theological explanations. This difficulty was cleverly minimized because a dualistic perspective always allows for new discoveries, new additions to natural knowledge (Aquinas' "truth by reason"), while still retaining a belief in entities beyond the scope of traditional scientific methods (the supernatural "truth by revelation").

Charles Darwin's *Origin of Species*, in 1859, provides the earliest biological challenge to the dualist tradition. Darwin was not a fan of dualism and in fact denounced the supernatural as unnecessary to explain Ray's and Paley's "Creation."

> The old argument of design in nature, as given by Paley, which formerly seemed to me so conclusive, fails, now that the law of natural selection has been discovered. We can no longer argue that, for instance, the beautiful hinge of a bivalve shell must have been made by an intelligent being [i.e., a god], like the hinge of a door by man. There seems to be no more design in

> the variability of organic beings and in the action of natural selection, than in the course which the wind blows. Everything in nature is the result of fixed laws (Charles Darwin's autobiography (ed. Barlow), 1958 p. 87).

Darwin's beliefs were incompatible with dualism. If nature is the "result of fixed laws" and all natural phenomena are undesigned, invoking a supernatural force is useless and hence, a dualistic approach to natural history is erroneous. Despite the success of Darwinism, dualism is still a potent form of reasoning in many modern scientific works, prompting Ernst Mayr to identify it as a "plague" that has infected us ever since Descartes (Mayr, 1982, p.98).

Monism spread within evolutionary biology progressively beginning with Darwin. It is the logical philosophical antithesis of dualism. Where a dualist sees permanent mystery and limitation of knowledge in the sphere of the supernatural, a monist sees a vast universe of exploration, both microcosmic and macrocosmic, many parts of which we have not had time yet to comprehend. To a monist, all natural phenomena are the result of evolution, which entails nothing but natural law, as a creator, to explain their origin in material terms. The supernatural has no explanatory purpose.

> Just as the natural doctrine of development on a monistic basis has cleared up and elucidated the whole field of natural phenomena in their physical aspect, it has also modified that of the phenomena of the human body [, which] has been built up slowly and by degrees from a long series of vertebrate ancestors, and this is also true of our soul; as a function of our brain it has gradually been developed in reciprocal action and re-action with this its bodily organ. What we briefly designate as the "human soul," is only the sum of our feeling, willing and thinking - the sum of those physiological functions whose elementary organs are constituted by the microscopic ganglion-cells of our brain (Haeckel, 1903 p.40).

Ernst Haeckel was most ardent in his characterization of monism as the most

plausible evolutionary world-view. According to him, Coppernicus delivered the death-blow to geocentrism in 1543, and Darwin killed anthropocentrism in 1859 (Haeckel, 1894, p.15). A Darwinist, according to Haeckel, can only view mankind as a unity with nature, and hence, a dualist conception of a supernatural mind, or soul existing as separate from the material corpus, is un-evolutionary.

The impact of monistic thinking in evolutionary biology was the creation of a battle line that would forever affect its relation to traditional theology. The fundamental tenets of canonical western religion are simply incompatible with a purely monistic stance. A monist refuses "to accept the distinction usually drawn between the natural and the spiritual. The latter is only a part of the former... both are one" (Haeckel, 1894, p.4).

Although Haeckel was instrumental in asserting the uncompromising atheistic stance of monism, its philosophical roots go back to Spinoza who wrote, in 1677[1], "we are part of universal nature, and we follow her order" (Russell, 1945, p.574). Two hundred years later, Darwin demonstrated just how correct Spinoza was on this matter. Whatever the path, historically, monism was abhorrent to Christians and the idea that mankind is inseparably linked with nature is still today controversial and unacceptable to theologians.

The dualism/monism schism is a causal factor that sets up a more obvious division within modern evolutionary biology. Most evolutionary biologists are aware of the potential conflicts between their science and theology. Some think very deeply about the conflicts and their troubling implications. Others seem not to care at all, despite their acknowledgment for potential disagreement. Many evolutionists maintain

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1 It isn't clear when Spinoza's *Ethics* was written, for it was published posthumously.

that we cannot ever know the secrets of the universe merely by studying science. The result is that evolutionary biologists are polarized toward either a non-compatibilist stance (evolution and religion have mutually exclusive tenets) or a compatibilist one (evolution and religion are perfectly compatible paths to knowledge).

A bold middle ground began to materialize in the middle of the 20th century with the publications of the highly influential evolutionary biologists Julian Huxley, who wrote *Evolution in Action* (1953) and *Religion Without Revelation* (1957)[2] and George Gaylord Simpson who wrote *The Meaning of Evolution* (1949). Both saw evolutionary biology as a reasonable replacement for traditional canonical belief systems, based on the premise that science is the only path to knowledge (Bowler, 1984 p.309). Philosophers of biology are still debating the plausibility of Huxley's ideas (Ruse, 2003), many of which have been amplified and re-stated (avoiding the pitfalls of progress and purpose so common in J. Huxley's work) by E. O. Wilson (1984, 1992). Determining the degree to which Julian Huxley's and Ernst Haeckel's monistic vision is still alive in the minds of evolutionary biologists today is one of the motivations for this dissertation.

The current project is an attempt to illustrate the shared world-view of the most illustrious evolutionary biologists alive at the turn of the 21st century. The starting point of this ambition is to understand compatibilism[3] between evolution and religion.

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2 This book was originally published in 1927. The edition cited throughout this study, however, had "undergone considerable revision and alteration, notably by the substitution of wholly new chapters in place of the original Chapters 3 and 8 (preface,1957 edition)" which reflects the most developed state of Huxley's thinking on the issue.

3 The belief that two philosophical views or bodies of knowledge are intellectually compatible; in the case of this project, evolutionary biology and religion.

Generalizations about compatibilism are generated by analyzing the beliefs of living evolutionary biologists. Through careful questionnaire construction and interviews it is possible to analyze central tendencies of beliefs. The issue of compatibility itself is meaningless unless some consensus exists among evolutionary biologists on the degree to which their field is affected by traditional theology.

If obvious, agreed upon, theoretical grounds preclude mixing of theological and evolutionary tenets, compatibilism can only result from a drastic reshaping of either a religious or an evolutionary world-view. If religion and evolution are compatible, the style of the compatibilsm will be one of the following: 1. religion is considered essential to study evolution; 2. religion studies things evolution does not; 3, religion is a part of evolution, explainable as a human adaptation.

This dissertation is the report of findings and implications from a questionnaire, sent to 271 evolutionary biologists who are members of national academies of science in 22 countries, focused on revealing their world-views. The analysis is based on returned questionnaires (149 in all, a return rate of 54.9%), and on interviews with 12 prominent members of the sample group.

The earliest attempt to understand scientists' attitudes toward religious beliefs is James Leuba's famous book, *The Belief in God and Immortality, a Psychological, Anthropological, and Statistical Study* (Leuba, 1916) . A psychologist and social statistician, Leuba asked an undifferentiated group of the leading American scientists two questions, via questionnaire, about the most fundamental aspects of Judaeo-Christian faith, namely, belief in god and belief in immortality. The scientists were selected from a list in the directory of American Men of Science. Although his questionnaire was simple (only seven possible choices total for two questions), his analysis was profound. He spent 322 pages addressing the philosophical, ethical, and

educational implications of his results. This pioneering study showed the world, for the first time, the extent of disbelief, among greater[4] American scientists, in gods and in life after death. Of the biologists, 17% affirmed belief in god and 25% believed in immortality. Seventeen years later he repeated his study, using the same questionnaire, and found that only 12% of greater biologists believed in god and 15% believed in immortality (Leuba, 1934). The increase in disbelief revealed by his two studies convinced him that the 20th century would see "the churches continue to lose their already diminished influence and suffer the penalty due to institutions which remain unaltered in a changing world" (Leuba, 1934, p.300).

In 1996 Edward Larson and Larry Witham tried to demonstrate Leuba's predictions. They sent the same questionnaire used by Leuba to 1000 randomly chosen scientists listed in the American Men and Women of Science directory. The results of their study show that 39% of their sample believe in god (Larson and Witham, 1997). This percentage signifies that

> Today, many people presume that scientists are far less likely to believe in the supernatural than the general population, so religious Americans will doubtless be pleased to know that as many as 40 percent of scientists agree with them about God and afterlife (Larson and Witham, 1997 p.435).

The high percentage of belief revealed by their 1997 study, however, cannot be compared to any but the most general of Leuba's statistics because Larson and Witham did not distinguish greater and lesser scientists in their sample (American Men and Women of Science no longer uses the asterisk to denote status). This high rate of

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[4] Although Leuba (1916) contains polls and statistics for other demographic groups as well, the "greater scientists" of his study - those depicted by asterisks in the list of American Men of Science - are the people most closely matched in status to members of National Academies of Science in this study.

belief was not an accurate portrayal of the beliefs of the most highly esteemed scientists.

Recognizing this, Larson and Witham sent out another questionnaire in 1998, repeating the questions on Leuba's original, to members of the U.S. National Academy of Science in order to poll the greater scientists of today. In that study, only 7% affirm a belief in god; biologists show the lowest rate of belief in god among the entire sample. 5.5% (Larson and Witham, 1998). This finding reveals that belief in god among the top scientists in America is very low and among biologists it has dropped significantly since the time of Leuba.

The meaning of this low rate of belief is not adequately discussed by Larson and Witham. Their reports appear in the correspondence section of *Nature* which does not allow sufficient space to discuss the implications that Leuba addressed in his book. Furthermore, Larson and Withams' analysis does not address one of Leuba's most important concerns: whether the reason for declining belief, especially among greater scientists, is due to an incompatibilist perspective on religion and science. This shortcoming, and a desire to explore more deeply the complex nature of religious compatibilism among evolutionary biologists, are the major motivations for this dissertation.

Mine is the first statistical study of evolutionary biologists beliefs. My project measures evolutionists' attitudes toward religion, and analyzes the concomitant effect religious ideas have on their world-views. Evolutionary biology is at the forefront of many of society's most controversial attacks from religious factions. From the "Scopes monkey trials" of the 1920s, to the Roe v. Wade abortion rights conflict of the 1970s, to the legislative enforcement of creationism in Kansas in the 1980s, to the prohibition of stem-cell research in the 1990s, evolutionary biologists constantly assert their

scientific expertise to counter claims made by theologically minded politicians. My report follows the tradition of Leuba (1916), and it illustrates the degree to which evolutionary biologists' beliefs correspond to construct a naturalistic world-view. The foundation of that shared world-view is the amount and style of compatibilism present among the participants.

METHODOLGY

I. Creation of the sample group and construction of the questionnaire

Two hundred and seventy two evolutionary biologists from 22 countries comprise the list of possible participants used in this study (the List, Appendix II). To qualify for the List two criteria must be met: 1. The person must be a member of an elected, privileged body of scientists (a national academy) that a country's government recognizes as worthy of its highest honors. For example, in the United States this criterion applies to those who are members of the U. S. National Academy of Sciences; in England, the analogous body is called the Royal Society; in Germany, the Union of German Academies of Science and Humanities; in Sweden, the Royal Swedish Academy of Sciences; and in France, the Academie des Sciences. 2. The persons within these national academies of science must have at least one published article or book in, or list as their specific area of research, at least one of the following areas of study: evolution (specifically organismic), phylogenetics, population biology, population genetics, paleontology, paleoecology, systematics, organismal adaptation, or evolutionary genetics.

The research to compile the list consisted of browsing web pages of national academies of science. Conveniently, the Interacademy Panel[5] at the United States National Academy of Science lists 81 countries' URL web addresses. These constitute all of the known national academies in the world. Most of them list members, their research interests and contributions, and their mailing addresses. Many of the web pages, particularly those in developing countries, are not well constructed and

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[5] Address: http//www4.nas.edu/iap/iaphome.nsf?opendatabase

relatively uninformative. In those cases where members' interests were not listed, I searched the internet to find publications written by them. If the titles contained any of the search criteria (see #2 above) I added them to the List.

Many national academies around the world are primarily research academies, particularly in countries that do not have very good university systems. Most of the scientific research in these countries takes place at one campus, called the "national academy." In such cases, the members are not appropriate for this study because it is not possible to determine their honor status; it is possible that a department hired them for their possible future academic output instead of honoring them for their past achievements. Thus, in order to compile a meaningful list of the world's most highly esteemed evolutionary biologists, I stuck by rigorous criteria in order to eliminate subjective selection judgements. If a national academy in a developing country is equivalent to say a typical research institution here in the United States it is rejected. The large number of evolutionary scientists excluded by these criteria creates a highly selective sample group that rightfully deserves to be called the most highly respected evolutionary biologists in the world.

I designed a web site as the repository for the answers to the questionnaire. Every evolutionary biologist on the list (Appendix II) received an invitation to take part in the study, with a URL that could be used to answer the questionnaire online. The web site www.cornellevolutionproject.org not only records answers, but also displays the results to the public and scientific community. Every effort was made to insure anonymity for the scientists answering the questionnaire, if they desired it.

Anonymity on the world-wide web is a hot topic for discussion among internet architects, and it was an important factor in the construction of this project. Reluctance to speak about beliefs might be due to fear of being singled out as a

controversial scientist misappropriating the tools of her trade. I decided that I should create a project where one could share her views with the confidence that she would never be identified. Thereby I removed the reservation one might feel from desiring to participate in the study.

An internet specialist, Jon Luini (www.chime.com) was responsible for the technical back end construction the project's web site. He assured me that it is difficult to make a web site totally anonymous. For instance, if we want only a privileged class of people to visit our web site (those who are invited to take part in the study) we have to issue passwords. If we issue passwords, we must send them to an email address which is a unique identifier of the owner; in this case, the participants of the study. The only other option is to make a web site open to all visitors (a free web site, no privilege is necessary to visit it), in which case anyone, even non-scientists could answer the questionnaire and foul the data. We didn't want a totally free web site, but we couldn't issue passwords and at the same time keep the project anonymous. We decided to create a web site on which it was impossible for us to trace users, while at the same time be quite sure that only those scientists who received invitations would visit. For this, we created a "choose-password page" that consisted of a number of passwords. The number of passwords equaled the number of invitations that went out to the scientists. Once a scientist clicked on a password and then clicked "GO" his browser brought him directly to the first question and automatically directed him through the entire sequence of questions. At that point all of his answers were recorded, even if he didn't finish the entire questionnaire. We could identify the passwords, but not the user unless the scientist opted to fill in his name in the biographical section of the questionnaire.

The URL on the invitations directed the scientists to the "choose password"

page. The invitations also requested that the respondents not share the URL with anyone because the study was being conducted by invitation only. Thus, in order to protect the scientists' anonymity, we allowed them to freely choose available passwords. We had to trust, however, that they would not breach the instructions of secrecy on the invitations. We could hardly imagine a more trustworthy group of people with which to work, so we felt justified in our compromise.

Along with the invitations, I sent paper questionnaires with stamped return-envelopes to every evolutionary biologist on the List, giving them the option of answering manually instead of logging on to the internet. Of course, if a respondent chose this option, a postmark would identify his location, even if he refused to add his name to the questionnaire. This method of answering was the least anonymous but the intention of the project was to calculate the percentages for each answer on the questionnaire not to single out any particular evolutionary biologist's answers.

I sent the invitations and questionnaires to 271 evolutionary biologists, from 22 countries, on January 4th, 2003, followed by an email reminder on March 5, 2003. Between these two dates many responses came back, many of them signed. I refrained from sending the email reminder to anyone who identified themselves on a returned questionnaire.

II. Description of the questions and brief introductions to the relevant evolutionary issues affecting their construction.

The questionnaire appears in Appendix I. The following is a description of the questions and some aspects of the implications raised by possible answers. The questionnaire has three mandatory sections, section one: Statement of Belief, section two: What Evolution Studies, What it Ignores, and section three: Religious Belief and

the Practice of Evolution. Section one consists of questions numbered one through seven; section two, eight through 12; and section three, 13 through 17. There are two optional sections after question 17. Section four, question number 18, consists of a blank section for comments on any question, and section five, question number 19, is for volunteered biographical information.

Question number ONE: Do you consider yourself a religious person? Yes or No.

This question reveals how a participant regards the word "religious." The word (religious) is undefined and nebulous because it is possible that some evolutionary biologists do indeed consider themselves religious, favoring some kind of naturalist religion for instance, without having any connection at all to traditional belief. Precisely this kind of information is one of the goals of the project. Other questions bring out more specific aspects of their belief. For this question we can get an idea of the reluctance or ease with which evolutionary biologists use the word "religious;" what it means to them is another question raised elsewhere in the questionnaire.

Question number TWO (only for those who answered YES to number one): Which best describes your religion? A. Christian; B. Islamic; C. Judaism; D. Buddhism; E. Other

Evolutionary biologists who answer YES to number one are offered very broad religious categories as choices on this question. If they so desire it is possible to choose "other" as a religious description if they think of themselves as not participating in one of the traditional religions but still consider themselves religious.

Question number THREE (only for those who answered NO to number one): Which best describes your belief system? A. Atheist; B. Agnostic; C. Naturalist; D. Other

The use of the term "belief system" is used here *in lieu* of the word "religion" because the only people answering this question are those who answered NO to number one, which means that they don't recognize the word "religion" as something to which they subscribe. Every intellectual presumably has some sort of a belief system from which they form a world-view. This question intends to reveal that belief.

Once again the option to choose "other" allows a respondent to write in her own belief system if she is not satisfied with the three choices provided: atheism, agnosticism, or naturalism. I left the belief systems undefined. What can we assume about the answers?

If someone chooses atheism as their belief it carries numerous possible implications, but here it simply implies the null-hypothesis "I reject that gods exist." Agnosticism is a softer way of expressing doubt about the existence of god. Thomas H. Huxley, one of the first evolutionary biologists, introduced the term in 1889 as a way of neither denying nor confirming something, due to too little evidence. Agnostics are not at all willing believers that a god exists, but they are less confident than atheists to assert a null-hypothetical stance. Generally, an agnostic belief system has more room to entertain the possibility and appreciation of god's existence than does that of an atheist.

The choice of naturalist implies that neither atheist nor agnostic nor any other belief system appropriately appeals to the respondent. If someone chooses naturalist as his belief system he is saying something about his belief in natural law or natural history that is more satisfying to him than making a claim about the existence of god.

As a profession, a naturalist is thought of as someone who studies nature for a living, but as a belief system, "naturalist" is faith in investigation, verification, and discovery as the paths to truth, without appeal to the supernatural. The inclusion of naturalism as a choice on this question about belief makes it obvious to the respondent that I am not asking for affirmations about their profession.

What might compel someone to choose naturalism as his belief system? Homer Smith suggests that the study of nature reveals a picture of reality that informs the respondent's world-view: "Naturalism [is] not this or that special theory of petty principle; it [is] a belief in the uniformity of nature and in the unity of life as a part of nature." (Smith, 1952; p.403). A naturalist is willing to advocate for natural science as the path to understanding reality on which we all must walk, lest we suffer from a fantastic delusion. In this respect, naturalism implies atheism; and, like the null-hypothesis stance of the atheist, a naturalist puts her faith in the empirical procedure of verification to drive belief. The respondent who chooses naturalism believes she can discover reality using the tools and discoveries of natural science. Naturalism might be a more appealing choice to many because it seems more hopeful than atheism. Simply stated, naturalism is an affirmation of belief in natural law while atheism is a rejection of belief in gods.

Question number FOUR: Do you believe in God, or an entity that exists beyond the scope of our observations that is responsible for designing and maintaining life on earth? A. I believe in God as stated in this question; B. I believe in God, but my God merely started the processes of the universe, and of life on earth, and does not intervene on a day-to-day basis; C. I don't believe in God in

any traditional sense of the word; D. I don't believe in God, but I do believe that there are entities in the universe that are beyond the scope of science and are forever going to remain so.

The choices of this question can be divided into two classes. "A" and "B" comprise variations for believers while "C" and "D" are options for those who do not believe in god. Thus, if a respondent answered "Atheist" or "Agnostic" on number THREE, we may reasonably expect her to answer "C" or "D" on this question. If someone identified herself as a "Naturalist" or "Other" on number THREE, any one of the four choices are reasonable, although "A" and "B" are still somewhat of a stretch for a naturalist in the sense that it was described above.

A theist in the tradition of William Paley might logically connect options "A" or "B" from this question with "C" from the previous question, implying that subscription to naturalism is merely methodological (see discussion) and has nothing to do with Revelation, a combination I assume to be rare. Such a combination also requires that the theist not regard herself as religious (in which case she would be directed to skip question three), a logical unlikelihood.

Option "B" is most appealing to those with a belief in deism. A deist believes that the universe was created *de novo* by god in the beginning. Along with his material creations, god imparted natural laws to which all matter corresponds. The most original concept in deist belief is that, after creation, god ceased in his actions and no longer controlled the behaviors of material bodies. Deist belief allows for a purely naturalistic conception of evolution with the reservation that ultimate origins come from a supernatural source. In other words, it allows one to study nature without seeking scientific understanding about ultimate origins. This tradition, popular during the enlightenment, became difficult to reconcile with Darwinism because one of the

implications of evolutionary theory is that all origins have a materialistic source. Like the hypothetical theist above, a deist might logically choose "C" on number three, but only if they refuse to think of themselves as religious by selecting "B" on number one.

Option "D" gives us a glimpse of the pessimism with which evolutionary biologists treat their scientific practice. Those who have no hope that science will someday discover "entities in the universe" that are today beyond our view should naturally gravitate toward this option. An agnostic might be attracted to the limitations implied by this option. Consider the following from the archetypal agnostic himself, T.H. Huxley:

> Nobody, I imagine, will credit me with a desire to limit the empire of physical science, but I really feel bound to confess that a great many very familiar and, at the same time, extremely important phenomena lie quite beyond its legitimate limits. I cannot conceive, for example, how the phenomena of consciousness, as such and apart from the physical process by which they are called into existence, are to be brought within the bounds of physical science. Take the simplest possible example, the feeling of redness. . . [or, as regards the orang-utan] I doubt not that our poor long-armed and short-legged friend, as he sits meditatively munching his durian fruit, has something behind that sad Socratic face of his which is utterly "beyond the bounds of physical science." Physical science may know all about his clutching the fruit and munching it and digesting it, and how the physical titillation of his palate is transmitted to some microscopic cells of the gray matter of his brain. But the feelings of sweetness and of satisfaction which, for a moment, hang out their signal lights in his melancholy eyes, are as utterly outside the bounds of physics as is the "fine frenzy" of a human rhapsodist (Huxley, 1896b pp.122, 123-124).

A respondent who selects "D" believes that certain things are off limits to scientific investigation, which suggests they allow more tolerance for religious explanations than a naturalist or an atheist allows.

Question FIVE: What role does evidence play for you in determining your belief in God?

A. I believe there is a God no matter how insubstantial the evidence; B. I believe that there is not enough evidence to justify a belief in God; C. I don't apply scientific methodology or principles to my beliefs.

This question is a further elucidation of the participant's belief. Option "A" is for the religiously minded while "C" allows for the same disregard of evidence without affirming belief in god. Thus an agnostic would not select "A" but might find more comfort in "B" or "C." A respondent who chooses "A" or "C" is admitting that evidence plays no role in their belief system, and that grounds for belief are useless. The Huxleyan agnostic tradition is opposite: ". . . every man should be able to give a reason for the faith that is in him; it is the great principle of Descartes; it is the fundamental axiom of modern science" (Huxley, 1896 p.246). The entire issue of justification hinges on inductive logic, which is fundamental to scientific knowledge. Any non-scientist armed with a healthy dose of blind faith is likely to choose option "A" or "C."

Option "B" is the most likely choice for an atheist or naturalist, because it emphasizes evidence as the foundation of the belief system. An atheist maintains that god does not exist precisely because there is no positive evidence from which to construct a belief. An agnostic might also gladly choose option "B" because an agnostic is waiting for positive evidence before he constructs his belief. The absence of evidence does not dissuade an agnostic from his position, but it further entrenches the atheist in his hypothesis that no gods exist. If no evidence exists, after millennia of searching, one must at some point conclude that whatever he is searching for probably

doesn't exist. Once again, the atheistical null-hypothesis, "no gods exist," requires no proof, its justification simply depends on a Popperian stance, uneroded by falsifiable evidence. A naturalist and an atheist might equally favor option "B."

Option "C" suggests a de-coupling of science and belief, for it admits that beliefs have no connection to a respondent's scientific practice and they are not subject to verification nor empirical demonstration. Both religiously minded believers and agnostics might choose this option for its non-committal appeal. In essence, option "C" is an affirmation of the following: "my beliefs are private and I don't want to share why I believe them." This would be a revealing result if it were popular among the participants. The sample group collects and shares evidence on a daily basis in their professional lives, and the claims they make are evidentially based. If they opt for "C" it suggests that they use different reasoning to ground their private beliefs than they use professionally. If this option turns out to be a popular one, we should wonder why evolutionary biologists would ever be consulted as having anything meaningful to contribute to theological debates about the origins of humankind or to discussions about ecological crisis.

Question SIX: I believe that there is something, not known to science, in human beings that lives on after the body dies. A. Agree with this statement; B. Disagree with this statement.

The participant's metaphysical beliefs are at issue here, for this question addresses the philosophical notion of what exists? The entire edifice of science has been erected by careful construction of a metaphysical foundation upon which all thinking men and women have built the various disciplines of knowledge about the physical world (Burtt, 1925). Considering the specialty of the sample group, there

should be universal denial of life after death. Or, perhaps it is premature to suggest that all biologists agree on what constitutes life?

This question, like question eight, is constructed to allow the dualists to have their say. If a respondent believes that the substance of the mind is materially different than that of the body, there is nothing to prevent her from believing that it could exist without the brain. Furthermore, if one believes that there is an invisible, unavailable, permanently mysterious nature to life, this too can be accommodated by choosing to disagree with the statement in this question. The presence of this notion within the ranks of the world's leading evolutionary biologists would raise serious questions about what exactly evolves, and how life is constituted, an issue seriously debated today by politicians coming to terms with stem cell research (Wallace, 2003 ms.). In short, if life after death is affirmed by even a minority of the participants, it suggests belief in life before birth, which is a major point of agreement for traditional religions that favor the existence of the soul. Hence, option "A," might act as a nexus of compatibilism for evolution and religion.

Question SEVEN: Please choose only one of the following: A. All biological organisms are locally determined by heredity and environment but humans still possess free will; B. All biological organisms are locally determined by heredity and environment and humans have no free will.

The presence of free will as an independently existing phenomenon in nature fits with a dualist or a theological world-view. Among scientists however, the issue is whether organisms, including man, can be determined by natural causes and yet still possess free will. This question tests the assumption that evolutionary biologists have

no mechanism for explaining free will and therefore must reject it as an illusion. The relationship of evolution and religion is nowhere more potentially explosive than it is when it ventures toward the issue of free will. When scientist and theologian alike bring up the topic in agreement, they must construct what Smith (1952) calls "the most astonishing logical paradox ever to be cherished by man. . . . that God in his omnipotence had predetermined the fate of every man . . . and yet he nevertheless holds every man responsible for his actions" (Smith, 1952 p.409). The answers to this question will reveal whether the world's leading evolutionary biologists invoke Smith's paradox.

Question eight: Organisms, including humans, consist of the following: A. Material properties; B. Spiritual/Non-material properties; C. Both material and spiritual/non-material properties (properties are here defined as determining factors).

When Darwin created an explanation for a purely materialistic explanation of the organismic order seen in nature, he essentially "robbed William Paley" (Crews, 2001) of the scientific validity of any notion that suggested a creative designer. This question tests whether today's leading evolutionary biologists believe that something more exists within organisms beyond the merely material entities, molecules, cells, organs, etc.

The presence of dualistic thinking can be deduced from this question (in correspondence with Q6, "A" and perhaps, Q4, "D")[6]. It is common to hear non biologists and philosophers discussing the reasonableness of assuming there is something more to organisms than their material make-up. Consider this passage from

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[6] The shorthand convention for denoting questions throughout this dissertation is: Q5 for question five; Q5, "A" for question five, option "A."

philosopher Michael Ruse: "I see no reason at all why one should not be a Darwinian evolutionist and think that in some sense minds involve the non-material in some way . . . not necessarily a supernatural substance, but more than just material physical objects" (Ruse, 2002). The problem with this kind of thinking is that it assumes more of life than is actually known. Dualism has appeared repeatedly throughout the twentieth century biological literature and might indeed have influenced some of the participants of this study.

"Organisms, including humans" implies that the leading evolutionary biologists see humankind as a product of the same natural evolutionary laws that created other species. If a participant chooses "B" or "C" it suggests they believe that spirits or non-material properties are present in all organisms, not just humans. Presumably, dualist evolutionary biologists, like Edmund Sinnott (1955), would be drawn to such a conclusions:

> We are standing at an impasse in our basic philosophy and seem to be faced with the necessity of a choice between the physical and the spiritual side of man as the final reality . . . I am persuaded that a satisfying harmony between these two attitudes, seemingly so diverse, is not impossible. . . . To accomplish this may seem an impossible task, but man's unhappy dualism is proving so disastrous, both for individuals and in its impact on society, that a study of every possible means of bringing together the two sides of him is worth investigating. . . . If a man's mind has a biological basis, his spirit must have one also (Sinnott, 1955 pp. 11 - 12, 121).

The affirmation of a non-material spirit implies that the ontological domain of biology is virtually limitless, and this makes life infinitely more difficult to study. T.H. Huxley stated the rejection of this notion most succinctly:

> In itself it is of little moment whether we express the phaenomena of matter in terms of spirit; or the phaenomena of spirit in terms of matter. . . .But with a view to the progress of

> science, the materialistic terminology is in every way to be preferred. For it connects thought with the other phaenomena of the universe and suggests inquiry into the nature of those physical conditions, or concomitants of thought, which are more or less accessible to us, and a knowledge of which may, in future, help us to exercise the same kind of control over the world of thought, as we already posses in respect of the material world; whereas, the alternative, or spiritualistic, terminology is utterly barren, and leads to nothing but obscurity and confusion of ideas. Thus there can be little doubt, that the further science advances, the more extensively and consistently will all the phenomena of Nature be represented by materialistic formulae and symbols (T. H. Huxley, On the Physical Basis of Life, 1896; from Bibby, 1967 p. 58).

Option "A" should be the overwhelmingly favored choice by the respondents if they favor a purely monist naturalism. Those who favor option "C" are possibly revealing their dualist world-view.

Question NINE: I believe that the findings of evolutionary biology can influence and alter morality. A. Agree with this statement; B. Disagree with this statement.

This question gauges the support for extension of evolutionary biology into a domain usually addressed by philosophers. Morality from evolution has been strongly opposed by Gould (1980):

> Our failure to discern a universal good does not record any lack of insight or ingenuity, but merely demonstrates that nature contains no moral messages framed in human terms. Morality is a subject for philosophers, theologians, students of the humanities, indeed for all thinking people. The answers will not be read passively from nature; they do not, and cannot, arise from the data of science. The factual state of the world does not teach us how we, with our powers for good and evil, should alter or preserve it in the most ethical manner . . . . If nature is nonmoral, then evolution cannot teach any ethical theory at all

(Gould, 1980 pp. 42-43, 44).

Gould's is a rather conservative view that closely echoes a notion set forth earlier in the 20th century by William Jennings Bryan in his concluding remarks defending the moral superiority of creationism during the Scopes trial: "Science is a magnificent material force but it is not a teacher of morals. It can perfect machinery, but it adds no moral restraints to protect society from the misuse of the machine" (Larson, 1997 p.198). Bryan's purpose was to maintain the superiority of canonical religion as the teacher of morals and to paint evolutionary biology as religion's nemesis. For evolutionary theorist Jacques Monod, such an attitude is ignorant of the fact that "values and knowledge are always associated in action just as in discourse" (in Barlow, 1994, p.197). From his perspective, since evolutionary biology is adding to our knowledge of humanhood, which we value as good, we cannot ever succeed in separating morality (the result of those values) from science.

Francis Crick stated a view similar to Monod's: "if revealed religions have revealed anything it is that they are usually wrong" when it comes to their attempts to answer questions about human nature, and furthermore "while we may not be able to deduce human values solely from scientific facts, it is idle to pretend that scientific knowledge . . . has no influence on how we form our values" (Crick, 1994 p.261). This conceptualization forms one of the polarized views among evolutionary biologists that most closely resembles option "A."

Option "B" is the opposing view, more akin to that of Gould's. It can be traced back to philosopher David Hume. "Hume said that no amount of science will derive values from facts; it was restated as the naturalist fallacy by G. E. Moore" (Bronowski, 1978). Both Moore and Hume saw limits to scientific knowledge. They saw science as merely a way to discover phenomena, a process which could only yield statements

pertaining to ontological truths (what exists and what doesn't). The "naturalist fallacy" is Moore's suggestion that observable facts, things from which we conclude "is" statements (The spotted hyaena IS an adept scavenger) cannot lead logically to "ought" statements (We OUGHT to preserve the hyaena's habitat).

T. H. Huxley implied that, based on the broad domain of biology, morality is reasonable topic for the life sciences:

> Now that we have arrived at the origin of this word "Biology," the next point to consider is: What ground does it cover? I have said that in its strict technical sense, it denotes all the phenomena which are exhibited by living things . . .we must include man and all his ways and works under the head of Biology. . . . It becomes hard to say why we should not include therein human affairs which, in so many cases, resemble those of the bees in zealous getting, and are not without a certain parity in the proceedings of the wolves. . . .[therefore] you should not be surprised if it occasionally happens that you see a biologist apparently trespassing in the region of philosophy or politics; or meddling with human education; because, after all, that is part of his kingdom (T. H. Huxley, On the Study of Biology, 1876; Bibby, 1967 p.39).

If the most highly esteemed evolutionary biologists agree that their science can provide an ethic of how we as a species should behave as, for instance, caretakers of a dying biosphere, as suggested by E. O. Wilson (1984), then option "A" will be the overwhelming favorite choice of the participants.

Question 10: Do you believe that evolution teaches us something about the objective reality of life on earth or is such a topic better left for philosophers to debate? A. I am committed to teaching about the objective reality of life on earth; B. I am content to let philosophers debate about objective reality, without addressing it

in my teaching; C. I don't believe that there is such a thing as objective reality, we all create our own reality.

This question takes an ontological turn to find out if objective reality is taken seriously in the teaching of the participants. An underlying implication of the question is whether there is motivation in the most highly esteemed evolutionary biologists to discover more reality than is known presently.

The dualist and theologian need not concern themselves with reality. For them, there is always the invisible, mysterious, supernatural, unearthly domain known only through faith. They are content to choose "B" or "C" placing the discussion of reality on the shoulders of philosophers or on other people who might not be educated biologically. The more serious answer for scientists in general is "A," for this is the choice of those who believe that they are contributing something to the catalog of empirical knowledge which forms the basis for a shared understanding of reality. If reality can only be discovered by empirical means, this depends on sense organs and consciousness are primary concerns; both of which are the study subjects of biologists, not philosophers nor the uneducated. Options "B" and "C" are, therefore, eliminated from the list of likely answers for the participants.

Question 11: What is your view of purpose and progress in evolution? A. Neither purpose nor progress plays any ultimate role in evolution ("ultimate" refers to any of the following concepts: intelligent design, teleology, or determining factors that science does not study); B. Evolution exhibits no ultimate purpose, but progress does occur in evolution; C. Ultimate purpose plays a role in evolution and progress is a part of that purpose; D. Ultimate

purpose plays a role in evolution, but it doesn't entail progress.

This question was created to reveal the degree of disdain for the use of the word "purpose" or "progress" in reference to the evolutionary process. Provine (1988) suggests that a major factor leading to the evolutionary synthesis in the 1930s and 1940s (called the "evolutionary constriction" by Provine, p.62), was the lack of scientific justification for including purpose as a driving force in evolution. A wholesale rejection of purposive evolutionary ideas left natural selection as the least objectionable candidate for producing adaptation. Although purpose in evolution has been discounted time and again throughout the 20th century, teleological tinges are still found throughout the modern biological literature, suggesting some compulsion still exists to include it as a biological concept. Perhaps it's because purpose is a part of the medieval intellectual tradition that is deeply ingrained in the teaching of most cultural institutions in western civilizations, and therefore it is something from which we cannot totally escape.

Option "B" refutes purpose for the most part. It shows, however, a willingness among the respondents to acknowledge progress as a part of evolution. The use of progress as a concept in evolution stems from Darwin himself who wrote, on the last page of *On the origin of Species*, without evidential justification: "as Natural Selection works solely by and for the good of each being, all corporeal and mental endowments will tend to progress towards perfection." The modern belief in progressive evolution stems, perhaps, from the post-evolutionary-synthesis understanding of evolution as a two-step process. Step one is the generation of genetic variation, a random process with respect to the current environment. Step two is the selection of only the favorable varieties, meaning the ones that exist to continue the process and are not destroyed. Step one is repeated each succeeding generation with new variation that is limited by

the previously existing generation creating a markovian process that imparts an evolutionary directionality, away from the genetic constitution of past generations. But towards what? About all that can be said about the direction is that it will not be repeated. Evolutionary biologists accept this characterization of evolution as a two-step process without much debate. Whether to call the direction progress is debatable; and whether to find a purpose to the progress is even more suspect.

Defining progress for meaningful biological discussions is crucial, as pointed out by Maynard Smith (1988). No matter how it is defined, however, we are left with puzzling questions as to why using the word progress is necessary to characterize the observed evolutionary phenomenon. After the phenomenon is established as progressive it becomes inextricably linked with, at minimum, a proximately purposive world-view. The adaptationists, roundly criticized by Gould and Lewontin (1979), see the evolution of structures as occurring for this or that proximate purpose. Adaptationists allude to an evolutionary process that is constantly driven by proximate adaptive requirements. This kind of purposive thinking leads naturally to concepts like "evolutionary arms races" (Dawkins, 1999) which is an explicitly progressive world-view. Those who would select option "B" gladly denounce ultimate purpose but still cling to a type of proximate purpose that is necessary because they have committed themselves to a progressive view of evolution.

Options "C" and "D" are variations on the same theme, namely teleology, requiring a view of evolution that incorporates ultimate purpose. Option "C" is, on the one hand, for the theist, who sees god's intervention in guiding evolution. On the other hand, it could be appropriate for the deist who merely sees progress as a part of god's design with purposive evolution conforming to it.

Question 12: What is your opinion on the relationship between evolution and religion? A. They are non-overlapping magisteria (teaching bodies) whose tenets are not in conflict; B. Religion is a social phenomenon that has developed with the biological evolution of *Homo sapiens*. Therefore religion should be considered as a part of our biological heritage and its tenets should be seen as a labile social adaptation, subject to change and reinterpretation; C. They are mutually exclusive magisteria whose tenets indicate mutually exclusive conclusions; D. They are totally harmonious. Evolution is one of many ways to elucidate the evidences of God's designs.

No other question gets at the compatibilism of evolution and religion more quickly than does this one. Three of the four options, "A," "B," and "D," are variations on the same fundamentally compatiblist viewpoints. The only option for a true non-compatiblist is "C," suggesting no way to reconcile evolution and religion because the two teaching bodies are fighting over the same ground; their conclusions are mutually exclusive.

The first option, "A," is based on Gould's (1999) NOMA principle, which states that religion and science are non-overlapping magisteria that address different types of knowledge, and, as such, cannot be in opposition to one another. He suggests that both science and religion should be studied and appreciated in order to enjoy the fullness of life. The NOMA principle is a resurrection of nineteenth century natural theological concepts. Asa Gray, Darwin's contemporary from Harvard's botany department, maintained that Darwinism was no more atheistic than Newtonian physics. Darwin and Newton merely discovered how nature works. The scientist only describes the order of nature, Gray maintained, leaving the religious thinker to seek an

explanation in terms of divine purpose (Bowler, 1984 p.210). Thus Gould (1999) echos a notion from Harvard's past, one that is fundamentally deist in its construction. Since it sees no conflict between evolution and religion, option "A" is one possible choice for the compatibilist.

Option "B" is far more naturalistic, and hence controversial than the view expressed in "A," and is another possible choice for those who find evolution compatible with religion. The compatibilism of "B" lies in an assumption that religion is a part of human natural history, best understood as a social adaptation, part of the process of evolution itself. Proponents of this view see no conflict between evolution and religion. They see religion as a natural part of human behavior that has evolved, like tool-making, for example. This view places primacy on the knowledge of evolution, particularly adaptation and sociobiology, because religion makes no sense without it. This option is, in all liklelihood, offensive to theologians. Recently, David Sloan Wilson suggested that religion is best understood as the outcome of group selection (Wilson, 2002).

The type of compatibilism expressed by option "B" erases the notion that evolution and religion are at war over the same territory, but it requires that evolutionary biology subsume religion as a sub-discipline, for it suggests that one cannot understand religion without a deep familiarity with evolutionary principles. Under option "B" religion is subordinate to evolution. Although this is an obvious offense to theology, it still expresses a technically compatibilist sentiment.

The hard core non-compatibilist will unhesitatingly choose option "C." If evolution and religion are in no way compatible, it is because they are both attempts to explain the same thing, namely origins. The religious conceptions of origins have been refuted and falsified throughout the ascendancy of the scientific age.

Evolutionary biology in the 20th century made matters worse for theology by demonstrating that humans and great apes are descended from a common ancestor. One of England's all time greatest statesmen and orators, William Gladstone, in the late nineteenth century, defined the non-compatiblist position when he stated his view of science and theology: "There are two sides to my house, and we will divide them: you shall take the outside" (Smith, 1952 p.403). He championed the theological side of the house, the inside. As the march of evolutionary biology proceeded through the 20th century, it turned out science and religion "were in every sense utterly irreconcilable: all history testified that the house could not be divided except as in Gladstone's epigram" (Smith, 1952 p.403), with evolution prevailing as the superior magisterium when it came to understanding origins. "C" provides a most welcome option for those who follow Gladstone's characterization of the house divided, but the participants of this project, presumably, now occupy the inside.

The final choice for this question, option "D," is the ultimate compromise. It allows for complete interpretive freedom of religion while assuming that no tenet of evolution acts to undermine it. Those who construct their own religions, or subscribe to completely unique belief systems, will find this option attractive. Given the historical tension of canonical religion and evolutionary biology this should be a very unpopular choice among the participants. Any remaining deists among the group of respondents, who have not chosen option "A" might very well choose "D". The NOMA principle allows for deism (choice "A") but does not mandate a deist philosophy, while option "D" goes even farther than NOMA by suggesting that religion and evolution harmonize well together to reveal a designed universe.

Question 13: I keep my beliefs about morality and ethics separate from my practice and teaching of evolution. A. Agree with this statement; B. Disagree with this statement.

A preliminary matter in justifying this question is to clarify the term "practice of evolution." At first glance it might appear that this is fraught with an assumption that evolution acts like a religion for the participants of this study; for no one would argue that people have religious "practices". But do scientists practice in the same manner? I mean only to suggest that since the participants of this study have devoted their lives to teaching and thinking about evolution, it seems only plausible that the process of acquiring knowledge and sharing knowledge through teaching are cultural practices of some sort. The conclusions at which they arrive about the science have come from field investigations or laboratory preparations or literature study. These routines I casually call practices.

The major focus of the question is to detect how willing the participants are to discuss some of the more personally meaningful aspects of evolutionary biology. Darwin was a very private person, but, according to his autobiography, he was not guarded in his discussions about the implications of evolution on ethics and morality. T. H. Huxley considered morality and ethics in public lectures and obviously considered them to be central issues in the development of evolutionary theory. The turn of events in the 20th century might have had an effect on the participants' desires to discuss the implications of evolutionary theory. This question will add light to that possibility. The more private participant, whose main goal it is to avoid controversy and forget the turmoil created by evolutionary theory, will gladly choose option "A". Whereas the integrative thinker, who sees more to evolutionary biology than a limited scientific explanation of origins, will likely select option "B."

For those who select "B" there is another implication hiding in this question, namely, that morality might influence the way science is taught and constructed. Certain beliefs and assumptions are built in to theory: "...fact and theory... are not categorically and permanently distinct" (Kuhn, 1962 p.66), and therefore a willful separation of morality, ethics, observation, and teaching, for instance, might be impossible. Those who select "A" might not recognize the ambitious nature of this option. They might simply favor "A" because it suits their teaching style not to discuss morality in class. This question might reveal, nonetheless, that participants believe the evolutionary biology curriculum to be no place for morality and ethics.

Question 14: Look at the following diagram (reproduced in #14 in Appendix One). Choose the letter that corresponds to your philosophical preference.

More than any other question, this one reveals a participant's commitment to a purely naturalistic world-view. This exercise forces participants to combine their belief in god with a preferred philosophical approach to science. It is extremely informative and it allows for many subtle distinctions between well-defined end points. The respondent can choose any of three philosophical positions which are all defined for him, or he can choose any number of in-between positions based on his preference for the endpoints. For example (please refer to the diagram) if he is an uncompromising theist he should gladly choose "F". However, if theism is repugnant to him, there are two other end points that might be more accommodating: deism "I", or naturalism "A." Supposing that all three of them are equally useful in constructing his world-view, option "M" is directly in the middle, which of course says "I prefer not one of these positions over the other, they all equally contribute to my knowledge."

The diagram is a classic tool in petrology known as a ternary diagram. In determining rock compositions, it is a graphical representation of the mineral amounts found in any geological sample. The classification of entire families of rocks depends on the relative abundance of key minerals they contain. Determining the key minerals (which provide the end points on the diagram) is the crux of the entire classificatory scheme. For instance, it is well-known that the relative amounts of potassium feldspar, sodium feldspar, and quartz, alone determine the entire range of granites that exist on the planet, irrespective of associated minerals (Best, 1982 p.115). Such a useful classification depends on the identification of dominant distinguishing factors while still allowing for the importance of their intermingling. In the case of the present study, this means distinguishing theism from deism from naturalism - the three major intellectual strains that have motivated the literature of evolution - while still recognizing their possible connection.

Naturalism has been expressed in many ways by thinkers from every branch of science. For this question, the definition of naturalism comes from Homer W. Smith (1952) who masterfully discussed naturalism and its importance to modern science: naturalists "set as their first test, the verifiability of their beliefs" (Smith, 1952, p. 403). This nicely matches the view of T. H. Huxley that one should always be prepared to give grounds for one's beliefs; and yet it adds another dimension. A naturalist's belief is verifiable as well as based on reasonable grounds. The tradition of naturalism holds to the belief "that the empirical procedure of exploration and verification is the only known, reliable method of discovering truth." (Smith, 1952, p.403). This is defined on the questionnaire in order to make it explicitly obvious what endpoint "A" represents. The other endpoints are also defined (Appendix I, Q14).

The goal of this question is to depict, graphically, the world-views of the

leaders in the field of evolutionary biology. The same approach, using the ternary diagram, could be used with the same endpoints on a different group of academics and it might reveal a totally different philosophical *milieu*. In the present project, the degree of theism and deism in the naturalistic thinking of modern evolutionary biologists is a primary concern addressed by this question.

Question 15: Do you think that your body of work in evolutionary biology reflects your position on the diagram of number fourteen? A. Yes; B. No.

The effect of world-view on professional work is difficult to discern merely from studying a scientist's publications. This question allows a respondent to verify that her evolution research informs her philosophical preference. For example, a philosophical naturalist, from Q14, might answer "yes" on this question, which suggests that she sees correspondence between her professional work and her philosophical world-view. If she answers "no" to this question, we can deduce that she has formed her philosophical preference by appealing to something other than her work in evolutionary biology, in which case it is likely that she will have checked "no" on number five, "disagree" on number nine, and anything but "A" on number ten. Correspondence of this question with others provides a useful illustration of a respondent's world-view.

Question 16: Do you consider yourself a naturalist in the metaphysical sense? (One who subscribes to metaphysical naturalism, the notion that the only reliable method of discovering truth comes from empirical investigation). A. Yes; B. No.

Metaphysical naturalism has been identified as a social evil by Phillip Johnson (1995). He sees evolutionary theory causing modern social chaos and wishes to establish theism as a more reasonable social doctrine. Despite Johnson's antipathy for evolution, his classification of metaphysical naturalism and methodological naturalism is both thought-provoking and germane to this project (see discussion). A metaphysical naturalist is one who believes that truth can be found in only one way, through observation and verification. This is offensive to those who maintain that the truth derived from, say, music or fiction literature is just as reasonable as the truth derived from science. For these people the naturalist provides useful truths, but only of the methodological variety. Methodological naturalism, according to Johnson, is the principle that science can only study observable phenomena (Johnson, 1995 p. 212). Unobservable entities (supernatural things) are beyond the domain of science.

Therefore, theism, Johnson's main focus, is compatible with methodological naturalism but is not compatible with metaphysical naturalism. His entire argument hinges on the belief in God. "Of course a social order should be founded on reality and not on unreality, but if God exists, a naturalistic order is founded on unreality and naturalistic rationalism is an illusion" (Johnson, 1995 p.48). Johnson calls himself a "theistic realist," one who is "convinced that God is objectively real, not merely a concept or fantasy in my own mind" (Johnson, 1995 p.49). "Since God is rational and created our own minds in his image, we would expect the universe to be on the whole orderly, and therefore the success of science in determining many regular processes and mechanisms is entirely consistent with 'theistic realism'" (Johnson, 1995, p.209). This nod to methodological naturalism is a covert way of allowing science a place, alongside theism, to reveal the order of god's handiwork. It is "new creationism" or "intelligent design" re-written as "theistic realism". The metaphysical naturalist,

however, requires proof that god is rational and needs some sort of independent ontological verification for believing that god exists in the first place. Johnson's *a priorism* is simply incompatible with metaphysical naturalism.

The participants who affirm this question agree with Edelman and Tononi (2000) who offer one of the most recent theories of consciousness, based on a sound metaphysical naturalism: "[we] cannot accept the position taken by those who embrace a materialist metaphysics with a dualist rationalist or idealist epistemology" (Edelman and Tononi, 2000, p.215). They insist that epistemology[7] should be "grounded in biology."

If a respondent checks option "B" he will be admitting that non-scientific types of truth are just as reasonable contributions to knowledge about the natural world as are the truths of science. If this is the dominant response, there is plenty of room for theistic and deistic views to flourish in modern evolutionary biology. If this is true, the science has not changed much since the time before Darwin.

Question 17: What kind of belief system would you advocate, if pressed, as being most consonant with a lifelong practice of evolution? A. One of the traditional religions (i.e., Christianity, Islam, Judaism, Buddhism, etc.); B. A naturalistic one that is based on materialism, and incorporates advances in scientific knowledge; C. One that incorporates some aspects of traditional religion and some aspects of modern science; D. Other.

As the last of the mandatory questions, question 17 addresses possible world-

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[7] Epistemology - considerations that include questions like: "How do we know something is true? What is knowledge?

views. As in question 13, the term "practice of evolution" is brought up again to emphasize the teaching and research activities of professional evolutionary biologists. The question's focus is: "What kind of belief system is most consonant with their professional activities?"

If it turns out that deism or theism reigns supreme in the minds of the participants, as determined from question 14, then option "A" or "C," or some combination of the two of them, should be the overwhelming favorite. This implies that respondents' professional practices in no way interfere with their intellectual enjoyment of traditional religion.

If naturalism is the predominant answer to Q14, we should see option "B" chosen most frequently on this question, implying that the professional teacher and researcher of evolutionary theory finds no distaste in advocating for a unique type of modern belief system and further, suggesting that it is most consonant with their lifestyle.

The option "D" was added for those who have a belief system in mind, for which they would like to advocate as being most consonant with their own private lifestyle, for it neither matches the concept of naturalism for them, nor traditional religion. This implies that there are other, alternative belief-systems among the world's most highly esteemed evolutionary biologists that are consonant with at least some of the tenets of modern evolutionary theory (unless they chose "C" on question five).

Questions 18 and 19, optional.

The rest of the questionnaire is optional. Question 18 allows the participant to make comments on any question and write on an entire blank page. Question 19 asks respondents to supply the following biographical information: Name, institution of

highest academic degree, area of research concentration and classes taught, age, country of citizenship, and country of primary education. The following questions were asked near the bottom of the optional biographical page: Were you formally introduced to any religion in a ceremony or rite of passage? If yes, which? Are you practicing in that religion now? Are you practicing in any religion now?

RESULTS

I. Demographic statistics

One hundred and fifty one evolutionary biologists answered invitations to participate in this study, a return rate of 55.7% of those on the List (Appendix II). Two of the scientists sent letters claiming that they could not accept the invitation to participate. One reasoned that "I am an anthropologist, not an evolutionary biologist." The other scientist refused to answer because he had just published a large book that contained his views on evolution and religion: "They cannot be summarized by answering a questionnaire," his letter stated. This left 149 participants who responded with answers to the questionnaire (Figure 1). These answers form the data of this project. 37 participants (24.8%) used the web site to answer the questionnaire while 112 (75.2%) returned their answers by postal mail.

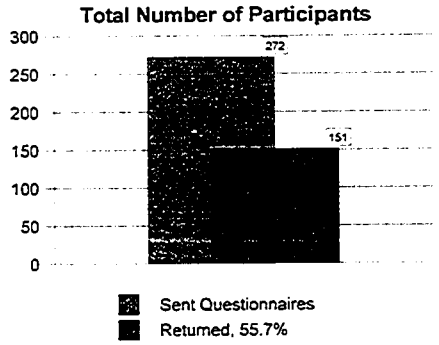


Figure 1. The ratio of responses to invitations sent to those on the List (Appendix II). The final number of participants in the study is 149. Two of the 151 returns were refusals to participate.

One hundred and seven questionnaires were returned with names, amounting to 71.8% of the respondents (Figure 2), which illustrates the willingness of the respondents to list their beliefs without requiring anonymity. The 27.2% who withheld their names are likely more private about their views on religious topics.

Since anonymity creates a dearth of auxiliary data, geographical information is incomplete. A certain amount of data can be generated, however, from information on

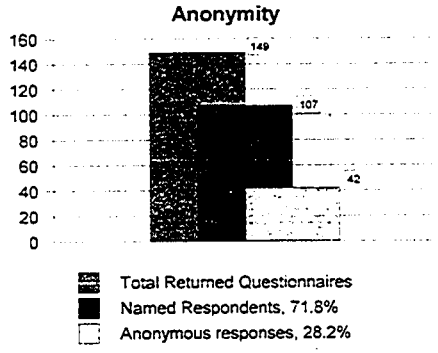


Figure 2. The ratio of anonymous to named questionnaires reveals that most participants did not require anonymity built in to the study.

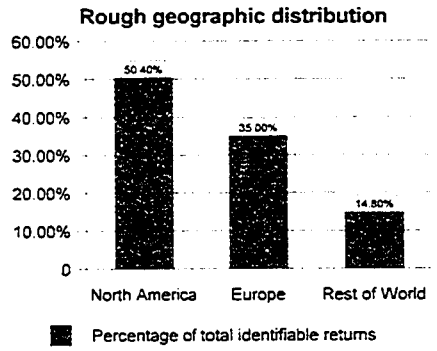


Figure 3. Roughly half the participants of this study come from outside North America.

the postmarks of the return envelopes from those who did not provide their names. 14 anonymous respondents (9.3% of the total) chose to answer on the web site, which of course provided the most geographic and biographical anonymity. All of the return envelopes reveal a postmark allowing for geographic separation. One hundred and

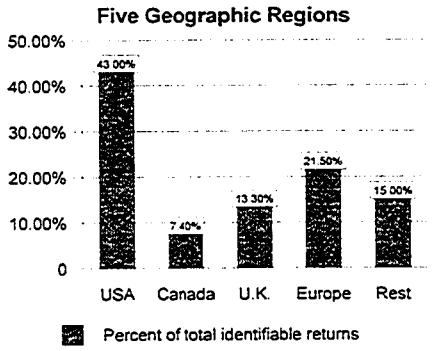


Figure 4. Members of the United States National Academy of Science make up 43% of the total number of evolutionary biologists taking part in this study.

thirty five of the 149 questionnaires can be grouped geographically, giving us a good

estimate of the geographic breadth of the respondents. They can be coarsely assembled into three major categories (Figure 3): North America (USA and Canada, 68 respondents), Europe (U.K. and other European countries west of Russia and North of Africa and the Arabian peninsula, 47 respondents), and "Rest of World" (all countries falling outside the previous two categories, 20 respondents). North American evolutionary biologists make up 50.4% of the total participants in this study.

The participants can be further separated into five regional categories resulting in finer geographic resolution (Figure 4): USA (58 respondents), Canada (10 respondents), United Kingdom (18 respondents), Rest of Europe - exclusive of U.K. (29 respondents), Rest of World - exclusive of all the previous geographic categories (20 respondents). The complete demographic breakdown appears in Appendix III.

II. Response statistics

The following figures represent the statistical tallies of respondents' answers to the questionnaire. Unless otherwise noted, N=149.

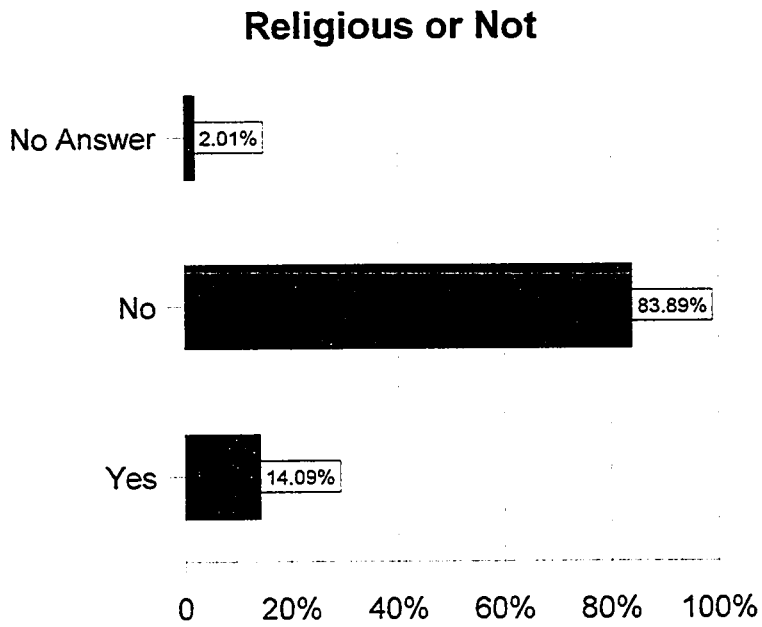


Figure 5. Responses to question one: "Do you consider yourself a religious person?"

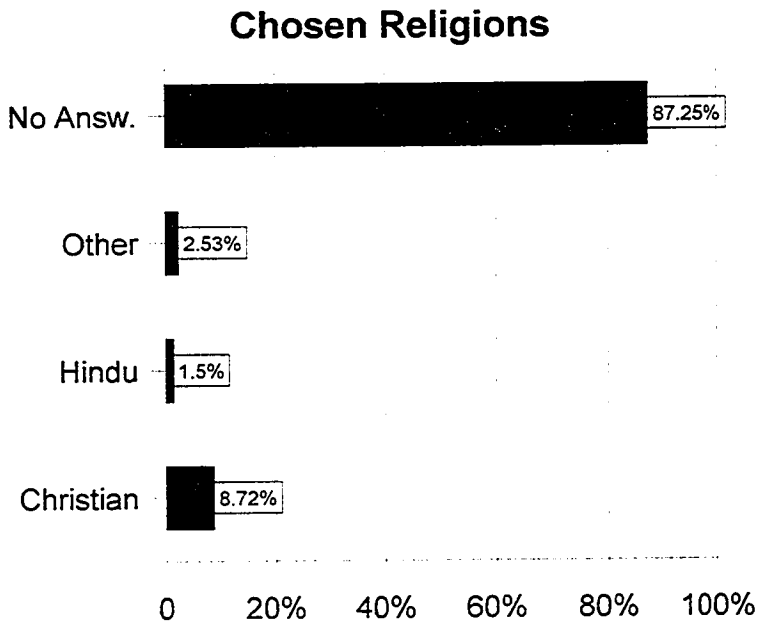


Figure 6. Responses to question two: "Which best describes your religion?"

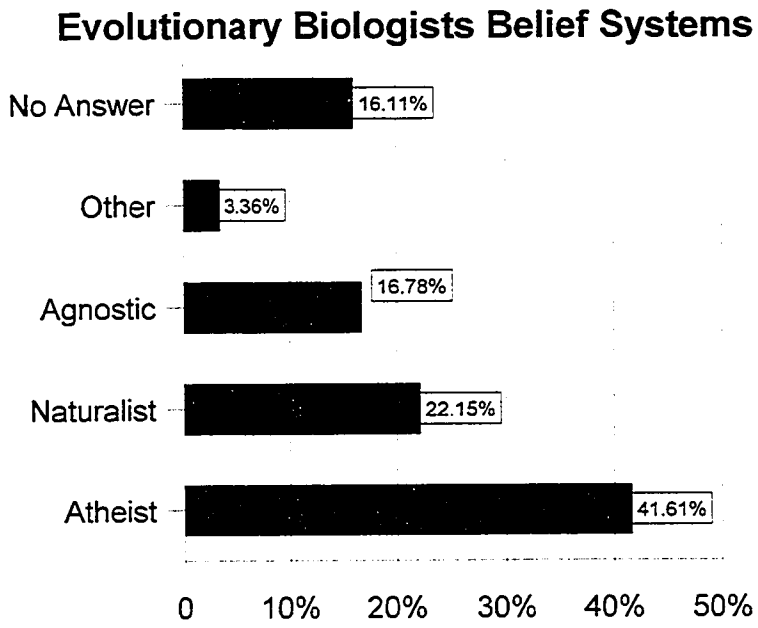


Figure 7. Responses to question three: "Which best describes your belief system?"

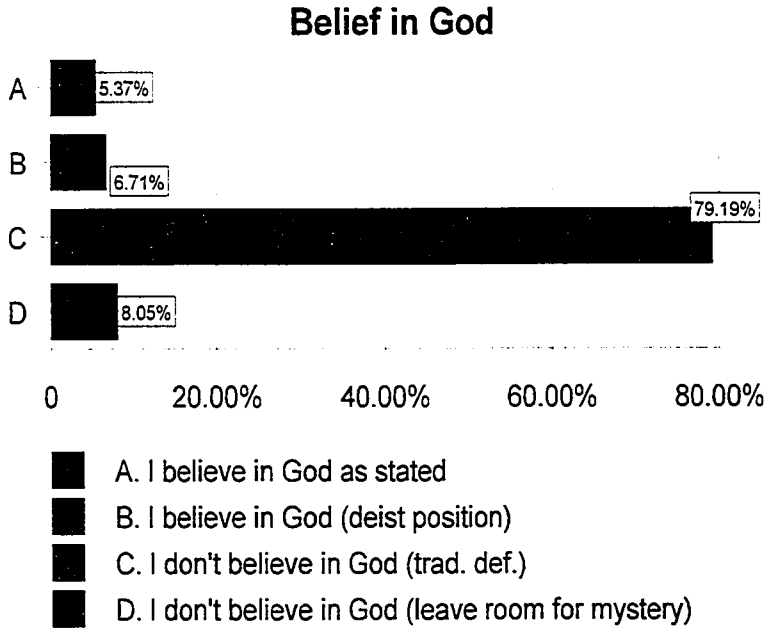


Figure 8. Responses to question four: Do you believe in God, or an entity that exists beyond the scope of our observations that is responsible for designing and maintaining life on earth? A. I believe in God as described in this question; B. I believe in God, but my God merely started the process of the universe, and of life on earth, and does not intervene on a day-to-day basis; C. I don't believe in God in any traditional sense of the word; D. I don't believe in God, but I do believe that there are entities in the universe that are beyond the scope of science and are forever going to remain so.
Note: One respondent left this question blank. This amounted to 0.67% of the total number of answers for this question.

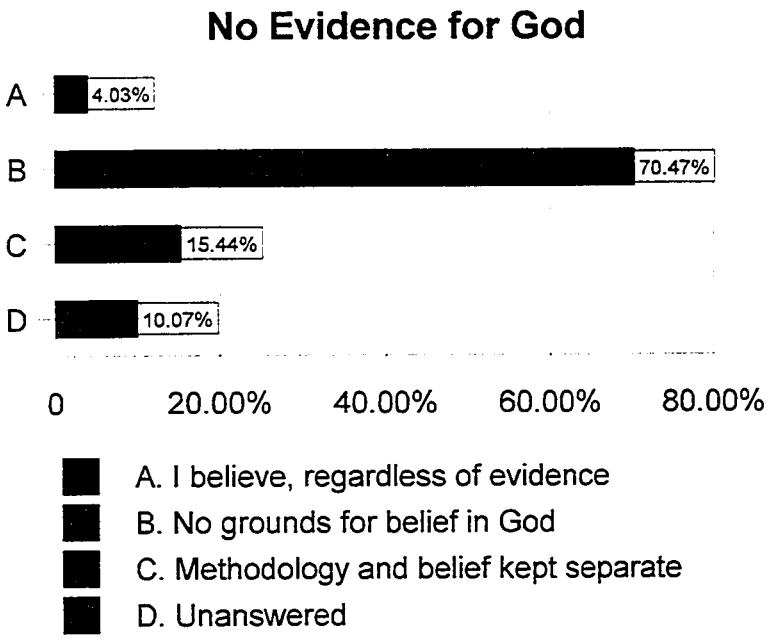


Figure 9. Responses to question five: "What role does evidence play for you in determining your belief in God?" A. I believe that there is a God no matter how insubstantial the evidence; B. I believe that there is not enough evidence to justify a belief in God; C. I don't apply scientific methodology or principles to my beliefs.

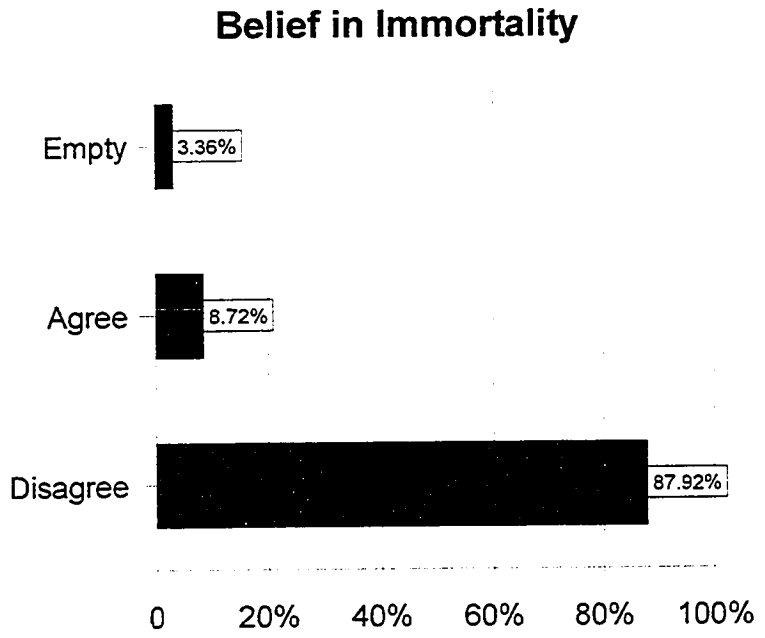


Figure 10. Responses to question six: "I believe that there is something, not known to science, in human beings that lives on after the body dies."

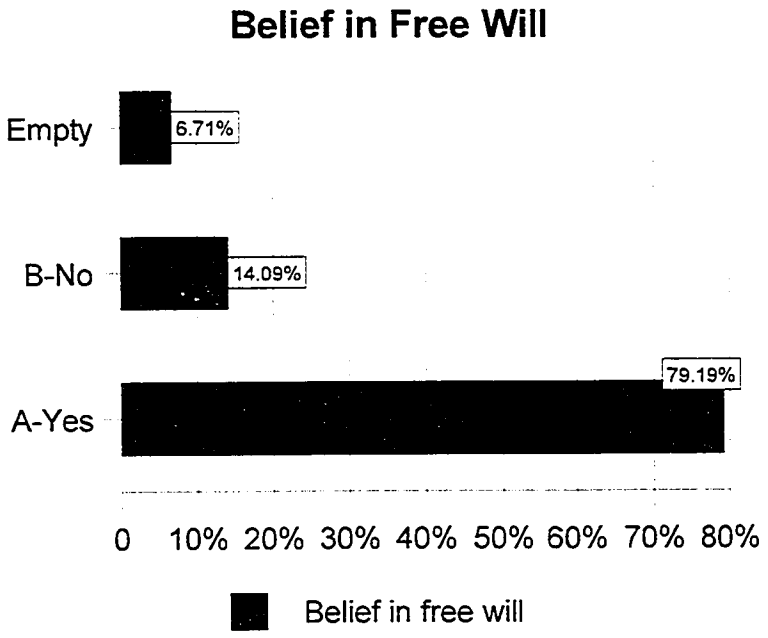


Figure 11. Responses to question seven: "Please choose one of the following: A. All biological organisms are locally determined by heredity and environment but humans still possess free will; B. All biological organisms are locally determined by heredity and environment and humans have no free will."

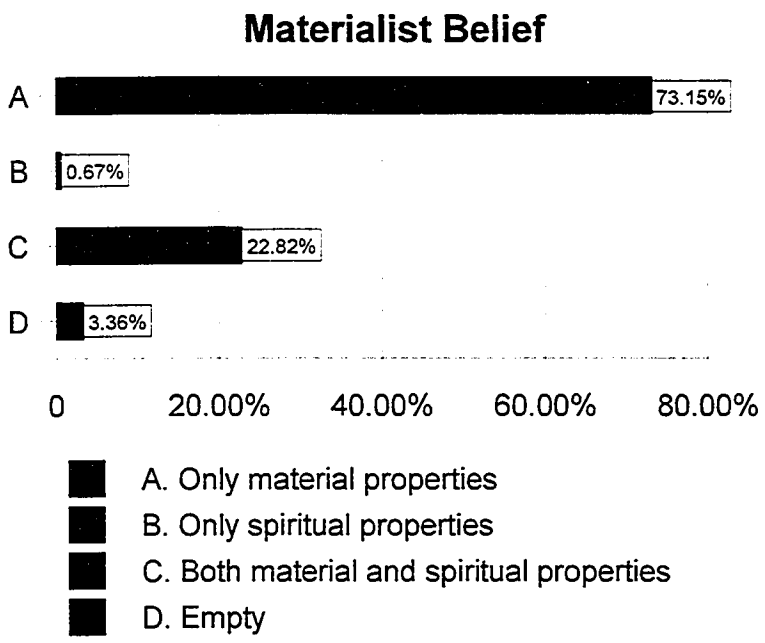


Figure 12. Responses to question eight: "Organisms, including humans, consist of the following:"A. Material properties; B. Spiritual properties; C. Both material and spiritual/non-material properties;
D. Questionnaires returned empty on this question

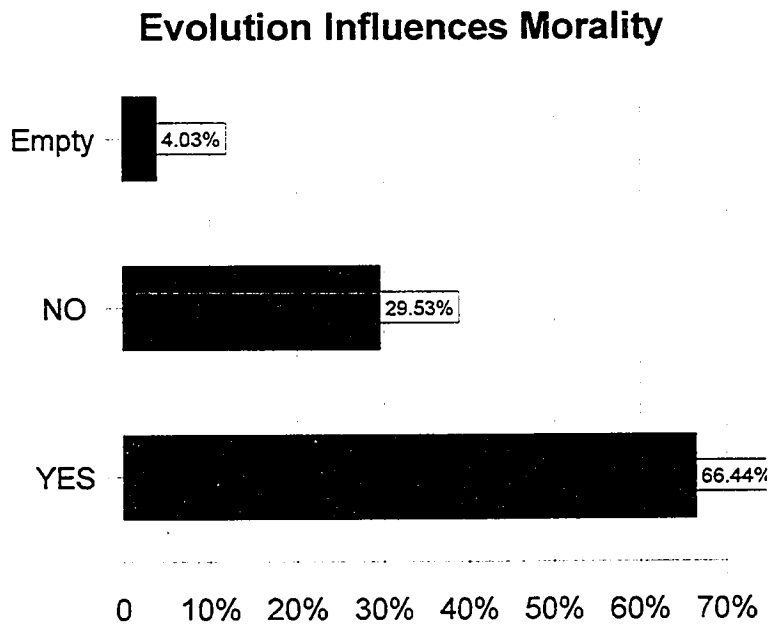


Figure 13. Responses to question nine: "I believe that the findings of evolutionary biology can influence and alter morality."

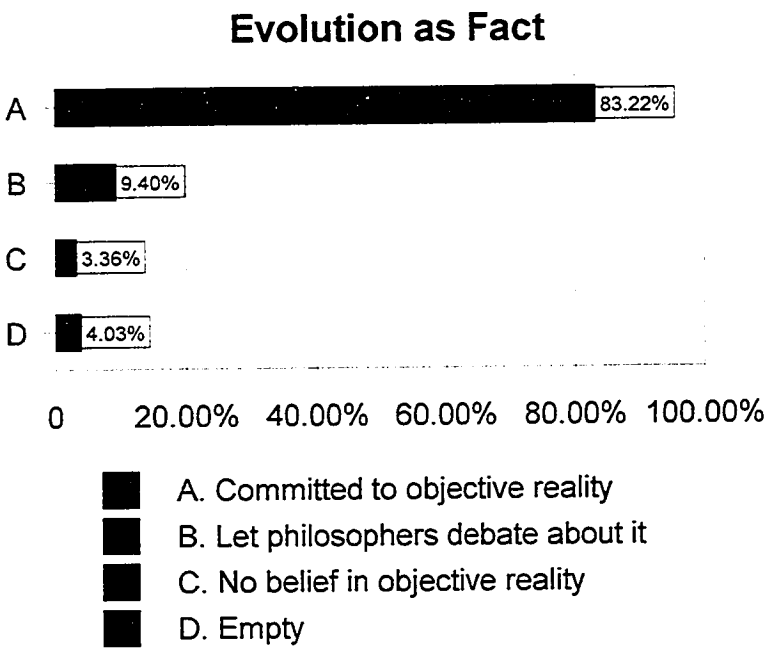


Figure 14. Responses to question 10: "Do you believe that evolution teaches us something about the objective reality of life on earth or is such a topic better left for philosophers to debate?"
A. I am committed to teaching about the objective reality of life on earth; B. I am content to let philosophers debate about objective reality, without addressing it in my teaching; C. I don't believe that there is such a thing as objective reality, we all create our own reality;
D. Questionnaires returned empty on this question.

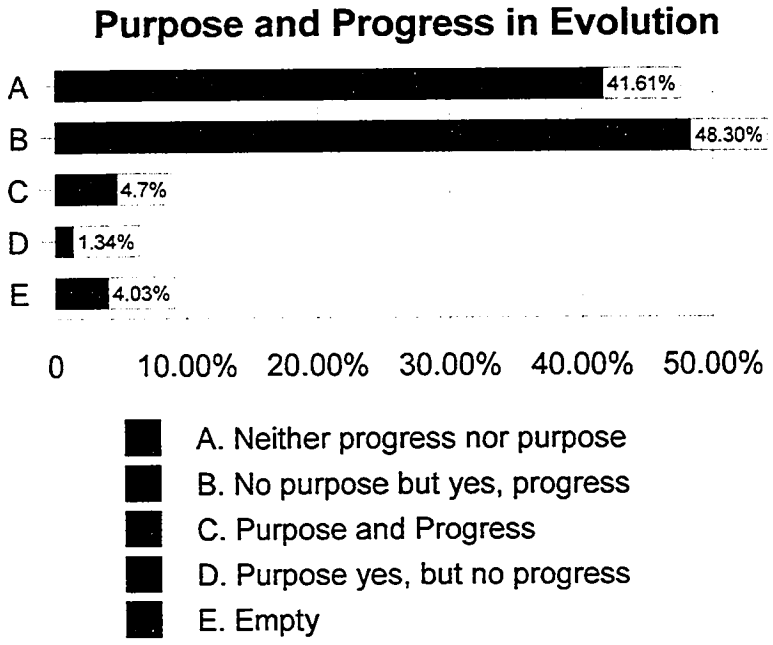


Figure 15. Responses to question 11: "What is your view of purpose and progress in Evolution?" A. Neither purpose nor progress plays any ultimate role in evolution; B. Evolution exhibits no ultimate purpose, but progress does occur in evolution; C. Ultimate purpose plays a role in evolution and progress is a part of that purpose; D. Ultimate purpose plays a role in evolution, but it doesn't entail progress; E. Questionnaires returned empty on this question.

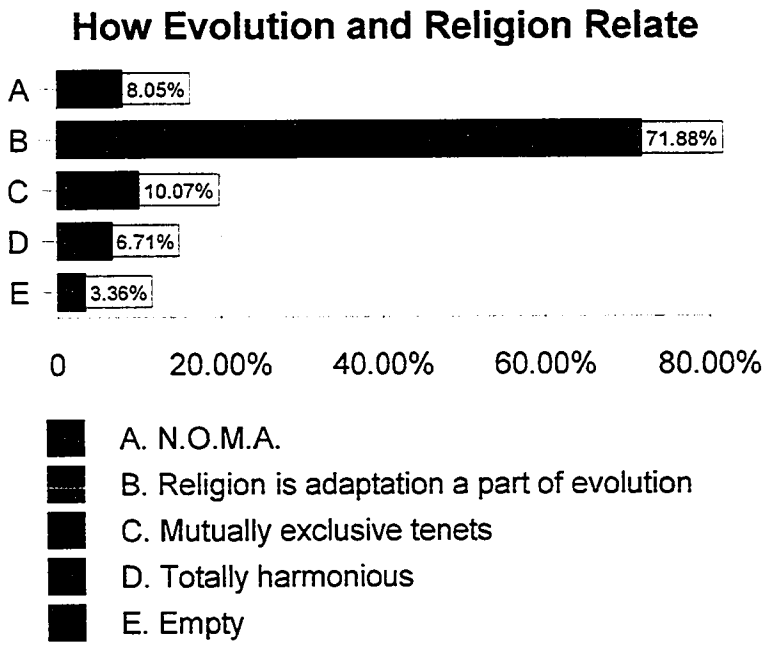


Figure 16. Responses to question 12: " What is your opinion on the relationship between evolution and religion?"A. They are non-overlapping magisteria whose tenets are not in conflict; B. Religion is a social phenomenon that has developed with the biological evolution of *H. sapiens*. Therefore religion should be considered as a part of our biological heritage and its tenets should be seen as a labile social adaptation, subject to change and reinterpretation; C. They are mutually exclusive magisteria whose tenets indicate mutually exclusive conclusions; D. They are totally harmonious. Evolution is one of many ways to elucidate the evidences of God's designs; E. Questionnaires returned empty on this question.

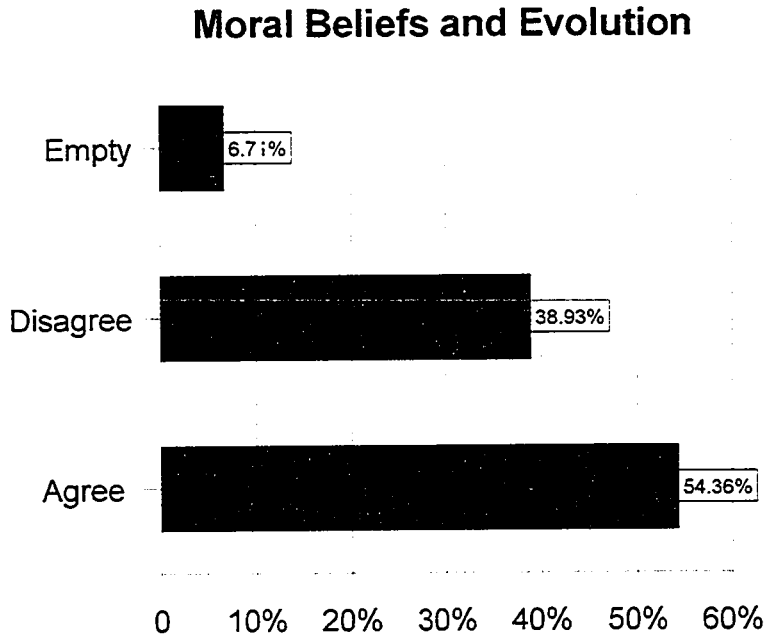
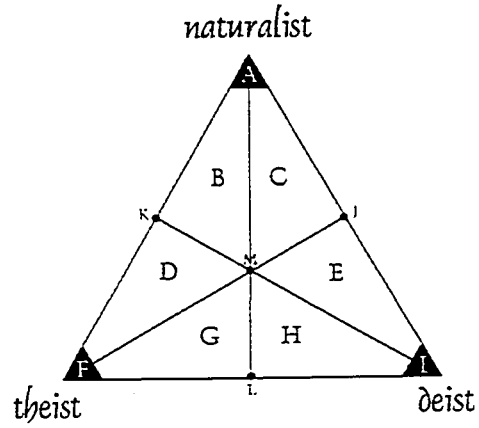
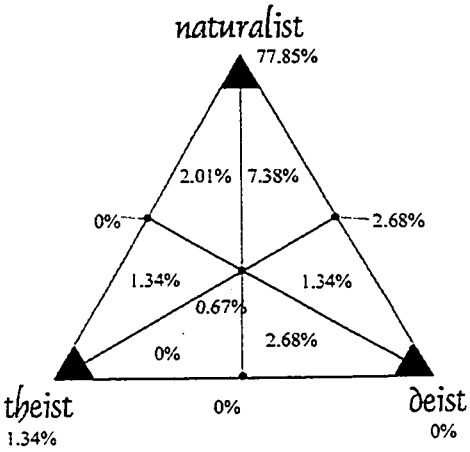


Figure 17. Responses to question 13: "I keep my beliefs about morality and ethics separate from my practice and teaching of evolution."



a.



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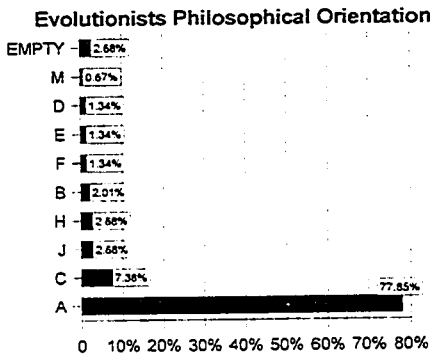

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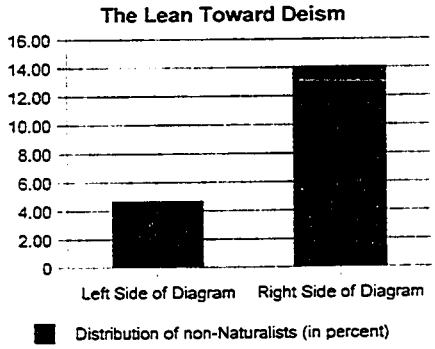

d.

Figure 18 a. Original ternary diagram as it appears in the questionnaire; b. Diagrammatic statistical representation of the choices for each region; c. Statistical distribution of the data shown in b.; d. statistical distribution of those who didn't choose "naturalist." The right side of the ternary diagram, toward "deist," is heavily favored over the left side toward "theist."

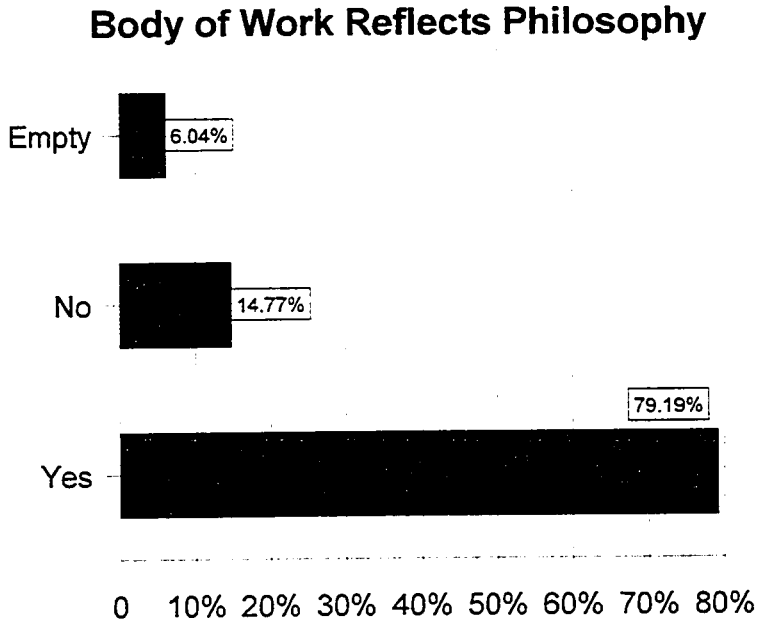

Figure 19. Responses to question 15: "Do you think that your body of work in evolutionary biology reflects your position on the diagram of #14?".

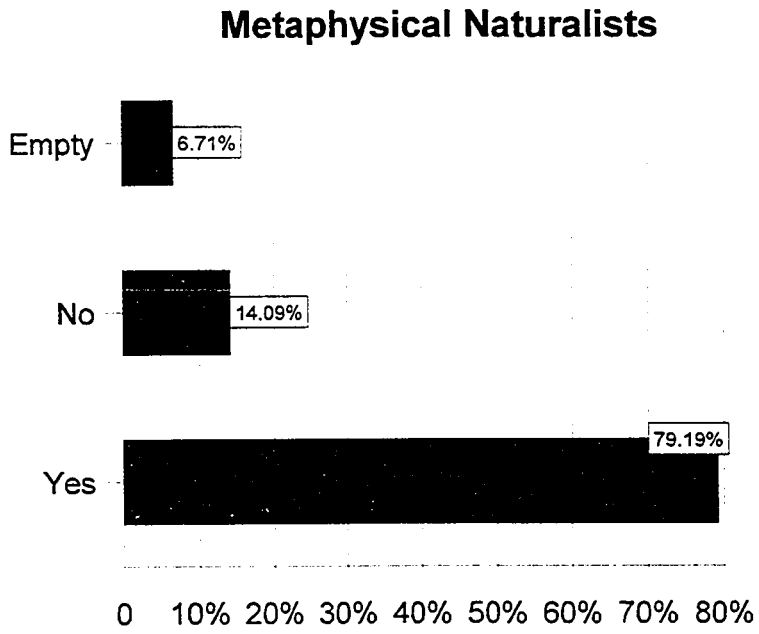

Figure 20. Responses to question 16: "Do you consider yourself a naturalist in the metaphysical sense?"

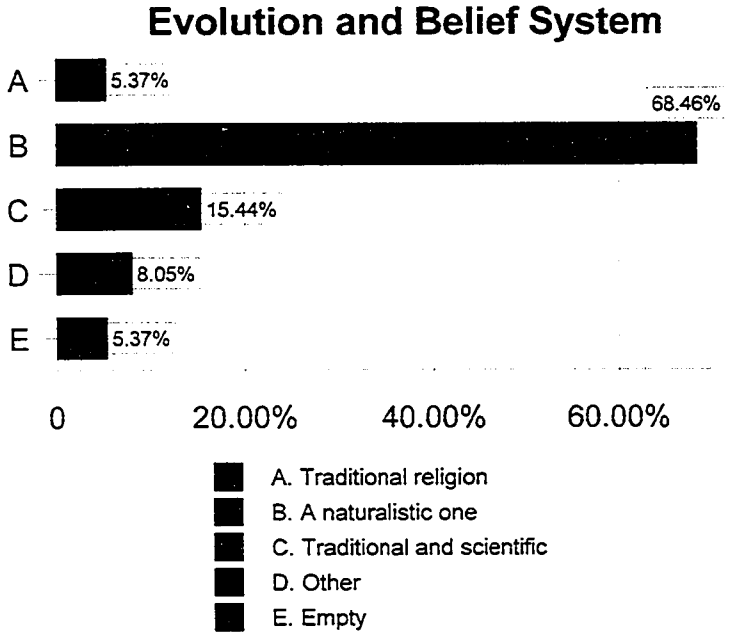

Figure 21. Responses to question 17: "What kind of a belief system would you advocate, if pressed, as being the most consonant with a lifelong practice of evolution? A. One of the traditional religions (i.e. Christianity, Islam, Judaism, Buddhism etc.); B. A naturalistic one that is based on materialism, and incorporates advances in scientific knowledge; C. One that incorporates some aspects of traditional religion and some aspects of modern science; D. Other; E. Questionnaires returned empty on this question.

DISCUSSION

I. Introductory remarks on the interpretation of the results

My training in biology biases me toward quantitative analysis of behavioral data, essentially in the style depicted by Krebs and Davies (1981) and in the spirit of Wilson (1975, ch. 27): "Let us now consider man in the free spirit of natural history, as though we were zoologists from another planet completing a catalog of social species on earth" (Wilson, 1975 p.547). Thought, the characteristic human behavior, can be quantified by questionnaire data and qualitatively analyzed by the methods of social science (Strauss, 1987). The pioneering work by James Leuba (1916, 1934) provides a template for this study. It demonstrates how qualitative and quantitative methods are employed simultaneously to understand religious belief among scientists.

The literature on qualitative analysis "is sparse, and even the ethnographic monographs generally give little clue as to the authors' analytic processes" (Strauss, 1987, p.xiii). Nonetheless, for this project I used both qualitative and quantitative data to understand the similarities in evolutionary biologists world-views.[8] The quantitative approach is revealed by the data from the questionnaire. The qualitative approach is revealed by the interviews (Appendix IV) and by the context of the sample group, all are members of a certain social class - national academy members who study evolution. The following discussion proceeds with a fundamental acknowledgment

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[8] World-view is used in the sense Dobzhansky (1967 p.5) characterizes the German "Weltanschauung:" "The German word *Weltanschauung* [has] no precise English equivalent. The usual translation, "world-view," subtly betrays the meaning. A world-view, like a view from a mountaintop, may be pleasant and even inspiring to behold, but one can live without it. There is a greater urgency about a Weltanschauung . . . [it] is felt to be indispensable for a human being. The Latin "credo" is becoming acclimatized in English in a sense most nearly equivalent to "Weltanschauung."

that analytical methods for qualitative data, though rudimentary as outlined in Strauss (1987 p.1) when grounded in quantitative data, yield satisfying results. One of the problems in collecting data for qualitative analysis is that too much information readily accumulates, creating an unfocused mass of historical and documentary facts that don't easily lead to concise narratives (Strauss, 1987 p. 169). I have indeed collected more data than I will analyze here. My hope is that the biologists' responses and viewpoints are seen as a contribution to historical documentation, and even if some aspects go un-analyzed in this dissertation, they will be of use to future investigators. The results represent the central tendencies (Hinton, 1995) of the participant's preferences for each of the questions.

After a careful historical study of evolutionary biology and science in general, I determined that professional opinions on the compatibility of evolutionary biology and religion were of two classes. On the one hand are compatibilists who see no conflict, characterized by popular works such as Gould (1999), Miller (1999), and Ruse (2001). On the other hand are non-compatibilists who do not see any intellectually satisfying way to reconcile the tenets of canonical religion and evolutionary biology (Darwin, 1958; Dawkins, 1996). The most popular method of maintaining a compatibilist stance is invoking a dualist presumption that maintains two universal realities, one physical and open to investigation by evolutionary biology, and one supernatural, off-limits to science. Under this view, science and religion peacefully coexist only by addressing different realities.

This style of compatibilism blends the language of traditional dualistic theology with biology:

> Those who ask from science a final argument, an ultimate proof, an unassailable position from which the issue of God may be decided, will always be disappointed. . . . But I do claim that to a believer, even in

> the most traditional sense, evolutionary biology is not at all the obstacle we often believe it to be. In many respects, evolution is the key to understanding our relationship with God. God's physical intervention in our lives is not direct. But His care and love are constants, and the strength He gives, while the stuff of miracle, is a miracle of hope, faith, and inspiration (Miller, 1999 p.291).

The history of this style of compatibilism is old and the source is conservatively theological. Consider the following from the Syllabus of the Vatican Council in 1871:

> But although faith be above reason, there never can be a real disagreement between them, since the same God who reveals mysteries and infuses faith has given man's soul the light of reason, and God cannot deny himself, nor can one truth ever contradict another (Draper, 1874 p.348).

The foregoing led me to believe that a major factor driving compatibilism is desire to entertain theological discussions, not hope for an intellectually satisfying union of evolution and religion. To test this I created a questionnaire to understand the world-views of the participants, and to determine how their world-views influence compatibilism. The results show that strong central tendencies are present on many of the questions. The most relevant ones are discussed below.

II. Discussion of results.

II.A Leuba and Larson and Witham revisited.

When James Leuba studied the belief in god and immortality among American scientists in the early part of this century he found that 16.9% of greater biologists (those roughly equivalent in status to the evolutionary biologists of this study, see pg. 8) affirmed a belief in God (Leuba, 1916, p.255). He repeated his study 17 years later, in 1933, and found only 12% of greater biologists at that time believed in God. Recently, Larson and Witham (1999) reported that among the U. S. National Academy

of Science biologists, fewer than six percent affirm a belief in God. As Leuba predicted, the 20th century saw a significant drop in scientists' belief in a theistic god. Mine is the only study in the last 100 years to poll evolutionary biologists exclusively, and it is the only study with an international focus. Direct statistical comparison of the current study with those of Leuba and Larson and Witham is problematic because the sample groups were significantly different. Each investigator was interested in making a different case based on the implications of belief in god. Therefore, the qualitative analyses variously biased the conclusions in each investigation.

For instance, Leuba was a psychologist interested in understanding how the educated mind is socially biased. Therefore, he polled numerous demographic groups from college students to senior professional scientists of every conceivable sub-discipline. The huge scale of his sample group required a very small number of questions, and he only focused on a few broad issues: belief in god, belief in immortality, and the desire for immortality.

Edward Larson is a law professor and social historian at the University of Georgia and Larry Witham is a religion journalist and theist (he affirms that he believes in "Leuba's God," i.e., one who answers prayers, see Larson and Witham, 1999 p.92 and author notes p. 93). Larson and Witham's publications (Larson and Witham, 1997; 1998; 1999) focus on the role of scientists in American life, expressing worry about "the balancing act that materialists in science must play, living and working as they do in a traditionally Christian culture." (Larson and Witham, 1999 p.91). "What stands out is an image of American natural science that has not fundamentally changed since 1914" (p.90). Their analysis reveals that shifts in scientists' political maneuvering, as opposed to the increase in scientific knowledge, leads to more room for religious beliefs in our society. They conclude with: ". . . some

politically savvy scientists (in the U.S.) recognize the value in downplaying the negative implications for the supernatural that arise from their study of the natural." (Larson and Witham, 1999 p.93). Their interpretation serves their goal of limiting the authority of science in a Christian culture.

To summarize, we have three studies that are ultimately focused on addressing three different aspects of science and religion. Larson and Witham were ultimately focused on demonstrating that believing in god affects all of modern American society, even its most prestigious scientists; Leuba was focused on understanding the distribution of belief in god among American demographic groups; and, in the current project, I am asking, among other things, how is belief in god distributed among the most prestigious masters of evolutionary theory, and what role does belief play in forming the world-view of this group of scientists?

My belief-in-god statistics are qualitatively comparable to Leuba's and to Larson and Witham's. Figure eight shows that, worldwide, the top evolutionary biologists have a higher frequency of belief in god than do American biologists of the National Academy of Science from Larson and Witham's study (Larson and Witham, 1999; Figure 8, "A" and "B"). Question 14, however, asks the participants to precisely define their philosophical belief and only 1.3% favor strict theism (Figure 18, c, F), 3.3% favor a mix of theism and naturalism (Figure 18, c, D, B), adding up to the lowest percentage of theistic belief in any of the studies cited, 4.6%. Thus, my worldwide sample of evolutionary biologists from national academies shows the lowest rate of belief in a theistic god for any group of scientists polled previously (Leuba, 1916, 1933; Larson and Witham, 1997, 1998). Leuba would rejoice if he could witness that his predicted downward spiral of theistic belief continues into the 21st century on a worldwide scale. The rejection of immortality in my results is 8.8%

(Figure 10, "Agree"), slightly higher than Larson and Witham's (1998) statistic for American biologists, 7.1%. Most of the participants in my study who cite a belief in god are deists (Figure 14 D), and this demands a closer look.

Leuba's questionnaire gave only one choice for those who believe in God: #1, "I believe in a God in intellectual and affective communication with humankind, i.e., a God to whom one may pray in expectation of receiving an answer. By 'answer' I mean more than the subjective, psychological effect of prayer." The other two choices were #2, "I do not believe in a God as defined" or #3, "I have no definite belief regarding this question" (see Larson and Witham, 1997 p.436 for a reproduction of the questionnaire). It is clear that if a deist answered Leuba's questionnaire he would have no option but to choose the second because he in fact doesn't believe in god as defined, but he still believes in god! This throws into question the entire statistical conclusion reached not only by Leuba, but also Larson and Witham, who repeated the same faulty questionnaire.

My questionnaire forces the participants to specify whether they believe in a theistic or a deistic god (Figure 18). Leuba was only interested in theistic belief because deism was one of those "God conceptions known to philosophers" that are so often associated with atheism. Leuba was only interested in

> religion as it actually exists among us in its organized forms; i.e., I desired to determine with some degree of accuracy the percentages of believers and of non-believers . . . [because] Christian worship, in all its varieties, the Unitarian not excepted, implies the direct, intellectual and affective communication of man with God, in the definite form which communication takes between man and man: i.e., an exchange of ideas and feelings and an expression of desires and intentions accompanied by the conviction that God may grant request or desire, whether it be a change of weather, a cure of disease, or a deliverance from moral evil. Abandonment of that direct personal relation would so materially transform the existing religions as to make them unrecognizable (Leuba, 1916, xvii).

The deism of participants in the present study qualifies as unrecognizable to Leuba's and Larson and Witham's questionnaire. They would have been considered non-believers.

Was this just careless experimental design? Leuba deserves the benefit of the doubt. He was not careless in his construction so much as he was merely attempting a different sort of analysis. He was not interested in understanding the variation in belief systems. His analysis was based on understanding the psychological aspects of specifically Christian belief which is founded on a theistic philosophy. It seems clear why Leuba didn't include an option for deists; he probably didn't care if they were grouped together with non-believers. Larson and Witham could have been more careful in their methodology because they understand the historical importance of deist belief among scientists.

My study shows that deism is still active among evolutionary biologists, and, if it was prevalent earlier in the century, it would have skewed Leuba's data. Larson and Witham's analysis doesn't address deism. Since they repeated Leuba's questionnaire exactly, there is no way they could distinguish deists from non-believers in their sample. Almost seven percent of the participants in the current study express a belief in deism, over half of those who affirm a belief in god (Figure 8, "B"; Figure 18, "d"), suggesting that deism is still a popular alternative for scientists who maintain some sort of a theological world-view. The failure of other studies to offer an option for deism likely biased their conclusions toward a lower frequency of belief in god than actually exists among biologists.

II.B Religious evolutionists

II.B.1 Julian Huxley and Ernst Haeckel, religious evolutionists of the past

Julian Huxley was one of the most influential biologists of the 20th century. He thought evolutionary biology formed the foundation of a new type of religion, one that is not dependent on blind faith in "revelation" (Huxley, 1957). Huxley stated that scientific hypotheses are to science what god is to religion, basically

> attempts to understand the cosmos and explain or at least interpret the facts of experience . . . . History shows an increasingly successful extension of the naturalistic approach to more and more fields of experience, coupled with a progressive failure and restriction of supernaturalistic interpretation" (Huxley, 1957 p. 51).

Huxley's interpretation of religion matched his view of human evolution as "biological improvement" (Huxley, 1953 p.34) almost perfectly. He characterized religion as showing a history of progress, purging itself of "baser elements such as fear" in favor of more noble pursuits (Huxley, 1957 p. 11).

Julian Huxley provided a respectful view of the history of religion, as having a course all its own, fusing eventually with science, toward greater human achievement. In order to facilitate the fusion, Huxley took certain traditional theological matters seriously, such as the "Spiritual forces at work in the cosmos" (Huxley, 1957 p.209), which proved to meld with teleological depictions of evolution that became widely criticized (Huxley wrote the preface for Teilhard de Chardin [1964], probably the most criticized of all books on evolution in the last 50 years). The influence of Huxley's vision at the time, however, was his conception of "god as nature" characterizing the new, naturalistic religion.

Traditionally then, god is the way to understand the cosmos in the absence of

natural science, but today, according to Julian Huxley, in our more advanced social state, god is redefined as being understood through natural science. To him, god can be seen "under one aspect as a number of vital but separate facts . . . regarded as a unity, as a creation of the human soul, compounded of the hard facts of soulless nature" (Huxley, 1957 p.14). In this respect, natural science is theology without supernaturalism at its core. This was Julian Huxley's way of eliminating any controversy between science and religion; he merely subsumed religion under the guiding principles of science. His religion focused on making sense of the natural world through scientific understanding, and for Huxley that meant evolutionary biology should play a central role in this new theology.

A similar view was expressed earlier in the century by Ernst Haeckel (1920), who strongly advocated for a monistic belief system that he saw as most consonant with an evolutionary world-view (also see Haeckel 1894). Haeckel based his beliefs on naturalistic biological discoveries, just as Julian Huxley would decades later. For instance, Haeckel discounted the traditional view of the soul, because it could not pre-exist before sperm and egg are united (Hackel, 1920 p.138), the ovum being "the unicellular starting-point of the individual life from which the complex multicellular frame of all the . . . tissue-forming animals and plants is developed." The material ovum also precludes the possibility of immortality, for "[o]ne cannot see how a being that thus has a beginning of existence can afterwards prove to be 'immortal'" (Haeckel, 1920, p. 138).

Despite having had good grounds to reject the traditional theological explanations of it, Haeckel still honored the idea of the soul. He confidently wrote about the "cell-soul and its memory" and of hereditary transmission that "extends to the finest characteristics of the soul as well as the body" (Haeckel, 1920, p. 137).

Accordingly, he saw the soul as a material property shared with, but differing in degree of development, all higher mammals (Haeckel, 1920, p. 145). Haeckel didn't abandon religion, he merely based it on materialist principles and suggested we re-interpret the canons based on our new understanding of biology.

Unquestionably, had Haeckel's and Huxley's conceptions been adopted widely by society, the face of religion would have been drastically altered from its traditional dualistic stance to a monistic theology. Religion had a place in Haeckel's and in Huxley's evolutionary biological world-views. To some degree, that tradition is still found among today's evolutionary biologists as revealed by the results of this study. Haeckel and Huxley both would likely have chosen Q1, "A."

Haeckel's views were willfully forgotten by scientists because of cultural factors that center around the fascist movement and its collapse. Haeckel's views about monism were readily adopted into the fascist ideologies. Around the middle part of the 20th century, anyone whose name became associated with Hitler and Mussolini was quickly forgotten. This might be the reason that Julian Huxley doesn't cite Haeckel at all in his 1927 version, nor his 1957 updated edition of *Religion Without Revelation*, even though the views expressed in that book were very similar to Haeckel's. Invoking the German scientist as an ally might have raised even more controversy for Julian Huxley, whose religious views were already controversial.

The attack on Haeckel continues to this day, from sociologists. Scientific Haeckelian monism is "the most important common denominator of National Socialist and Fascist ideology throughout Europe" before World War II (Gasman, 1998). Furthermore, Haeckel is overlooked entirely by modern philosophers such as Midgley whose book *Evolution as a Religion* mentions nothing of Haeckel. (Midgley, 1985 for example). Had Ernst Haeckel's ideas been embraced by democratic governments

during WWI and WWII rather than by his native Germany, Haeckel might have had a different fate. Julian Huxley's ideas, also monist, never were embraced by fascist governments. But for that historical fortitude, and the probably willful abandonment of the word "monism" from his titles to distance himself from fascism, Julian Huxley is spared from the ire of social historians, even though his naturalistic religious views were every bit as monist as Haeckel's and, ironically, his prose is far more socially ideological than was Haeckel's. Most of the participants in this study were being educated about evolution during WWII or within a decade of its conclusion; a time when Julian Huxley's progressive new religious ideology seemed particularly relevant while Haeckel's "confession of faith" was all but forgotten.

II.B. 2 Religious evolutionists of the current study

Is there any remnant left of the tradition established by Ernst Haeckel and Julian Huxley? The rejection of religion by evolutionary biologists in the current study is very high, 84% (Figure 5). Had Haeckel or Huxley answered question number one on my questionnaire they would have likely answered "YES" or at least indicated in the commentary section their sentimental feelings toward religion. Very few comments were received on this question at all from the participants, just an outpouring of negations.

Of the 14 percent of the respondents who answered "YES" to Q1, we find only a hint of the naturalist religious tradition established by Haeckel and Huxley. In one case, it is from a senior member of the study group, Ernst Mayr, who actually uses Julian Huxley's term "evolutionary humanism" as equivalent to "naturalism" to describe his sentiments toward religion. Most who checked "YES" qualified their answer in some way to explain why they consider themselves religious. Those who

answered "NO" generally did not find it necessary to explain or qualify their answer. One respondent from India stated a view that clearly negates Huxley's hope for a new advanced religion devoid of base elements: "A significant proportion of scientists in India 'worship' God not because of strong belief but due to fear or even due to 'obsessive compulsion' induced in the childhood." Another comment, from a respondent in Africa, shows that some of the participants have religious views that significantly pre-date Ernst Haeckel, and are perfectly acceptable examples of 18th century Voltairean deism:

> I think that the creation signifies the settlement by God of the laws and the principles which are responsible for the course of the universe and the maintaining life on earth. So, for me, the laws of evolutionary biology and of evolution are a part of the principles of this creation. And the scientists are discovering little by little these laws during their works and their experiments.

This passage belies either a complete discounting or a complete ignorance of any of Ernst Haeckel's or of Julian Huxley's religious ideas.

Another respondent melds knowledge from neuroscience to form a religious opinion:

> I don't believe God intervenes in any direct way (e.g., causing the "accident" or the disease or the weather, eruption etc. . . .) or played a role in the billions of years before humans. (S)He is distributed among all human minds, is a creation of our minds, can influence our free will and act in the world through that influence. . . . My God is a caring (for humans) entity but does not intervene physically. He acts through humans, whose attitudes, motivations, and priorities are influenced by God and other humans.

To this scientist, some ghost in the machine might be understood by neurobiologists eventually, but his view differs dramatically from that of Haeckel and of Huxley who see humans in charge of their own destiny. No caring god is directing us in any way. Both of the above comments express a deistic world-view infused with a healthy dose

of dualism. Indeed, the latter respondent chose "BOTH" on question eight, indicating his belief that material and spiritual properties make up organisms. He is a dualist. In fact 80% of the respondents who answered "YES" to number one answered either "B" or "C" on number eight, explicitly acknowledging their dualist belief. Eighty percent of the religious evolutionary biologists in this study are dualists (12 out of 20).

A unique dualism is offered by a participant from Canada who considers himself religious and thinks that god is only interested in human beings: "I believe God intervenes in this world through the lives of people who are in contact with God, but does not intervene to mediate the effects of the natural laws of the physical and biological universe." He makes a distinction between natural laws (operating on material properties) and god (operating on distinctly human properties, i.e., the mind and its products) that corresponds nicely to a traditional dualist perspective.

The foregoing view could have just as easily been proposed if the questionnaire had been distributed in the 17th century, for Descartes himself would have agreed that god is responsible for the mind substance, which does not obey the mechanical laws that control our bodily functions. The respondent here differs from the classical dualism of Descartes, however, in that he believes that god has no part in the mechanistic laws of the universe. Notice how this respondent rejects one half of the classical dualist position, the half that sees god as creating the laws of the universe. Descartes' classical dualism holds that god created both the laws of nature (which we can study and know) as well as the laws of the mind (which are beyond our abilities to observe).

Another religious participant, from the U.K., offered the following:

> I believe that Christianity, the only religion of what I have significant experience, captures much truth about the Nature of human experience, and yet I believe that "God". . . was created by man. I would prefer to

> say that our idea of "God" is an emergent property of our own consciousness - and in that sense, does exist in "Nature."

The foregoing is, to this respondent, one of the ways religion and biological science intersect, offering us a vestige of Haeckel's beliefs, in the sense that they both accept god as a product of the material human brain.

This respondent further elaborates his rejection of dualism: "I reject the dichotomy of material/spiritual. Just as life is an emergent property of the non-living, I see spiritual as an emergent property of the material." Here we see a word that was not at Haeckel's disposal, "emergent". Use of this word is a clever tactic for evading the metaphysical question of whether the spirit exists or not. If spirit is an emergent property, in what sense does it exist (see below)? Nonetheless, this respondent leans toward monism in his acknowledgment that the spiritual comes from the material. Logically, if the spiritual is wholly dependent on the material, they are both composed of the same substance, which is a monist position. This participant makes things more confusing than they need to be, however, by implying that the emergent property of god belies a different metaphysical reality than the brain cells from which it came. He insists god exists, which sounds dualist, but he explains god out of existence by suggesting that god is wholly dependent on human brain cells in action, which is monist.

The religious tradition established by Ernst Haeckel and by Julian Huxley is nearly forgotten. The vast majority of the respondents do not consider themselves religious at all (Figure 1). Of the small percentage of participants who consider themselves religious, very few explicitly profess the monist faith that Haeckel advocated, and fewer still accept the progressive view of religion maintained by Julian Huxley. As illustrated below, the bulk of monistic faith is instead found in the non-

religious portion of the sample group, although it is not always explicitly promoted. According to my results, the religious evolutionists are primarily deists (Figure 22, caption), motivated by dualistic tendencies, and interested in entertaining traditional theological discussions.

The optional biographical information some of the religious participants provided reveals that half of the religious evolutionary biologists come from merely two professional sub-groups, paleontologists and botanists. Only two religious respondents (10% of the religious evolutionary biologists) are professional behavioral or field biologists or geneticists, the two fields that have emerged as the leading areas of evolution research in the 20th century. The vast majority of evolutionary biology sub-disciplines are free of religious thinkers while paleontologists and botanists have the highest likelihood of harboring religious evolutionists. Roughly 40%[9] of all paleontologists who participated in this study answered "YES" to Q1, and they make up the largest single group of evolutionary biologists who consider themselves religious (Figure 22).

Perhaps the most revealing extant version of Julian Huxley's religion without

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[9] Numerous questionnaires were returned anonymously so these percentages are rough approximations based on positive identifications. Also, some people refused to answer Q1.

revelation can be found in the views of George C. Williams, who, along with Ernst

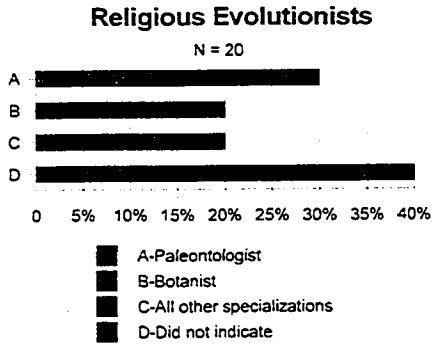

Figure 22. Evolutionary biologists who consider themselves religious are comprised primarily of paleontologists and botanists.

Mayr, answered "YES" to number one and represent the only two field naturalists of the study to do so. "That creation out there implies a creator" wrote Williams on his questionnaire:

> The idea is: let's define God as that which produced that universe out there. Now this means that theology can be a real science. You go examine that universe and come to conclusions about the designer and perpetrator and whatever you want to call it. I think the term "first cause" may be a little too simple. There may be a collection of causes. But at any rate, I don't think we should imply that there was a first cause but then no subsequent influences on what that universe is doing. These are things you want to find out - you examine that universe. Do we need to recognize something is doing something to it now? Or is it simply following its own internal attributes to wherever they lead? (Appendix IV, Williams interview).

Like Julian Huxley, Williams accepts a theology, rooted in naturalism, that studies "religious reality from the side of the intellect" (Huxley, 1957 p.99) as opposed to the side of emotion or intuition. The role of god in this type of theology is defined by Williams (1997 p.153) "Whatever entity or complex of entities is responsible for

the universe being as we find it, rather than some other way or not there at all, can be called God." This image of "whatever entity" compares nicely to that of Julian Huxley's (1957 p. 101) conception of god as "an interpretation . . . of certain ultimate and irreducible facts." In this sense god has a complexion unlike any that we could imagine, composed of laws and material entities that are everywhere yet untenable, only manifest in their control of observable phenomena.

Quite simply stated, Williams' deist god is the origin of everything and the way to know god is by studying nature. Williams differs from Huxley in that he feels no desire to discuss cosmic spirit or progress, but his willingness to include theology in evolutionary biology and his deistic conception of god is remarkably Huxleyan. Furthermore, his conception resembles Julian Huxley's unrepentant affirmation of a religious world-view.

Thus, Williams is a case in point. Deists have a non-canonical religious world-view, and yet retain a desire for theological constructs in evolutionary biology. In what sense is this view religious at all? Isn't it merely equivalent to science in general? The deists do not resemble any kind of traditionally pious person who believes in a theistic god. In fact, Williams' world-view is completely offensive to a traditional religious view:

> The thing that really interests me is that if a designer [god] is somebody who does something for a purpose, you can examine something and see if it is really related to that purpose - and the only thing out there in the universe that does this is living organisms. The classic example being that the eye is for seeing with, and I think that is a totally justified idea. That's what the eye is doing. And it's precisely and elaborately designed for that function. But if you look at the design, you find that in all these attributes of organisms, if you look closely enough there are some really stupid aspects that ought not to be if it were intelligently designed. And the backwards retina is the best really good example of that. And of course, lots of arbitrary things like why are there six muscles that move the eyes. I think three would do it. . . . so God is

> mighty but fortunately he is stupid, so we can outsmart him. . . . But if you try to find out about the creator by examining creation objectively, then it seems to me, you've got a perfectly reasonable way of establishing a religion (Appendix IV, Williams interview).

Williams' idea of accepting a religion based on science is nearly indistinguishable from the denial of traditional religion by science. He suggests that a religion can be founded by revealing the stupidity of the deity, which is precisely the same argument for disbelieving in a deity at all, and not needing a religion to form a world-view in the first place. Fundamentally, Williams expresses the naturalistic world-view, but he insists on deism because of his desire to accommodate some sort of discussion of god. But his deist god is not any kind that theologians accept, so who is he accommodating?

The extension of evolutionary biology into the realm of ultimate questions is a religious exercise for Williams. For most of the participants, it is not. According to my study, only a small minority of evolutionary biologists allow theology or religion to play any role in their naturalistic world-views. In order to do so, they by and large reject the monist ideas of Ernst Haeckel and of Julian Huxley, and instead revert to creative deistic philosophies, often tinged with dualism (Figure 12 C). An even smaller minority, characterized by George C. Williams, consider themselves religious, and accept that theological questions can be appropriately addressed from an evolutionary biological perspective. This might be the last surviving vestige of Julian Huxley's "religion without revelation."

Finally, almost 84% of the world's leading evolutionary biologists reject religion entirely (Figure 5). Richard Dawkins, for example, suggests that religion is just bad science:

> If you look at why people actually believe their religion - ordinary naive people in the pew in the church - it's because of miracles. It's because Jesus healed the sick, and Jesus rose from the dead, and the virgin birth, and all that stuff which is absolutely flat scientific theory. It's erroneous scientific theory. It's making scientific claims, and that's what impresses people. And that's why people buy into it.
>
> Most of the people who are in church would not be there if they had to accept separate magisteria; therefore, no miracles, no supernatural, no life after death, no healing the sick, no rising from the dead. All of that would have to go [because science is the magisterium of these theoretical claims]. And as far as they're concerned they'd say, "Well that's my religion, gone!" (Appendix IV, Dawkins interview).

Dawkins suggests that science is a better way to understand the world; and he implies that if people were better educated they too would reject the traditional explanations of western religion.

A similar view is expressed by the following comment from an atheist's questionnaire:

> Although I am a thorough naturalist I do not necessarily assume that application of the scientific method(s) will enable us to learn everything. However, I believe that appeals to a deity add zero information content. Saying "God did it" is equivalent to saying "I don't know."

The last two quotes exemplify the dominant belief among the sample group that religious appeals are useless for a naturalist world-view.

II.C Agnostics, atheists, and naturalists.

An agnostic is reluctant to state his beliefs about anything unless there are sufficient evidential grounds on which to base them. Consider geneticist J. M. Thoday's response to number four: "No answer fits the true agnostic position. My position is met by 'I don't believe in an interfering god, but I DON"T KNOW whether there was a creator or not'" (he chose two answers to this question, the Deist option

Q4, "B" as well as "C:" "I don't believe in God in any traditional sense of the word"). Here is a classic example of the agnostic tradition, a reluctance to state belief because one's world-view is so dependent on known facts for its construction. To an agnostic, if there is no knowledge, there is no opinion.

Agnosticism, a Victorian tradition, grew out of the positivist philosophy of Auguste Comte, a philosopher deeply influenced by Francis Bacon of the late 16th century: "All good intellects have repeated, since Bacon's time, that there can be no real knowledge but that which is based on observed facts" (Comte, 1856, p.27). Comte's major struggle in life was to found a non-theistic religion that put aside the failings of the Medieval canonical theology in exchange for a progressive theology thoroughly grounded in metaphysical truths discovered by science (Ruse, 1995). One of those failings was a dependence on revealed truths as a source of knowledge. The modern agnostic, as exemplified by comments like Thoday's, above, has no faith in revealed truths of religion, and yet will not testify to any beliefs that aren't thoroughly grounded in fact. But this tradition misses something in its eagerness to maintain a positivist scientific stance. Comte himself acknowledged that

> . . . it is equally true that facts cannot be observed without the guidance of some theory. Without such guidance, our facts would be desultory and fruitless; we could not retain them: for the most part we could not even perceive them (Comte, 1856 p.27).

Thus, an agnostic has no way of making use of facts about gods because he has no theoretical guide for which to make discoveries about gods. In this sense it is a thoroughly un-scientific stance.

The atheist, however, erects a null hypothesis that states essentially "no gods exist." If no evidence supports claims of a god's existence, they are rejected as untrue. The rejection of god is based on the success of science at explaining all known

phenomena. This attitude is apparent from the high percentage (88%) of atheists who affirm that there is not enough evidence to justify belief in God (Figure 9, "B"). They reject god on hypothetico/deductive grounds due to lack of evidence, in concert with their purely materialistic naturalist world-view. Richard C. Lewontin states it like this:

> I don't know what to say to [my critics] who tell me "Well, you just start out as an *a priori* materialist," just like they start out as, say, an *a priori* deist. I say "yeah, that's right, end of discussion." You have to make up your mind whether you're going to describe the world in material terms and assert that everything is material or not. And if you're not, then the sky is the limit. The advantage of my [materialist] system is that I'm bounded. I can't make it up. I'm not allowed to make it up. Whereas if I were a deist I could make it up. . . . I go along with Lewis Beck who said, "Anybody who believes in god can believe in anything." That is literally true (Appendix IV, Lewontin interview).

The naturalist who professes an agnostic position is a curious sort. He remains true to a naturalistic method of obtaining truth, but refuses to incorporate an hypothetical stance on the issue of god, as if it is beyond reason. This is far more conciliatory to western religious tradition than is the naturalist atheist position and we might be witnessing the tradition of etiquette instead of the application of science among the agnostic naturalists.

Consider the reluctance of G. C. Williams to call himself atheist, "Perhaps I should take a moment to deal with what I mean by God. I am not an atheist flaunting a caricature to offend people's religious sensitivities." (Williams, 1997 p.152). Although Williams does not describe himself as agnostic (rather, he is self-described as "anti-theist"), he typifies here the attitude that atheists are tacitly militant and offensive in promoting the hypothesis that god does not exist.

Another of the participants was quick to point out an unsolicited comment on this question: "I am not opposed to religious faith in others" as if Q3 implied some

sort of antagonism. Agnostics never receive such ire or scrutiny because they fail to take a position on the issue. We are left with confusion when trying to interpret what they believe.

The following comment comes from someone who checked both "agnostic" and "naturalist" on Q3: "I am a 'naturalist' but agnostic about realities beyond matter." This participant acknowledges 'realities beyond matter,'" which actually excludes him from the philosophical naturalist position, regardless of his desire to ally himself with it. The classic agnostic stance is to state no knowledge about something that is pre-defined as unknowable, in this case realities beyond matter, whatever that might be. In any difficult discussion the best way to avoid controversy is to side-step the issue at hand; and when it comes to the existence of god that is precisely what an agnostic does.

As long as atheism is seen as militant and intransigent instead of a working null hypothesis that is subject to falsification, perhaps the best we can hope for is a compromise somewhere between agnosticism and atheism, akin to Williams' anti-theistic deism. In addition to Williams, Belgian cell biologist and Nobel Prize winner Christiane deDuve expresses such a compromise position:

> My own position I find difficult to define. I could take refuge in agnosticism, except that this position appears to me a cop-out, a comfortable way of evading the issue. If pressed, I refuse to describe myself as an atheist. Yet, I am unable to subscribe to the notion of an anthropomorphic God. In my view, we must "depersonalize" God, just as the new physics tells us we must "dematerialize" matter. To me, there is no other term in our language for the entity that will emerge in this way than "ultimate reality" (deDuve, 2002, p.303).

The belief in ultimate reality is a poetic tool, but useless to the scientist. In deDuve's words, ultimate reality is "something ineffable, utterly mysterious but real" (p.308) which suggest his ultimate faith in entities beyond the scope of science (Figure 8).

Question number three (Figure 7) reveals that preferences are widely

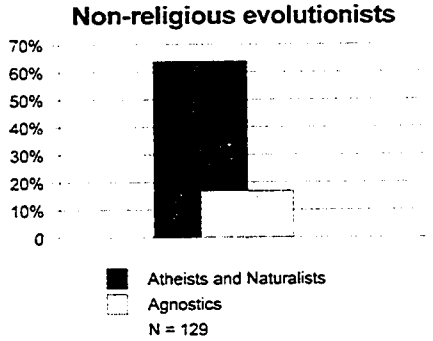

Figure 23. A comparison of the non-religious respondent's preferences reveals little satisfaction with agnosticism and predominance of atheist and naturalist belief systems. See Figure seven for raw data.

distributed among the non-religious participants with respect to atheism, agnosticism, and naturalism. Atheists, however, dominate by almost double the frequency, over the preference of Naturalism. Agnosticism shows the lowest preference. Taken together, atheists and naturalists outnumber agnostics four to one (Figure 23).

What does it mean to characterize oneself as naturalist instead of atheist? One respondent checked both "naturalist" and "atheist" on Q5, indicating a conceptual similitude in these two terms. Question three shows, however, that many respondents prefer the term naturalist more than atheist. Could it be that the participants simply don't like the confrontational stigma associated with atheism? Or are there measurable differences in the way someone who is a naturalist with respect to belief in God might construct her philosophical world-view with respect to deism and theism? One way to answer this question is to analyze the answers from numbers five and 14 from the different perspectives of the belief systems in question three.

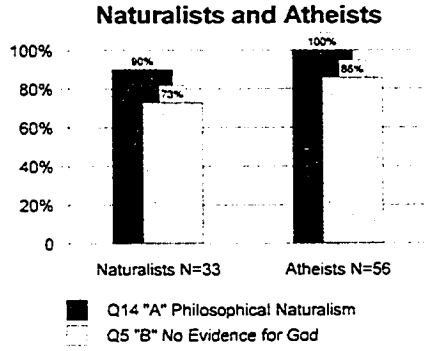

Figure 24. Slight differences exist between naturalists and atheists in their beliefs about evidential support for God. Atheists are less likely than naturalists to decouple their beliefs about God from their scientific philosophy (Q5, C). Atheists show a total commitment to philosophical naturalism (Q14, A) while, ironically, naturalists are more likely to stray toward deism.

The answers for Q5 taken by themselves strongly suggest that evidence plays a major role in the beliefs of most participants (Figure 9). I found a high correspondence between atheism and evidential justification for belief in God (Figure 24) in addition to a total correspondence between atheism and philosophical naturalism, confirming the viewpoint of Richard Dawkins (from Appendix IV, Dawkins interview):

> I think of it [naturalism] as anti-supernaturalism. It is a belief that we should not believe as if there are entities in the universe for which there is no evidence. It's very different from saying that I deny that there are any entities that we don't yet know about. There are plenty of things that we don't yet know, but those are things which are waiting to be drawn into the embrace of naturalism. . . . And I'm inclined to think it's more of a hope than a belief - it's a hope that science will be powerful enough that the category (of things we don't know yet) will eventually become zero. . . . I would like to phrase it as naturalist in the sense of including atheist. Nobody who is an atheist would not be a naturalist

Thus, to the atheists of this study, god is subject to verification in the same manner as any other natural phenomenon. Without any verifiable evidence, one has no grounds for believing gods exist.

While all atheists affirm their preference for naturalism, not all naturalists are atheists as revealed by question three. Ten percent of those who claim naturalism as their belief system (Q3, "C") actually strayed from philosophical naturalism on question 14. Two of these respondents chose "C" and one chose "B" on Q14; both are leanings toward deism (see Figure 18, "d"), which suggests that the naturalist belief system allows for a less hard line approach to religious philosophy than does the atheist belief system, which might be the source of atheism's bad reputation. Atheism's intransigence is not inherently confrontational nor controversial any more than scientific hypotheses in general are confrontational. Atheists merely require evidence to provide grounds for their belief just as scientists in general require evidence to support hypotheses before committing to an acknowledgment of fact.

II.C.1 Thomas Henry Huxley's agnostic tradition has been transformed.

T.H. Huxley was one of the founding fathers of evolutionary biology as well as one of the great Victorian essayists to extensively comment on agnosticism, after having coined the term himself to contrast his beliefs with those of the gnostics of the early church "who professed to know so much about the very things of which I was ignorant" (Huxley, 1896 p.239); he was referring to the supernatural. Gnosticism, popular during the second through the fourth century A.D., was dualist (Pink, 1995), which suggests that agnosticism was Huxley's attempt to define an opposite, or monist philosophical stance. His sort of agnosticism was concerned with the "limitations of possible knowledge" (Huxley, 1896 p.237). His conception of agnosticism was based

soundly on scientific principles:

> Agnosticism, in fact, is not a creed, but a method, the essence of which lies in the rigorous application of a single principle . . . that every man should be able to give a reason for the faith that is in him; it is the great principle of Descartes; it is the fundamental axiom of modern science. Positively the principle may be expressed: In matters of the intellect, follow your reason as far as it will take you, without regard to any other consideration. And negatively: In matters of the intellect do not pretend that conclusions are certain which are not demonstrated or demonstrable. That I take to be the agnostic faith, which if a man keep whole and undefiled, he shall not be ashamed to look the universe in the face, whatever the future may have in store for him (Huxley, 1896 p. 246).

For Huxley agnosticism was a naturalistic approach that thoroughly discounted the *a priori* knowledge required by the church about the existence of God.

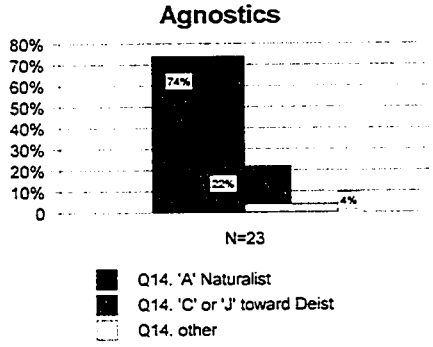

Figure 25. T. H. Huxley could but wonder in perplexed amazement at the high percentage of agnostics with leanings toward deism (22%). This betrays his original conception of agnosticism which was strongly opposed to *a priori* reasoning exhibited by deists. Most agnostics of this study, however, show a strong commitment to philosophical naturalism (74%).

Today, "agnostic" has come to be used as a colloquialism for not offering any conclusion on belief in gods. The agnostics of this study show a strong preference for philosophical naturalism, like their atheist counterparts (Figure 25). Much of Huxley's original concept, however, has been transformed, as shown by the high percentage of agnostics in this study who believe in deism (Figure 25). Huxley was no fan of the "fatal weakness of *a priori* philosophizing" that deism requires (Huxley, 1896 p.19).

Every atheist, and most of the naturalists from Q3, would probably agree with the principles of agnosticism laid out by Huxley (see Q5, "B") in that it is fundamentally a naturalist philosophy founded on the empirical procedure of observation and verification. The atheists unanimously opted for "A" in question 14 (Figure 18) revealing their total commitment to philosophical naturalism. Agnostics differ from atheists in one major respect, summarized by J. M. Thoday:

> In believing that there is not a god, you have as little evidence for that as believing there is a god. . . . But it isn't sitting on the fence in this case. It is positively saying that this is an area beyond which knowledge doesn't go, except some kind of knowledge which is certainly not the sort of knowledge that you're playing with when you are doing science (Appendix IV, Thoday interview).

Thoday exemplifies a textbook agnostic opinion. He goes on to show his deist belief, which is derived from G. G. Simpson:

> Certainly, the whole concept of evolution as one has it, leaves one with, as Simpson said, "no room for gods except as first cause;" And that's where I say it's illogical to be atheist because that is saying there is no first cause. (Appendix IV, Thoday interview).

"First cause" is an ancient idea that played an essential role in Aristotle's conception of god as the unmoved mover. It matches the deist concept of god as a non-intervening creator of nature. Thoday's statement, as an example of the deists in this study, suggests that it is more logical to be an agnostic deist than it is to be atheist.

Most participants disagree (Figure nine, "B;" Figure 7). In any event, Thoday's deist agnosticism would not sit well with T. H. Huxley.

To what degree do the agnostics contribute to the lean toward deism recognized in Figure 18, "d"? Among the participants who stray from a hard-line philosophical naturalism there is a strong trend toward the right side of the ternary diagram at a rate of about 3 to 1 over the left side (Figure 18, "d"). This suggests that evolutionary biologists who don't subscribe to pure philosophical naturalism (those who chose something other than "A") favor deism over theism. In fact, 92% of the participants of this study are either pure philosophical naturalists (78%) or blend naturalism with varying degrees of deist philosophy (14%). Only a tiny fraction (around 1.3%) consider themselves pure theists, as stated earlier.

Further analysis reveals that a high percentage of the deists is made up of agnostics. Although many agnostics prefer pure philosophical naturalism (Figure 25) they make up 25% of the total number of deists in Figure 18, "d". Remember that agnostics answered "NO" to number one, indicating that they are not religious, yet a paradoxical one-quarter of the agnostics subscribe to a deist world-view. Figure 18, "d" reveals that, among the participants of this study, a sizeable percentage of those who consider themselves agnostic and the majority of those who consider themselves religious evolutionists resort to deism as their philosophical preference. This contrasts markedly with those who consider themselves atheist who are totally unified in their philosophical preference of naturalism.

II.D Can a deist be a monist?

To review, 25% of the deists (N = 37) are agnostic, 60% of the deists are religious, and 15% of the deists prefer a naturalist belief system (Q3) but,

paradoxically, do not commit to a naturalist philosophical position (Q14). This is a curious puzzle. It implies that some evolutionary biologists have a monistic naturalist belief system and at the same time believe in a deist god of some sort. This deserves a closer look.

The prime example of this unique world-view is E. O. Wilson who favors a "provisional deist" philosophy coupled with a naturalism that is thoroughly grounded in materialism. Wilson's views are paradoxical because deism originated as the dualist's compromise, a way to study nature as a materialist while leaving room for discussion of god. Wilson (1978 p.1) suggests "Deity can still be sought in the origin of the ultimate units of matter, in quarks and electron shells . . . but not in the origin of species." The god he describes is a process of origination resembling nothing of the gods in canonical religions:

> I am open to deism as an unsettled hypothesis. It's probably an astrophysical question. Thus I am not an atheist (who can be so sure as to take that position?) nor an agnostic (who can claim that the question is unanswerable?) but a provisional deist, willing to leave the door open for the possibility of a cosmological god or gods. However . . . a personal, biological god seems pretty well excluded by all we know of the origin and evolution of life and the human mind (Wilson, 2003, pers. comm.).

Wilson echoes a sentiment identical to that expressed by Ernst Haeckel (1903 p.19-20) in his characterization of monist faith:

> Although, however, monism is on the one hand for us an indispensable and fundamental conception in science, and although, on the other hand, it strives to carry back all phenomena, without exception, to the mechanism of the atom, we must nevertheless still admit that as yet we are by no means in a position to form any satisfactory conception of the exact nature of these atoms, and their relation to the general, space-filling, universal ether. Chemistry long ago succeeded in reducing all the various natural substances to combinations of a relatively small number of elements; and the most recent advances of that science have

> now made it in the highest degree probable that these elements . . . are themselves in turn only different combinations . . . of one single original element. . . . We might therefore represent God as the sum of all natural forces, the sum of all atomic forces and all ether vibrations (Haeckel, 1903 p.78).
>
> However variously [traditional] anthropomorphic ideas [of god] may have shaped themselves in dualistic and pluralistic religions, all in common retain the unworthy conception that God and man are organized similarly and according to the same type. In the region of poetry such personifications are both pleasing and legitimate. In the region of science they are quite inadmissible. They are doubly objectionable now that we know that only in the late Tertiary times was man developed from pithecoid mammals (Haeckel, 1903 p.115).

Although Haeckel never expressed an allegiance to deism, the connection between his world-view and Wilson's is unmistakable. The heavy emphasis on materialism unites Haeckel's and Wilson's views (as well as those of G. C. Williams' religious view, "anti-theism"). This union demonstrates that a monist can be a deist as long as the important provision of materialism is met in order to drive the discussion forward. Materialism is the key component in determining the tone of any theological discussion. Wilson's concept of "Deity" deals with the origin of material things. It offers no room for dualist notions of the supernatural or non-material nature. With materialism at the core, deism can be monist and show very little divergence from pure naturalism except in one respect. In the case of the monistic deist, the "door is left open" for discussions of a god with very limited usefulness or power, while the hard core naturalist has locked the door and disposed of the key. The deist allows the term "god" to account for the origin of matter and first cause, thereby disposing of his adherence to pure materialism, opting instead for a nebulous, limited theological conceptualization of god. The naturalist prefers a term with scientific meaning to account for origins.

II.E Dualism

Figure 12 depicts an anomaly that underscores a metaphysical problem found often in discussions of science and religion. 22.8% of the participants believe that BOTH material and spiritual properties constitute organisms. The pure materialist/naturalist position discounts spiritual or non-material properties. Almost 23% of the participants are dualists who believe that non-material properties are an important constituent of organisms. How can this anomaly be explained?

The respondents who believe that BOTH material and spiritual properties exist come from a wide variety of belief systems (determined from Q1, Q2, and Q3). About one third consider themselves religious, which is not surprising in the sense that a traditionally religious person readily accepts the supernatural as part of their canonical belief. A more surprising finding is that 29% of the respondents to Q8 "C" are naturalists, from Q3. Furthermore, about 9% of them are atheists. Agnostics make up 12% of the total in Q8 "C". Hence, dualist belief is far from absent among

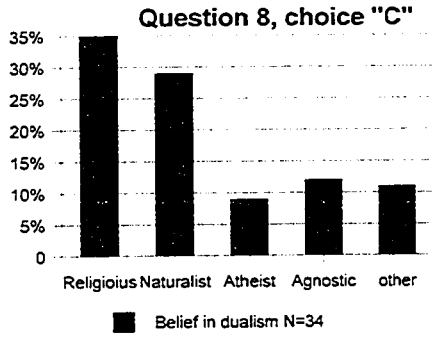

Figure 26. Dualists, as determined from option "C" on question eight (see Figure 12), are associated with a variety of belief systems. "Other" refers to those who answered Q8 but didn't respond to Q2 or Q3.

evolutionary biologists. Furthermore, religious belief, and belief in gods, does not necessarily play a role in the dualist thinking. The metaphysical root of this problem needs more analysis, but that is beyond the scope of this project. If the dominant belief among evolutionary biologists is 1) only material properties exist (as indicated by the vast majority of belief, see Q8, "A"), and 2) the only reliable method of discovering the truth about nature is from observation of those material properties (as revealed by Q16, "YES" and Q14, "A"), how can the minority reconcile their belief in a spiritual reality with the dominant view of their colleagues?

A clue to the answer comes from the comments of one of the respondents: "I reject the dichotomy of material/spiritual. Just as life is an emergent property of the non-living I see spiritual as an emergent property of the material." This respondent uses a conceptual complication to maintain his dualism. He accepts that spiritual reality is nothing more than material properties in action, thereby asserting his materialism. In this sense, claiming that spiritual properties exist as separate from material properties is impossible. The material properties are the only entities that have any ontological significance. So what is the use of using emergent properties at all in the discussion? The reason, I suspect, that this participant uses emergent properties is because it allows him to take the concept of the spirit seriously when engaged in theological discussions. Here is his comment prompting my suspicion: "I am a member of the community of the church . . . I find myself in agreement with some liberal theologians."

If we could go back and force acceptance, by those who chose Q8 "C," to the resolution that emergent properties do not exist in nature, but are instead no more than the product of material properties in action, I believe that it would result in a drastic lowering of the percentage on Q8. Whether spirituality can be predicted from

understanding of neuroscience remains to be seen. Hence it is too early to assign the spirit emergent properties all its own that distinguish it from the material properties of the brain. I have come to be wary of all use of the term emergence as it relates to ontological discussions. Emergence is controversial, at best, in philosophical circles (Kim, 1995) and its usefulness in biology should be seriously questioned.

Emergence, like the concept of complexity, can be applied to almost any kind of biological phenomenon. Here is a comment from one participant who sees the complexity of human thinking as dependent on a different, unknown set of natural laws, within which god exists as does free will:

> All organisms are made of matter and are subject to the Laws of Nature as they affect matter. But in the case of humans matter is so organised in the brain that it produces rationality, consciousness, morality, aesthetics and spiritual awareness. In my view this takes humanity into a new realm beyond the material Laws of Nature. It brings us into contact with God and gives us free will.

The emergence of this "new realm" is totally dependent on the human brain, so although it could not be predicted from examination of one brain, in what sense does it actually exist? As far as can be told from this respondent's comments, god is merely brain cells in action. Another respondent has a similar view but like the comment above asserts that god, not the brain cells, should be acknowledged:

> I believe that the evidence for God exists within men and women, that there is within us an innate response to a higher being. The evidence for this is the persistence of religious feelings in most humans and the devotion and diligence of religious people through the ages. If you require physical evidence of that spiritual feeling, look around you at the cathedrals and churches and mosques that throng our cities.

Cultural emergence, for this participant, is the same as evidence for god. Yet another respondent points out that emotions must be considered: "Thought, love, free will I consider to be non-material properties. They are 'emergent' properties." According to

this participant, emergent properties can lead to truths undiscovered by traditional empirical methods. He cites "philosophical reflection, artistic inspiration, etc. etc. [as] valid approximations to truth." This justifies his claim that he is not a metaphysical naturalist, unlike the vast majority of his colleagues (Figure 20), and that he is committed to the notion that art is truth. Another comment reveals the popularity of the notion that art is truth: "I think there are different kinds of truth (e.g., material/natural, moral, human - interpersonal; as described by great novelists, in music, art, intuition)."

The idea that art is truth comes up often and it is usually discussed by people who have no professional experience at all with art that assume some standard of artistic truth is established among professional artists. Artists, however, generally have no experience with empirical research or scientific conclusions. The connection between art and truth is poorly established and not a very promising avenue to lead us toward justification for assuming that emergent properties of the brain have any use in epistemological discussions.

One of the best illustrations of emergence as tool for communication, rather than as something real that we can study, comes from biologist Ursula Goodenough. In her attempt to sanctify biology by making it consistent with theology, Goodenough (1998) describes her feeling of "Mystery" (her capitalization) that awakens her and fills her with desire to know more about life. She describes how life emerges from non-life:

> Life can be explained by its underlying chemistry, just as chemistry can be explained by its underlying physics. But the life that emerges from the underlying chemistry of biomolecules is something more than the collection of molecules (Goodenough, 1998 p.28).

Goodenough's "something more" is a personal belief, not a scientifically viable

concept. Biologists grossly deal with the phenomena of life in terms of cells, tissues, organs, and organisms, and carefully distinguish them from their constituent molecules. Ontologically, life is not something more than its rudimentary molecules in action. Goodenough uses emergence as a communicative tool to describe her understanding and perception of the "miracle" of life.

> I take the concept of miracle and use it not as a manifestation of divine intervention but as the astonishing property of emergence. Life does generate something-more-from-nothing-but, over and over again, and each emergence, even though fully explainable by chemistry, is nonetheless miraculous (Goodenough, 1998 p.30).

Here, again, as we saw with the monistic deists, Goodenough borrows a traditionally theological concept (miracles) and applies it to discoveries made in biology. This underscores the point I want to make. Many biologists use emergence to support and encourage dialog between traditional theology and biology. For someone who is ignorant of theological principles, but well versed in biology this seems unnecessary. Other biologists use "emergent" to explain resultant biological features rather than their causal constituents. For example, organs are composites of tissues. Instead of studying the tissues and their interactions, it is more convenient to think of the organ as having "emerged" from the tissues. One may study the organ without understanding all of the details of the constituent tissues and their constituent cells, etc.

The following materialist's comment reveals a qualified use for the concept of emergence on Q8 "A," that only material properties exist: "As long as it is understood that properties of mind, including moral sense, emerge from the physical processes of the brain." There is no supernatural implication here. Only material properties exist, but from them, some very unpredictable things emerge. Even without theological motives emergence seems an awkward topic.

Richard C. Lewontin has a different materialist view of consciousness that

doesn't entail emergence:

> I believe that humans probably will be extinct before we understand the human central nervous system. That's very hard [because] . . . there is a strong possibility that we will never have a decent story for it. Our [biological] stories so far have made no contribution to unpacking the mechanisms of the human nervous system. I'm a mechanist materialist, and most biologists are. . . . I have a mantra: "organisms are the nexus of a large number of weakly determining forces;" and that makes them very hard to study. The only way we have to study things is by holding everything constant and varying one thing. But you can't do that with organisms [or consciousness] (Appendix IV, Lewontin interview).

Lewontin acknowledges that consciousness is difficult to study, but sees no reason to invoke a new kind of non-material reality, one that emerges from neurons in action.

Organismic development could easily be described as a series of emergent properties that result from the mysteries of embryonic induction, but materialists think such an explanation is not necessary. For instance, the discovery by Spemann and Mangold, in the early 1900s, that embryos can be made to develop more than one embryonic axis by transplantation of dorsal blastopore cells led to numerous experiments that created multiple embryos and chimeras. The new creations produced by these embryonic inductions could not have been predicted from the knowledge of the undifferentiated blastocyst at the time (remember it was the early 1900s and very little was known about embryonic induction or biochemistry). "There followed many years of research in many distinguished laboratories to find what chemical substances might be responsible for this 'embryonic induction.' The results were quite confusing and unsatisfactory . . ." (Bonner, 2000 p.4). At this stage might not the researchers have resorted to discussing the induction as emergent and describing it as something-more-from-nothing-but? This would surely have directed research in a different direction. But, with the advent of molecular biology, and a stoic materialist resolve:

> . . . it became possible to analyze the molecular basis of Spemann and

> Mangold's experiment. Now we know many of the substances involved - not only the specific proteins, but the genes that are responsible for their production. In fact, the level of detail of our present knowledge is quite staggering. . . . In the case of the molecular biology of development, the explanation of even the smallest step has become enormously complex. . . . I think it is essential and important and has produced stunning advances (Bonner, 2000 p.4).

This short illustration underscores an important point. In the rush to call something emergent might not there be a fatalistic appeal to dualism that suggests something is totally beyond comprehension when in fact it is just very early in the history of understanding the phenomenon naturalistically?

II.F The naturalists dilemma: monism or dualism?

The term "naturalist" is used to denote a field biologist collecting data on some species or other, but it is also denotes a philosophical belief. Among evolutionary biologists, particularly those who study organisms in the field, there is a strong correlation between both the philosophical and the practical connotations of the term. This section demonstrates the difficulty in maintaining a dualist stance with a naturalist world-view.

Consider John Maynard Smith's conception of the term naturalist:

> I am a naturalist in the sense that I love bird watching and collecting plants . . . so natural history is a very important part of just my enjoyment of the world and always has been. It's also an absolutely essential part of my science in the sense that I have quite an extensive knowledge of natural history, and I often start from a problem in natural history. If I see something or I read something that seems to be puzzling, that is the start of a piece of science; that's certainly the origin of all the stuff I've done on game theory - seeing animals do things that didn't seem to make sense. So in all those senses I am a naturalist (Appendix IV, Maynard Smith interview).

Ernst Mayr believes that the skills of a naturalist are required to understand the

philosophy of biology and the species:

> Biology consists of two branches, and usually this is overlooked. One is the functional biology, and everything in functional biology ultimately can be reduced to the same forces and principles as if I am in physics, such as physiology, etc. And you have another [branch of] biology, evolutionary biology, in which you deal with phenomena, and principles, and processes that don't exist in physics. We need a special kind of philosophy of biology which is not there now. If you look at the books on philosophy of biology like Michael Ruse, David Hull, or Kitcher, or Sober, they all start from a philosophy of physics or mathematics, and they all lacked a training in biology. We are left unsatisfied. When I read what these people write, it isn't a philosophy of biology. My conclusion is - in some ways disappointing - that you have to be raised as a young naturalist who really understands nature.
>
> Now, take a person like George Gaylord Simpson. I will tell you a little story. The biological species concept is something on which I have written 62 papers. A little while ago I wrote again on the subject. I looked up the species concepts of Huxley and Dobzhansky and Stebbins and all the other founders of the evolutionary synthesis. And species definitions all made sense with the exception of Simpson. It was a definition sort of put together from pieces of other people's definitions, but it didn't gel, and I said to myself, "Why does he produce such an inaccurate species definition?" And I came to the conclusion that he had never been a naturalist who really knew species in the field. He had only worked with fossils; and they [paleontologists] usually work with general orders of species, and species is [to them] somehow a typological concept. So I went through his life history, and it turned out that when he went to college he was an English major. And I checked whether he had an interest in bird watching or butterfly chasing or anything like that, and no, he hadn't been interested in nature at all. It was in his senior year in college that he got interested in geology. So it confirmed my view that unless you are a young naturalist you will never understand the species (Appendix IV, Mayr interview).

According to Tom Eisner, a naturalist is:

> somebody who is willing to go to nature without preconceiving a problem to work out but is willing to respond to events as they happen and file each in the appropriate place in the memory bank. If you start as a naturalist, you don't start with a bank account full of questions and theorems and beliefs. You just pick things up because they are there

> and you're wondering what they're all about . . . That's why you pick up a beetle when you're three years [old] and you put it in your mouth. That's your first experiment (Appendix IV, Eisner interview).

The naturalist has no preconceived notion about what exists, or what she might find, simply an open curiosity: "[if] they're always looking at the ground in front of them to see what's crawling there, then I classify them as naturalists" (Appendix IV, Eisner interview). Eisner goes on to say that naturalists cannot explain everything, because so much is yet to be discovered. Eventually, however, things that seem mysterious, or beyond the scope of science will be "drawn into the embrace of naturalism," in the words of Richard Dawkins.

Phillip Johnson (1995 p.212) distinguishes between naturalism as an observational science (a.k.a. "methodological naturalism") and as a belief system (a.k.a. "metaphysical naturalism" see note on Q15):

> *Methodological naturalism* - the principle that science can only study that which can be observed in nature.
> *Metaphysical naturalism* - the philosophical position that limitations of science imply the limitations of the natural world, i.e. limitations of reality itself.

Methodological naturalism can be combined with theist or deist philosophies, for it leaves room for entities that are forever beyond the scope of science. Metaphysical naturalism, however, is totally incompatible with dualism. According to a metaphysical naturalist, nothing is forever beyond the scope of science. Metaphysical naturalism is the belief that, theoretically, everything will be understood naturalistically through discovery, verification, and the experience of learning by observing nature. Tom Eisner, illustrates the metaphysical naturalist stance in the following passage:

> We [all] learn from experience. . . . when somebody becomes mystical and says that this [something or other] is going to remain permanently

outside of the realm of human explanation, I call this the physicists' syndrome. It's more than once that I've known older physicists who come up with an argument [to make sense of] things that they can't explain–like late in life when they're getting tired of physics–they all turn to the human brain, and they find that in the five years they are giving to the problem, they can't explain the human brain in full, so they decide that it's outside of the range of discovery, and they become vitalists.[10] I saw this in Victor Weiskopff who gave a wonderful lecture at Cornell, but at the end of it, he started listing the things that would remain–he became a total vitalist. And my attitude, as a biologist, is that we haven't been smart enough so far to figure this out, but that doesn't mean it's outside of the realm of scientific explanation.

Take a look at the history of science. Science has been the field that has come into being through observation and through the extension of our senses. The extension of the senses has been a major thing. Just look at how the electromagnetic spectrum was discovered one bit at a time, indirectly by techniques that have enabled us to see to the left of ultraviolet and to the right of the infrared. We created instruments that expanded under the capacity of our senses.

And with each such expansion came the phenomenal increase in knowledge. We postulated about the existence of molecules because they were phenomena that could only be explained with particulate matter. But once the microscopes extended vision to the infinitesimally small, there they were. By the same token, there were predictabilities made about pulsars that led eventually to the actual discovery. So I have tremendous faith in scientific capacity. I have much less faith in the speed with which these culturally revolutionary things can be incorporated into the daily activity of humans and dealt with in politics and so forth.

Just look at the religious barrier to stem cell research which pisses me off personally because I'm a possible beneficiary with Parkinson's. There is where I find I become very conscious of the dangerous aspects of religious power.

The foregoing reflects Eisner's monistic faith. "Extension of the senses,"

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10 Vitalism is a belief that supernatural or special properties are found in living matter that cannot be understood by science. The idea that consciousness is shrouded in permanent mystery, or purposive directional tendency in the evolution of lineages or clades, i.e., teleology, are examples of vitalistic thinking. Vitalism is a form of dualism.

through technological advancement, grounded in science, is the key to truth, while appeals to dualism (or vitalism), lead nowhere. Anyone who believes that there is a dual nature (natural and supernatural) cannot be considered a metaphysical naturalist. Thus, metaphysical naturalism matches the monistic philosophy as defined by Ernst Haeckel.

79% of the respondents to Q15 affirm metaphysical naturalism as their preference. This corresponds nicely with the 78% who are philosophical naturalists as depicted by the ternary diagram (Q14 "A"). Thus, roughly 22% of the respondents resort to methodological naturalism which allows them to have leanings toward deism, and consider science of limited use to discover all of reality. By contrast, based on their monist faith, the metaphysical naturalists believe that all new discoveries will be comprehensible by materialistic explanations.

Any cursory examination of history will reveal prominent thinkers in the past that have combined methodological naturalism with other philosophies, natural theology was pure methodological naturalism. One need look no farther than the title of William Paley's 1802 masterwork, "*Natural Theology: Or, Evidences of the Existence and Attributes of the Deity, Collected from the Appearances of Nature*," to recognize that a mix of theism and naturalism was exercised fully in the past. Mixtures of philosophies, such as these, however, were concocted to appease the dominant dualist theology of the times.

Though such theological concern is rare today (Figure 18, F), dualism is still an important driving force that explains much of the variation in philosophical preferences on Q14. 35% of the deists and all of the theists are religious dualists. This leaves us with an interesting resolution. A meaningful distinction that can be made among this group of illustrious scientists between monist and dualist belief. A

naturalist can lean toward deism or theism, the two most common theological components of naturalism from history (Figure 18). The participants stray from pure metaphysical naturalism in correlation with their belief in the limitations of science. Without a dominant theology to guide them, the evolutionary biologists of this study generally gravitate toward a purely monist, metaphysical naturalism that is characterized by the belief that the only reliable method of obtaining the truth comes from the scientific pursuit of observation and verification. Rarely, we see a unique monist appeal to deism, characterized by E. O. Wilson and G. C. Williams. Less rare is a dualist tradition of deism that correlates with traditional religious belief. Theism is the rarest of preferences and requires a purely dualistic philosophy.

II.G Questions with indistinct or anomalous central tendencies

Three results show divided preferences among the participants and are accompanied by the largest number of comments on the questionnaires. The three equivocal questions, Q11 (Figure 15) on progress and purpose, Q13 (Figure 17) on morality and evolution, and Q7 (Figure 11) on free will, probably caused confusion because their subject matter is not well-defined biologically. Most participants consider them worthy topics for evolutionary biology, but there is little agreement on the definitions of free will and progress, and there is prodigious controversy over morality and evolution. The following discussion reveals that more careful work needs to be done in the future to resolve these important issues.

II.G.1 Progress and Purpose

The rejection of ultimate purpose as a factor in evolution is nearly universal. Only six percent affirm a belief in purpose (Figure 15). Historically purpose was the major motivation for discussions of progress in evolution (Provine, 1988), but today it is no longer popular among evolutionary biologists. One might expect the discussion of progress to have waned also. My results contradict this expectation.

Ruse (1996) provides an exhaustive historical study of progress. His conclusion is as equivocal as the results to Q11 (Figure 15). Ruse's primary conclusion is that the evolutionary synthesis of the 1930s and 1940s came at a price, the "expulsion of progress" from evolutionary biology.

> My key point is that progress is not in evolutionary thinking today because of pure epistemic factors. . . . Not only has evolution functioned as an ideology, as a secular religion, but for many professional biologists that has been its primary role. It has not been a mature science, governed by epistemic norms, nor has that necessarily been an end ardently sought. Very belatedly has evolution been brought to professional standing, as a result of steps taken when there were major competitors and detractors within the life sciences, like molecular biology. . . . The expulsion of progress occurred less because the epistemic factors were overwhelming and more simply because its practitioners wanted the status as professionals (Ruse, 1996 p.536, p.530).

My study contradicts the foregoing conclusion. Almost half of the professionals participating in this project affirm a belief in progress (Figure 15, B). Ruse qualifies his conclusion by pointing out that progress might well be present in the literature and thinking of professional evolutionary biologists but it is "of little moment because, qua cultural value, it has been effectively neutralized" (Ruse, 1996 p.534). Neutralization, he claims, is manifest in conceptual re-definitions of progress under the names "arms race" or "Red Queen hypothesis," for example (I have listed other possible re-definitions, see below). By not defining it on Q11, progress is open to interpretation.

Almost 50% of the world's most highly esteemed evolutionary biologists believe it plays a role in evolution, completely defying Ruse's (1996) conclusion. The one concordance between Ruse's (1996) and my study is that the results of Q11 (Figure 15) are as confusing as his conclusion is, indicating that more work is needed.

Respondents are nearly evenly divided on the amount of progress in evolution (Figure 15). A very small minority, about 6%, believe that purpose plays an ultimate role in evolution. Fifty-three percent believe progress is part of evolution. Of this 53%, two-thirds (68%) are strict materialists who believe in purely naturalistic explanations for progress independent of ultimate purposive forces. While none of the respondents who chose Q11, "A" offered any commentary on their choice, many of the participants who believe in progress offered substantial comments, giving us a glimpse at their reasoning. "Progress needs definition. I mean by it increased complexity in the brain, leading to complex cognitive life, social life, cultural cumulative evolution - all of which develop in degrees with a marked saltation in *Homo sapiens*" wrote one respondent. Another respondent indicates a belief that information accumulation plays an important role: "Progress implies memories of complicated systems of events allowing for survival." Another participant points out that progress "can be seen to have occurred at the end of a period of evolution of some complex adaptation by natural selection. But there is no inherent drive towards progress and certainly no drive towards humanity." Still another agrees with this last-mentioned notion of progress without teleology: "Progress in the sense of increased complexity of some organisms has of course occurred, but not in the sense of progress toward some perfect or ultimate state."

Stephen J. Gould provided one of the most conservative, and hence useful, definitions of progress available in the evolutionary biology literature: "persistent

trends within clades based on characters interpretable as structural improvements, and leading to increase in representation of taxa bearing these features (usually at the expense of assumed comptetitors who don't)." He goes on to warn us, however, that "[e]very word in this definition (excluding only articles and prepositions) can be challenged as ambiguous, hence the extraordinary difficulty and contentiousness of the concept" Gould, 1988 p.324). Ambiguity aside, the use of progress to explain evolution is also illusory, according to David Raup, due to inherent properties of any time-series analysis, "The markovian time series that dominate the evolutionary process make apparent directional trends almost inevitable even in the absence of directional driving mechanisms" (Raup, 1988 p.316). As we saw with the monistic deist's use of "god," progress is an ambiguous term. Should the phenomenon be understood as directional trends away from the previous generation or as progressing toward some ideal or optimum?

If the comments cited above are any indication of the typical attitudes of believers in progress, many evolutionists believe that complexity is both tractable and measurable. Complex equals progress. Raup points out (above) that natural selection only operates on variation that is available, and does not bring back variation that has been lost. This illusion of progress is better described as directional change, but the respondents who favor Q11, "B" call it progress.

An indication of almost blind adherence to a belief in progress comes from one participant who suggests: "Progress occurs in the sense that we can build atomic weapons and reptiles cannot! As life evolved, organisms capable of surviving in extreme environments have emerged. Progress has meaning only in the context of life." By this definition of progress, we must assume that bacteria in marine geothermal vents or cyanobacteria that existed on vast intertidal mud flats of the

Cambrian continental shelves are in some ways progressive forms. In what sense is this progress?

This last question applies to every definition or qualification of progress given. If we assume that progress is no more than complexity, then progress has no meaning outside of our definition of complexity. The only thing that gives complexity any meaning is the fact that we admire complex systems and disparage simplicity. Without this value dimension we might as well see complexity as a result of natural selection and leave it at that. Although this respondent recognizes the arbitrary adherence to the "value" aspect of progress, he nonetheless believes that progress has occurred in evolution.

> Progress is a value term, and it is partly subjective in that it requires deciding what is the property that one would consider worth evaluating with respect to progress. Depending on what property is chosen, I may see progress, e.g., in 1) the increase in biological diversity; 2) the increase in "complexity" of some organism; 3) the increase in capacity to know (or more generally, to obtain information about the environment and to react flexibly to it), etc.

The following comments come from participants who see progress as an inevitable part of natural selection: "The process of natural selection inevitably leads to one form of progress, although this can be interrupted or destroyed by stochastic events." And: "Progress clearly occurs in evolution (in the establishment of any adaptation). Overall, well-adapted organisms have evolved in that respect; there has been a tendency towards progress." If natural selection is progressive, as these respondents believe, progress merely refers to an inherent property that adds nothing to our understanding of evolution. Just as we saw with the equivalency of complexity and progress, natural selection by itself is sufficient to explain the observed phenomena. Progress merely adds a confusing value term that does not accurately aid understanding of how natural phenomena evolve.

Adaptationists maintain that a trait's value can be measured by its contribution to an organism's fitness. Some traits, however, contribute nothing to fitness. Other traits might be involved in "evolutionary arms races"(Dawkins, 1996 p.191), possibly subject to "runaway selection" (Freeman and Herron, 2001). Eventually the normal functioning of other traits might be impaired resulting in decreased fitness. In such cases, the value of the trait must be constantly reassessed. The trait's value is, indeed, only relative to some pre-determined standard, and we must return to the question: In what sense is this progress?

What appears as progress might be better understood simply as the result of selection for one trait having a concomitant evolutionary effect on another trait. Discussions of adaptation, however, often revolve around progressive overtones in the modern literature (Strickberger, 2000 p. 544), while at the same time, some deny the importance of adaptation (Margulis and Sagan, 2002). Perhaps divisions among evolutionary biologists, along the lines of adaptationism vs. pluralism, contribute to the reason that the participants are so divided on Q11(Figure 15, A and B).

From the comments on Q11, "B", some respondents wish to infuse values into the evolutionary process, particularly with respect to the emergence of *Homo sapiens*. Such an infusion serves to polarize the discussion of evolution around the characters that humans value most, such as complexity, sociality, consciousness, and efficiency of design, concepts that some evolutionary biologists seek to explain. To do so they offer emergence as a metaphysical reality and they equate progress with complexity, perhaps in order to add a sense of aesthetics to their naturalistic world-view. This idea has not been tested but future work on progress and complexity in evolution would benefit from a questionnaire study and qualitative analysis.

II.G.2 Morality

The questions on morality show relatively weak consensuses. Although most participants agree that morality can be influenced by the findings of evolutionary biology (66%, Figure 13) a significant proportion of them, almost 40%, do not incorporate moral or ethical beliefs into their teaching or work in evolutionary biology (Figure 17). A two-thirds majority believe that evolutionary biology influences morality - presumably affecting their personal ethical outlook also - yet far less than half are willing to teach or investigate how their morality is influenced by their science. Privacy of opinion might not be the only thing at stake. Controversy is bound to follow anyone who discusses the possible biological base of morality, and there is ample evidence from the participants of this study that some scientists are not willing to take on such a burden.

E. O. Wilson has spent a great deal of time addressing morality and its evolution. He claims that what used to be considered "moral sentiments" by the eighteenth century British empiricists, are today described as "moral instincts" by modern behavioral scientists. The instincts "are derived from epigenetic rules, hereditary biases in mental development, usually conditioned by emotion, that influence concepts and decisions made from them" (Wilson, 1998 p.275). What we "ought" to do, the core of morality, "is the product of a material process," which accordingly was produced by, and is subject to, natural selection. Culture, no doubt, plays a role, but the objective study of morality proceeds from an understanding that the brain produces feelings and sentiments and, ultimately, our moral behavior. One of Wilson's main goals in his book, *Consilience* is highlighting the importance of eliminating transcendentalism (in essence another word for dualism) from intellectual pursuits dealing with human nature. Accordingly, he believes that morals and ethics

should be approached from a naturalist perspective:

> Ethical codes are precepts reached by consensus under the guidance of the innate rules of mental development. Religion is the ensemble of mythic narratives that explain the origin of a people, their destiny, and why they are obliged to subscribe to particular rituals and moral codes. Ethical and religious beliefs are created from the bottom up, from the people to their culture. They do not come from God or other nonmaterial source to the people by way of culture. . . . To the extent that this view is accepted, more emphasis in moral reasoning will be placed on social choice, and less on religious and ideological authority (Wilson, 1998 p.270).

Richard Dawkins sees a relevant connection between his evolutionary world-view and morality:

> I am strongly opposed to Social Darwinism, and Julian Huxley's view that we should somehow model human progress on what he perceived as evolutionary progress. But some of my moral considerations ARE INFLUENCED by evolution: for instance moralities that assume a great gulf between *Homo sapiens* and the rest of the animal kingdom are profoundly UN-evolutionary; e.g. anti-abortionists who cheerfully eat cows and kill chimpanzees for research purposes (from Dawkins' questionnaire).

Dawkins' disdain for moral inconsistency is matched, however, by an uncomfortable equanimity when he or his colleagues must deal with such moral considerations:

> I think it's more that we've all accepted a kind of weak-kneed tolerance that somehow religion deserves our respect, and so we must bend over backwards to give it every possible quarter that we can. And I think that bending over backwards is the right phrase. You don't say "Well, I don't believe in your religion and I think it's a load of rubbish." You say, "I don't believe in religion, but of course I totally respect it." Whereas you don't say that if you're talking to a right wing Republican. You don't say "I'm not a right wing Republican, but I totally respect your beliefs." . . . It's just something that has gotten into the culture. Just as it's polite to stand up when a lady comes into the room in some cultures, it's polite not to insult someone's religion, but you can insult their politics, or their views on this or that or the other, their football team or whatever.
>
> . . . I don't do the bending over backwards. And I get quite a lot

> of shtick for that because I'm regarded as a fanatic. I'm frequently described as a fundamentalist who is every bit as fundamentalist as creationists on the other side. And that actually does annoy me very much because there is evidence on one side and no evidence on the other. I may sound fundamentalist because I express myself strongly and clearly, but what I'm expressing is based on factual evidence rather than nebulous scripture and faith (Appendix IV, Dawkins interview).

Dawkins reveals that if one is not willing to do the bending over backwards on issues that might be offensive, one can expect controversy to follow. Many of the participants in this study are likely not up to the challenge and might find it distracting to what they see as more important work.

Caltech geneticist and Nobel Laureate Ed Lewis portrays himself as dedicated to problem solving instead of grand philosophizing:

> I try to avoid advising people on what they should do . . . I think (my focus) is somewhat narrow, but I do try to have a background in physics and chemistry, and statistics, and biology, all the sciences, and then I try to keep up with the faculty members here who are right on top of everything. We have lunch everyday and everyday we talk. . . . So it's all an ivory tower. I live in an ivory tower, and I'm going to stay in an ivory tower as long as I can. And so I don't really think about a grand philosophy, because I have a sort of contempt for attempting such a thing. In that realm you get all this controversy and an immense background. It's bad enough to keep up with the current backgrounds in science where you have to read a lot of papers and talk to a lot of people [scientists]. I imagine, in the field that you're in, [philosophy], there's so much more stuff to sift through. And that's why I don't read much; I don't have time. I mean time is so short, I'm 85 years old. But there are good spokesmen. You need good spokesmen to get out there. Spokeswomen maybe, at any rate. They should come from science, from biology even. But, boy, you're up against it if you try. You know 90% of the people are religious in this country. Fifty percent don't even believe in evolution. . . . And one of the basic problems is that congressmen have no education in science. That is a very serious problem.
>
> . . . I'm interested in and worried about the radiation results in the sense that they won't start nuclear testing and everything else, and that it is a genetic problem and a serious one. It's not genetic mutations

> and germ line, it's somatic cancer. It's estimated that 1% of our cancers are caused by natural background radiation. That came out of estimates that I did. So all the epidemiologists agree on the risks now but they're not accepted by anybody else. Medical people won't admit it to people who get breast cancer exams with mammograms - those are definitely producing breast cancer with a low frequency. . . . At any rate, that's a scandalous situation. . . . This is a serious ethical question that I devoted half of my life to, and that takes half your life and you can't go beyond it, and you've got to focus on something very serious. . . . You have to focus on some little branch where you can make a contribution because if you get too broad and too vague then you have to watch out. You get all these fringe-groups joining you and before you know it you're really in a mess. I'm very narrow in my focus, and it pays off. I've been focused all my life. (Appendix IV, Ed Lewis).

Lewis portrays himself as dedicated to solving problems. He stumbled on to a serious ethical problem (radiation research) from his early interest in "how we get new genes from old genes" (Appendix IV, Lewis interview), but he is reluctant to enter the controversy of telling people what they should do. Raising public awareness on moral questions requires a full-scale war with fringe-groups and politicians alike, an effort that might sap all emotional and financial resources and thereby prevent the problem-solving duties of a committed scientist. Lewis chooses the pragmatic option, as the questionnaire directs on Q13: "keep my beliefs about morality and ethics separate from my practice and teaching of evolutionary biology." Over half of the participants in this study agree with his pragmatism (Figure 17).

II.G.3 Free Will

The anomalous results of Q7 (Figure 11) reveal a high likelihood that most evolutionary biologists do not think deeply about free will, or do not consider free will a biological problem. A meaningful discussion of this issue requires two things, both of them contentious and poorly studied: 1, a realistic understanding of biological

determinism, and 2, a biological criterion for measuring freedom that is independent from the obvious concept of choice.

Most participants believe that organisms have free will despite being determined by heredity and environment (Figure 11, A). One respondent who believes in free will wrote: "Free will is a murky concept. I'm happy enough to talk about people having free will, along with monkeys, spiders, etc. but there's no spiritual or religious dimension to whatever I might have in mind for this casual expression." By his use of "murky" and "casual," this participant alludes to a belief that free will is not a very serious topic.

Another respondent who denies free will wrote "I chose option two reluctantly because the illusion of free will is so powerful that, to all intents and purposes, it might as well BE free will." For him, free will refers to the illusion, not the behavior of the organism. Another respondent brought up the illusory as well:

> I don't like having to choose this logically more correct alternative because no "free" will probably means different things to different people. The will, as influenced (formed) by heredity and environment may permit evaluations and decisions with considerable "freedom" for action and ethical behavior to be modulated by the individual. But the impression that our will is "free" in the sense of completely independent of genetic and environmental influence must be an illusion since our minds and actions are inevitably shaped by those things. We should feel and be taught (by elements of our environment) to be ethical and responsible in our decisions and actions. That is, absence of "free will" does not mean that we have no responsibility for our actions.

Another respondent claims:

> Based on strictly neurobiological facts free will is most likely a useful illusion. However, complex neural perception and processing systems provide considerable intellectual variability and plasticity that affects decision making abilities in organisms, including humans. In this sense, I would say that within limits we can speak of a free will.

Focusing on the illusion of free will and worrying about the implications of not

having it might have tipped the balance in favor of option "A" (Q11). The respondents could have been confused, however, because they might favor free will for the purposes of believing in the illusion, or one might deny free will on the grounds that the illusion is not ontologically real. The confusion comes from a casual treatment in the biological literature that discusses free will as equivalent to free choice.

> So we suggest that moral reasoning is based on the epigenetic rules that channel the development of the mind. Such reasoning appears to be ultimately dependent on the genes as well as on culture and self-conscious decision. But the rules only bias development; they do not determine ethical precepts or the necessary decisions in a fixed manner. They still require that a choice be made, and in this sense they preserve free will. . . . Deep knowledge of human nature can only increase free will, not diminish it. Here is the essence of that argument. All of our behavior is indeed predestined to the degree that we have deeply ingrained goals and principles that organize our daily lives. The free choices made are for the most part thoughts and actions put to the service of these internal guides . . . . A scientific understanding of human nature and the process of gene-culture coevolution can provide some measure of intellectual independence from the forces that created us. It can enhance true free will (Lumsden and Wilson, 1983 p.179; p.174).

This attitude is consistent with the notion that knowledge is power (from Bacon), and in this case knowledge, from education, ultimately from culture, allows us to toy with our instincts, through personal choice.

This popular notion of free will is used as matter-of-fact to justify the specialness of human intelligence:

> As tough as our self-control battles are, we at least have a fighting chance. Most animals, even intelligent chimpanzees, have no ability whatsoever to override their passions . . . . As difficult as willpower is for humans, our capacity for self-control sets us apart from the rest of the animal kingdom. So, in addition to genes that get us in trouble, we have genes for free will and self-discipline. It is within our very genes that we find the tools to fight our animalist urges and take control of our lives (Burnham and Phelan, 2000).

Lumsden and Wilson (1983) and Burnham and Phelan (2000) demonstrate the tendency to equate free will with choice in the literature of evolutionary biology. This prevailing notion of free will explains why Q7, "A" is the dominant selection among the participants of this study. A better result will come from future work that subjects free will to a serious biological treatment.

CONCLUSION

I. Evolution and religion, refining the questions for future work.

The popular notion that evolution and religion are at war with one another is not entirely accurate. Most participants reject both the tenets and the world-view offered by traditional religion as unsound; but they don't consider religion as a serious threat to their world-views. Only 10% of the sample group see evolution and religion as mutually exclusive (Figure 16, "C"). Rather, the respondents are more interested in figuring out a way to treat religion intellectually. The majority see it as a social adaptation (Figure 16, "B") which suggests that evolutionary biology plays a dominant role in understanding the origin and function of religion.

Richard Dawkins emphasizes the distinction between genetic and memetic factors in the origin of religion. Both are necessary to the discussion, yet one or both are often overlooked:

> If somebody says to me what's the Darwinian survival value of religion, I'm inclined to say that's the wrong question. It's rather like saying "What's the survival value of dominance hierarchies, peck orders in chickens, or wolves?" You can't ask that question because a dominance hierarchy is a phenomenon that you only see at the social level. At the individual level it's a manifestation. It's emergent from the fact that individuals learn who they can beat and who beats them. And if the individuals all do that, what you end up with is a dominance hierarchy. So you have to rephrase the question, not "What's the survival value of dominance hierarchy?" but "What's the survival value

> of learning who you can beat and who beats you?" And once you phrase it like that, it's a different question. The answer becomes a different one.
>
> In the case of religion, I think you might rephrase the question, "What is the survival value of having the kind of brain that lends itself to memetic exploitation?" or "What's the survival value of having the sort of brain that is vulnerable to parasitism by self-replicating memes that have no connection with Darwinian survival in the genetic sense?" Then if you asked me to give an example I would say perhaps child brains are shaped by natural selection to follow a rule of thumb that says "believe what your parents tell you." You can easily see why, in general, that rule of thumb would have genetic survival value. The world is a dangerous place. Children don't have time to discover by trial and error. It's too dangerous to discover by trial and error. Like, "don't swim in the river because there are crocodiles." You just have to believe what your parents tell you. If Darwinian genetic selection has programmed your child with the rule to believe whatever your parents tell you, then that is a rule for exploitation by parasitizing memes, which say that you have to sacrifice a goat to the "Great Juju" in the sky.
>
> And you don't know where that came from. Maybe it came from six generations back. Somebody made it up or whatever. But once it starts going down the generations, it will go on going down the generations because the child brain is set up with that rule of thumb, "Believe what your parents tell you." [This is] what you can call geographically arbitrary. In that area of the world they believe so and so. And in that area of the world they believe something totally contradictory. It's just like different languages but here they worship a sacred sun and there they worship the moon, and over there they worship a sacred ferret or something (Appendix IV, Dawkins interview).

Dawkins emphasizes the arbitrary nature of a meme. Some memes match reality, i.e. "don't go in the river, there are crocodiles;" and some do not, i.e. "when you die you live again;" but the ones that don't match reality persist nonetheless and might even thrive because they piggy-back (or parasitize) the genetic predisposition of the developing human brain to believe what it is told. This helps explain why religion is so popular even though it explains so little about the natural world.

Naturalism might be considered a meme also; one that has an equally profound effect on the developing brain. The naturalist tenet, "don't believe it unless you see it and can prove it to others" might be an example of a meme. For E. O. Wilson, a naturalist meme creates an ethical world-view that matches reality far better than traditional religion:

> At the age of 17 and 18, when I began to move away from my traditional Baptist and broader Christian beliefs, I began searching for a replacement for the satisfying mythic explanations for human existence, something that can be added to the bare bones knowledge that science produces concerning evolutionary origins of humanity and the human mind. Indeed I have been searching for this all my life. I have expressed my views in books like *Biophilia, Naturalist*, and most recently, *The Future of Life*: that here [in naturalism] is to be sought . . .a full substitute for those spiritual satisfactions that come to us through the easier routes of traditional religious experience. I don't see any need to invoke a traditional Judeo-Christian God to give purpose to these religious experiences. In fact, I think it's a waste of time, in the sense that we could be doing so many more interesting and valuable things with our minds.
>
> What traditional religion gives you is a fixed set of statements about the world and the origin and meaning of humanity. These statements are easily learned and in the context of personal relations or in tribal ceremonies, they evoke a deep sense of satisfaction.
>
> So long as we are bound by loyalties to a particular religion's dogmatic beliefs [However], we are not free in many sectors of human thought and experience to explore afield and more deeply. I find it far more interesting and satisfying to explore beyond, within the constraints of what we find out ourselves about how the real world works, the fuller explanation of what humanity is, where it comes from and its meaning. This freedom is not open to believers in traditional religions. That search, which may never be fully satisfied or found with success, is one of the best intellectual and spiritual endeavors of which the human mind is capable. That is essentially, if you would like to call it that, my religion (*Research News and Opportunities in Science and Theology*, Vol. 3, #11/12, July/August 2003).

Richard C. Lewontin agrees with Wilson that sociobiology explains the world better than traditional religion does, yet he criticizes sociobiology as unrealistic in its

attempt at universality:

> I think that religion does exactly the same job that sociobiology does. It's just as good. No better. Not worse. If the criterion of the explanation is that it has an answer for all questions. But the disadvantage of religion is that it blatantly postulates entities which no sociobiologist has to postulate. Namely, mysterious forces and god. Sociobiology is much closer to me than religion is because sociobiology is totally materialistic. Sociobiologists are materialists. They're just trying to generalize one of the forces that occurs on material objects into one that explains everything. But they're materialists. So if I had to choose between the Pope and Ed Wilson, I'd choose Ed Wilson every time.
>
> Can they give you an explanation for everything in their domain? In this sense, sociobiology is better than religion. I don't know of any religion that doesn't say "The ways of God are mysterious." Christianity has to say, "How do you explain the terrible suffering of babies?" And so on and so forth. And they have to say "Well, we don't understand God's plan." No sociobiologist ever says that. They have an explanation for everything. Sociobiologists are not called on to explain why there are injustices in the world. The word injustice doesn't appear there. Why do babies die? Well, I'll give you a biological explanation of why they die. Why are people what we could call nasty and cruel, they go killing babies and burning houses? Sociobiologists have an explanation for that too. Religion is in more difficulty there because religion adds questions of injustice and so on. Biological theories don't have that in them because they recognize that justice is a social construction. There is no justice outside of people. Sociobiologists want to explain [the evolution of the concept of justice] as a consequence of natural selection. Now, I don't. That's the difference.
>
> But do I think it is useful to study evolution? The answer is yes because the world-view that we want, that I want, is a materialist world-view. And everything true that we can learn about nature adds to our understanding of the material world. And that's desirable. So evolutionary biology is useful only when it says something that is true, in a Popperian sense. And every statement that can be made by evolutionary biologists, as true in that sense, adds to the pile of rocks which is the knowledge of the material world and may further convince people that material explanations will explain everything. And, therefore, there would be no need for canonical religion, in the sense of explaining the world. (Appendix IV, Lewontin interview).

Tim Clutton-Brock sees an important role for behavioral ecology (the name for

sociobiology in the U.K.) in understanding religion as a social adaptation:

> Evolutionary biology enables us to interpret our environment. It also has practical applications in dealing with the environment. And, if you don't understand how evolution operates, you don't understand how to control malaria, you don't understand how to deal with retroviral drugs to AIDS, you don't understand the problems you're going to have in limiting population numbers, and, you probably don't understand how to deal with agricultural problems or how to deal with fisheries, many, many areas where understanding evolutionary change is vitally important to actually predicting what's going to happen in biological populations.
>
> I think one of the main points of evolutionary biology [therefore] is that it helps you to understand the world about you. And what we're really [ultimately] saying is that it helps you to understand the people about you and the society about you. . . . Hopefully, there is a right view and a wrong view of the evolution of society. Ultimately, that affects the structure of how we understand animal societies, how we understand the context of human society. So how important is it [that evolutionary biologists agree on the social implications of their science]? It's very important! It's so important that people are going to disagree about bits of it for a long time. I'm not bothered by that. That is how science works. If you don't have disagreement, you tend not to have progress. But one hopes that it is progressing towards a better understanding (Appendix IV, Clutton-Brock interview).

Clutton-Brock's is an appropriate concluding remark reflecting the general opinion of the participants that the incompatibility of religion and evolution is resolved by explaining religion as an adaptation or some kind of meme that persisits despite its own lack of correspondence to reality. The participants show a strong concern for reality (Figure 14, "A"), however, and therefore, their compatibilism does not give religion equal status to evolution. The participants generally are compatibilist, with respect to evolution and religion, but they have thoroughly debased religion in order to be that way.

The naturalist world-view expresses a generally optimistic tone: studying organisms leads to a deeper understanding of our own species. One must shift gears,

however, to go from generalizing about animal societies to generalizing about human societies. I call that shifting of gears naturalism. Darwin made that shift plausible. My study demonstrates that naturalism is one of the most important focal points in evolutionary biology. T. H. Huxley alluded to naturalism as "natural knowledge," and emphasized its importance for the progress of society:

> Historically, indeed, there would seem to be an inverse relation between supernatural and natural knowledge. As the latter has widened, gained in precision and in trustworthiness, so has the former shrunk, grown vague and questionable; as the one has more and more filled the sphere of action, so has the other retreated into the region of meditation, or vanished behind the screen of mere verbal recognition.
>
> Whether this difference of the fortunes of Naturalism and of Supernaturalism is an indication of the progress, or of the regress, of humanity . . . is a matter of opinion. The point to which I wish to direct attention is that the difference exists and is making itself felt. Men are growing to be seriously alive to the fact that the historical evolution of humanity . . . is being accompanied by a co-ordinate elimination of the supernatural from its originally large occupation of men's thoughts. The question - How far is this process to go? - is, in my apprehension, the Controverted Question of our time (Huxley, 1896 p.7).

The total abandonment of dualism is incomplete among evolutionists (Figure 8, "D"; Figure 10, "Agree;" Figure 12, "C"). The majority of the respondents, however, reject deism and theism entirely, opting instead for a philosophical naturalism firmly grounded in atheistic materialism (Figure seven; Figure eight, "C"; Figure 12, "A"; Figure 18). A current of monistic belief is very strong among the world's most highly respected evolutionary biologists. The great controversy of T. H. Huxley's time extends itself to our own. Ernst Haeckel's and Julian Huxley's hope that evolutionists would become more religious is not confirmed by my results while James Leuba's prediction for a decline in theistic belief among scientists is verified by this sample of illustrious biologists. T. H. Huxley's "Controverted Question" has an answer.

II. Postscript

I began this project with a goal to determine whether evolutionary biologists use their science as a replacement for traditional theology. Biology, and evolution, particularly, answer all the "big" questions for me, and I have never had any religious training. I assumed that most evolutionists probably use science to answer their own "big" questions, even if they were previously religiously trained. After all, Darwin himself abandoned the theological concepts he learned in his youth once his theories and their implications became deeply rooted in his mind. I assumed that Darwin's incompatible stance with respect to religion and evolution was due to profound contradictions in the tenets of the two magisteria. If this was the case, how could compatibilist books like *Can a Darwinian be a Christian?* (Ruse, 2001), and *Finding Darwin's God* (Miller, 1998), written by evolutionists, be taken seriously by intellectuals? By what means is the religious world-view made compatible with the evolutionary world-view? These books did not depict the most respected opinion on the matter, or so I thought. If I could illustrate the world-views of the most-respected evolutionary biologists - members of national academies of science - it would become clear that it is not possible to be a Darwinian and a Christian at the same time.

I was keenly aware of the large amount of human behavior, including religion, explainable by sociobiology. Through the course of this study I realized that numerous evolutionists reject sociobiology, which is the only biological explanation of religion that I know. These same evolutionists, however, do not provide alternative scientific explanations for religion. Presumably, then, religion must be either accepted as a unique magisterium (yielding harmonious compatibilism), rejected as untenable (yielding conflict and incompatibilism), or synthesized with evolutionary theory

somehow (yielding a synthetic compatibilism). Which route did the participants take?

To my amazement, the results reveal that the majority of the participants favor a sociobiological viewpoint when asked about the relationship between evolution and religion (Figure 16 "B"), while only 10% favor strict incompatibilism (Figure 16 "C"). This proves that evolutionary biologists from national academies of science are generally compatibilists, but their world-views preclude them from maintaining a benign compatibilism because they don't give equal status to religion and evolution. Treating religion and evolution as equal magisteria, indeed, is highly unpopular among the participants (Figure 16, "A"). The most popular view debases religion severely and subsumes religion under the heading of sociobiology. Religion is best understood as a social adaptation.

As stated in the abstract, we are left with a strongly conditional, synthetic compatibilism. Evolutionary biologists see no conflict between evolution and religion on one condition: that religion remains mute on the most meaningful matters of human experience, such as belief in gods, life after death, spirits, or souls, all of which are deeply contradictory to a naturalistic world-view. The participants have very strong feelings about the importance of their science. I illustrated some of these feelings in the conclusion. Lewontin tells us that the world-view we want is a materialist world-view. Clutton-Brock states that studying animal societies gives us a foundation for understanding our own society. E. O. Wilson suggests that a suitable replacement for the mythic stories from Christianity is his life's quest satisfied through evolutionary biology. And Dawkins reveals that, through education, naturalism can spread just as readily as traditional religious mythology.

All indications from this dissertation point toward religion and evolution serving the same role for people. Evolutionary biology depends on observation,

verification, and belief that the supernatural is unnecessary to explain the most significant aspects of human experience. All is understandable through a monistic lens. This, to me, is the naturalist world-view.

APPENDIX I

The CORNELL EVOLUTION PROJECT

Questionnaire on Evolution AND Religion

section one: statement of belief

1) Do you consider yourself a religious person? □YES □NO

(If "no" please skip question #2; if "yes" please skip #3)

2) Which best describes your religion?

□Christian □Islamic □Judaism □Buddhism □Hindu □Other

(If "other" please describe)

_____

3) Which best describes your belief system?

□Atheist □Agnostic □Naturalist □Other

(If "other" please describe)

_____

4) Do you believe in God, or an entity that exists beyond the scope of our observations that is responsible for designing and maintaining life on earth?

□ I believe in God as described in this question
□ I believe in God, but my God merely started the processes of the universe, and of life on earth, and does not intervene on a day-to-day basis.
□ I don't believe in God in any traditional sense of the word.
□ I don't believe in God, but I do believe that there are entities in the universe that are beyond the scope of science and are forever going to remain so.

5) What role does evidence play for you in determining your belief in God?

□ I believe that there is a God, no matter how insubstantial the evidence.

□ I believe that there is not enough evidence to justify a belief in God.

□ I don't apply scientific methodology or principles to my beliefs.

6) I believe that there is something, not known to science, in human beings that lives on after the body dies.

□ I Agree with this statement □ I disagree with this statement

7) Please choose only one of the following:

□ All biological organisms are locally determined by heredity and environment but humans still possess free will.
□ All biological organisms are locally determined by heredity and environment and humans have no free will.

The CORNELL EVOLUTION PROJECT

Questionnaire on Evolution AND Religion

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section two: what evolution studies; what it ignores

8) Organisms, including humans, consist of the following:

□ material properties* □ spiritual/non-material properties □ both material and spiritual/non-material properties

*Properties are here defined as determining factors

9) I believe that the findings of evolutionary biology can influence and alter morality.

□ I agree with this statement □ I disagree with this statement

10) Do you believe that evolution teaches us something about the objective reality of life on earth or is such a topic better left for philosophers to debate?

□ I am committed to teaching about the objective reality of life on earth.
□ I am content to let philosophers debate about objective reality, without addressing it in my teaching.
□ I don't believe that there is such a thing as objective reality, we all create our own reality.

11) What is your view of purpose and progress in evolution?

□ Neither purpose nor progress plays any ultimate* role in evolution.
□ Evolution exhibits no ultimate purpose, but progress does occur in evolution.
□ Ultimate purpose plays a role in evolution and progress is a part of that purpose.
□ Ultimate purpose plays a role in evolution, but it doesn't entail progress.

* "Ultimate" refers to any of the following concepts: intelligent design, teleology, or determining factors that science does not study.

12) What is your opinion on the relationship between evolution and religion?
□ They are non-overlapping magisteria* whose tenets are not in conflict.
□ Religion is a social phenomenon that has developed with the biological evolution of Homo sapiens. Therefore religion should be considered as a part of our biological heritage and its tenets should be seen as a labile social adaptation, subject to change and reinterpretation.
□ They are mutually exclusive magisteria whose tenets indicate mutually exclusive conclusions.
□ They are totally harmonious. Evolution is one of many ways to elucidate the evidences of God's designs.

* Teaching bodies

13) I keep my beliefs about morality and ethics separate from my practice and teaching of evolution. □ I agree with this statement □ I disagree with this statement

The CORNELL EVOLUTION PROJECT

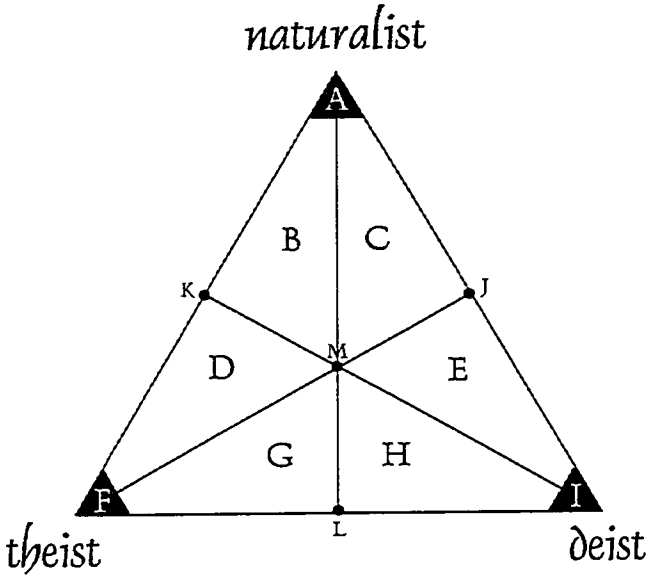
Questionnaire on Evolution AND Religion

section three: religious belief and practice of evolution

14) Choose a letter.

□A □B □C □D □E □F □G □H □I □J □K □L □M

Look at the diagram. Choose the letter that corresponds to your philosophical preference. For instance, if you are a naturalist* choose "A" if you are a Deist*, choose "I" and so on. If your philosophical position is intermediate between the end points, there are lettered fields you can choose. For instance "C" corresponds to a philosophy that is predominantly naturalist but includes some leanings toward deism. "H" is a deistic philosophy with some leanings toward theism*. "J", "K", and "L" are neutral positions along their respective axes. "M" is a totally neutral position, a philosophy without any leanings toward naturalism, deism, or theism.



***Naturalism**, the philosophical position that matter, energy, and natural laws make up the total composition of the universe, and that no God created or designed it, truth is found through the empirical procedure of exploration and verification.

***Deism**, the philosophical position that God exists and created the universe and its forces and matter but does not intervene in daily events; he is an uncaring God who started the evolutionary process but plays no role in its outcome; truth is revealed by design.

***Theism**, the philosophical position that God exists and cares for humans, and intervenes in daily events and processes to affect outcomes for the good of mankind, and that truth is revealed by such goodness.

15) Do you think that your body of work in evolutionary biology reflects your position on the diagram of #14? ☐ Yes ☐ No

The CORNELL EVOLUTION PROJECT

Questionnaire on Evolution AND Religion

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section three: religious belief and practice of evolution

16) Do you consider yourself a naturalist in the metaphysical sense?*

☐ Yes ☐ No

* One who subscribes to metaphysical naturalism, the notion that the only reliable method of discovering truth comes from empirical investigation.

17) What kind of belief system would you advocate, if pressed, as being the most consonant with a lifelong practice of evolution?

☐ One of the traditional religions (i.e. Christianity, Islam, Judaism, Buddhism etc.).
☐ A naturalistic one that is based on materialism, and incorporates advances in scientific knowledge.
☐ One that incorporates some aspects of traditional religion and some aspects of modern science.
☐ Other (please describe)

_____

_____

_____

THE REMAINING SECTIONS ARE OPTIONAL

section four: commentary (Optional)

18) If you would like to qualify any of your answers, or comment on any of the questions, please use this page to do so.

The CORNELL EVOLUTION PROJECT
Questionnaire on Evolution AND Religion

section five: biographical information (Optional)

19)
Your name:

Institution of highest academic degree:

Area of research concentration and classes taught:

Age:

Country of citizenship:

Country of primary education:

Were you formally introduced to any religion in a ceremony or rite of passage?
☐ Yes ☐ No ☐ N/A

If yes, which?
_____

Are you practicing in that religion now?
☐ Yes ☐ No ☐ N/A

For those who answered NO: Did the study and teaching of Evolution have an ideological impact on your decision to discontinue practicing that religion?
☐ Yes ☐ No ☐ N/A

Are you practicing in any religion now?
☐ Yes ☐ No ☐ N/A

WE THANK YOU SINCERELY FOR YOUR PARTICIPATION.

APPENDIX II

THE LIST

Evolutionary biologists who were sent questionnaires for this study (numbered in alphabetical order).

1. Arratia, Gloria	Academia Chilena de Ciencias
2. Akam, Michael Edwin	University of Cambridge
3. Alexander, R. McNeill	University of Leeds
4. Alexander, Richard D.	University of Michigan
5. Alvarez, Walter	University of California, Berkeley
6. Andersen, Nils Moeller	University of Copenhagen
7. Anderson, Wyatt W.	University of Georgia
8. Antonovics, Janis	University of Virginia
9. Arctander, Peter	University of Copenhagen
10. Arsuaga, Juan Luis	Universidad Complutense de Madrid
11. Ashburner, Michael	University of Cambridge
12. Avise, John C.	University of Georgia
13. Ax, Peter	University of Gottingen
14. Ayala, Francisco J.	University of California, Irvine
15. Babu, Cherukuri	University of Delhi
16. Baechli, Gerhard	University of Zurich
17. Baillie, Michael G.	Queens University Ireland
18. Baker, Paul T.	Pennsylvania State University
19. Bar-Yosef, Ofer	Harvard University
20. Barbarena, Mario	Porto Allegre Brazil (retired)
21. Barrett, Spencer C.	University of Toronto
22. Barth, Friedrich G.	Universitaat Wien
23. Barhlott, Wilhelm	Universitaat Bonn
24. Bartholomew, George	University of California, Los Angeles
25. Barton, Nicholas H.	University of Edinburgh
26. Baur, Bruno	Universitaat Basel
27. Beall, Cynthia M.	Case Western Reserve University
28. Beaty, Barry J.	Colorado State University
29. Beiguelman, Bernardo	University of Sao Paulo
30. Berberovic, Ljubomir	Academy of Sciences and Arts of Bosnia-Herzegovina
31. Berenbaum, May	University of Illinois Urbana
32. Bergstrom, Jan	Museum of Natural History Stockholm
33. Bertrand, Jean	Universitee de Geneve

34. Bielicki, Tadeusz	Polish Academy of Sciences
35. Boag, Peter T.	Queens University Canada
36. Bonner, John T.	Princeton University
37. Boomsma, Jacobus	University of Copenhagen
38. Bormann, Frederick H.	Yale University
39. Bose, Mahandra	Indian Academy of Science
40. Boxshall, Geoffrey A.	The Natural History Museum London
41. Breitinger, Emil	Universitaat Wien
42. Bremer, Kaare	Uppsala University
43. Brenner, Sydney	Institute for Molecular Biology
44. Briggs, Derek	University of Bristol
45. Brito da Cunha, Antonio	University of Sao Paulo
46. Britten, Roy J.	California Institute of Technology
47. Buikstra, Jane	University of New Mexico
48. Bullock, Theodore	University of California San Diego
49. Bulmer, Michael G.	Rutgers University
50. Burdon, Jeremy	CSIRO Plant Industry
51. Burrows, Malcom	University of Cambridge
52. Campbell, Kenton S.W.	Australian National Museum
53. Campos, Diogenes	Nacional Produccao Mineral Paleontologia Setor
54. Carneiro, Robert L.	American Museum of Natural History
55. Carroll, Robert L.	McGill University
56. Carson, Hampton	University of Hawaii at Manoa
57. Cavalier-Smith, Thomas	University of Oxford
58. Cavalli-Sforza, L. L.	Stanford University
59. Cech, Thomas R.	Howard Hughes Medical Institute
60. Chaloner, William G.	Royal Holloway University of London
61. Chandrashekaran, Maroli	Madurai Kamaraj University
62. Chengeux, Jean-Pierre	Institut Pasteur
63. Chant, D. A.	University of Toronto
64. Chauhan, Birendra S.	Indian Academy of Science
65. Chitty, Dennis H.	University of British Columbia
66. Christensen, Bent	University of Copenhagen
67. Christiansen, F. B.	University of Aarhus
68. Claes, Ramel	Stockholm University
69. Clegg, M. T.	University of California Riverside
70. Clutton-Brock, Timothy	University of Cambridge
71. Cockburn, Andrew	Australian National University
72. Colwell, Rita	National Science Foundation
73. Conway Morris, Simon	University of Cambridge
74. Coppens, Yves J. E.	College de France
75. Cordeiro, Antonio R.	Federal University de Rio de Janeiro

76. Crane, Peter R.	Royal Botanical Gardens
77. Crawley, Michael J.	Imperial College of Science Technology and Medicine
78. Crick, Francis	The Salk Institute for Biological Studies
79. Crow, James F.	University of Wisconsin
80. Csanyi, Vilmos	Hungarian Academy of Sciences
81. Currie, Phillip J.	Tyrrell Museum of Palaeontology
82. Davies, Nicholas B.	University of Cambridge
83. Dawkins, Richard C.	University of Oxford
84. Denton, Derek A.	University of Melbourne
85. Diamond, Jared M.	University of California Los Angeles
86. Dill, Lawrence M.	Simon Fraser University
87. Doebley, John F.	University of Wisconsin
88. Doolittle, Russell F.	University of California San Diego
89. Doolittle W. Ford	Dalhousie University
90. Duve, Christian de	Universite de Louvian Belgium
91. Edelman, Gerald M.	Scripps Research Institute
92. Edwards, Dianne	Cardiff University
93. Edwards, Peter J.	Geobotanisches Institut Zurich
94. Ehrendorfer, Friedrich	Universitaat Wien
95. Eisner, Thomas	Cornell University
96. Ericson, Lars	Umea University
97. Erlich, Paul R.	Stanford University
98. Ewens, Warren J.	University of Pennsylvania
99. Felsenstein, Joseph	University of Washington
100. Fenchel, Tom	University of Copenhagen
101. Ferreira, Candido S.	Brazilian Academy of Sciences
102. Fitch, Walter M.	University of California Irvine
103. Fitzgerald, P. H.	Royal Society of New Zealand
104. Flannery, Kent V.	University of Michigan
105. Fleugel, Helmut	Austrian Academy of Science
106. Follett, Sir Brian	Arts and Humanities Research Board London
107. Fontaine, Maurice A.	Museum National d'Histoire Naturelle
108. Fortey, Richard A.	The Natural History Museum London
109. Gadagkar, Raghavendra	Indian Institute of Science
110. Gadgil, Madhav	Indian Institute of Science
111. Gadgil, Sulochana	Indian Institute of Science
112. Ganeshaiah, K. N.	University of Agricultural Sciences Bangalore
113. Garruto, Ralph M.	State University of New York Binghamton
114. Gehring, Walter	University of Basel
115. Gibbs, Adrian J.	Australian National University
116. Gierer, Alfred	Max Planck Institut fur Entwicklungsbiologie

117. Gilbert, Walter	Harvard University
118. Godfray, Hugh C.	Imperial College of Science and Technology
119. Goodman, Morris	Wayne State University
120. Grant, Peter	Princeton University
121. Greene, R. C.	Royal Society of New Zealand
122. Griffin, Donald R.	Rockefeller University
123. Grotzinger, John P.	Massachusetts Institute of Technology
124. Hall, Brian K.	Dalhousie University
125. Harpending, Henry C.	University of Utah
126. Harper, John Lander	University of Exeter
127. Hawkes, Kristen	University of Utah
128. Heber, Paul D.	University of Guelph
129. Herak, Milan	University of Zagreb
130. Hill, D. F.	Royal Society of New Zealand
131. Hill, William George	University of Edinburgh
132. Hochachka, Peter W.	University of British Columbia
133. Hoelldobler, Berthold	Universitaat Wurzburg
134. Howell, F. Clark	University of California Berkeley
135. Hrdy, Sarah	University of California Davis
136. Jackson, R. R.	University of Canterbury Christchurch
137. Joyce, Gerald	Scripps Research Institute
138. Kerr, Warwick	National Research Institute for the Amazon Forest
139. Keverne, Eric B.	University of Cambridge
140. Kidwell, Margaret G.	University of Arizona
141. Kilpady, Sripadrao	Indian Academy of Sciences
142. Kirch, Patrick V.	University of California Berkeley
143. Knoll, Andrew H.	Harvard University
144. Koehl, Mimi	University of California Berkeley
145. Krebs, Charles J.	University of British Columbia
146. Krebs, John	University of Oxford
147. Kristensen, Niels P.	University of Copenhagen
148. Kuznicki, Leszek	Polish Academy of Science
149. Lakhanapal, Rjendra N.	Indian Academy of Science
150. Lambert, D. M.	Massey University New Zealand
151. Larcher, Walter	University of Innsbruck
152. Lardelli, Roberto	Schweizerische Akademie der Naturwissenschaften
153. Lawton, John H.	Natural Environment Research Council UK
154. Levi, Claude	Museum National d'Histoire Naturelle
155. Levin, Simon A.	Princeton University
156. Lewis, Edward B.	California Institute of Technology

157. Lewontin, R. C.	Harvard University
158. Linares, Olga F.	Smithsonian Tropical Research Institute
159. Loeffler, Heinz	Universitaat Wien
160. Loeschke, Volker	Aarhus University
161. Lomnicki, Adam	Polish Academy of Sciences
162. Lucas, William J.	University of California Davis
163. Lumley-Woodyear Henry	Museum National d'Histoire Naturelle
164. Mace, Georgina M.	Zoological Society of London
165. Mahendra, Beni C.	Indian Academy of Sciences
166. Malhotra, Kailash C.	Indian Statistical Institute
167. Margalef, Ramon	University of Barcelona
168. Margulis, Lynn	University of Massachusetts Amherst
169. Markham, K. R.	Royal Society of New Zealand
170. Markl, Hubert	University Konstanz
171. Marler, Peter	University of California Davis
172. May, Robert M.	University of Oxford
173. Maynard Smith, John	University of Sussex
174. Mayr, Ernst	Harvard University
175. McLaren, Digby	Royal Society of Canada
176. Meselson, M. S.	Harvard University
177. Mezzalira, Sergio	University of Sao Paulo
178. Michener, C. D.	University of Kansas
179. Morat, Phillippe	Museum National d'Histoire Naturelle
180. Moseley, M. E.	University of Florida
181. Moure, Jesus S.	Federal University Parana
182. Murthy, Mathur R. N.	Indian Institute of Science
183. Nei, Masatoshi	Pennsylvania State University
184. Nevo, Eviatar	University of Haifa
185. Newton, Ian	University of Oxford
186. Nilsson, Dan	Lund Unversity
187. Nusslein-Volhard, C.	Max Planck Institut fur Entwicklungsbiologie
188. Ohta, Tomoko	National Institute of Genetics Japan
189. Orgel, Leslie	Salk Institute for Biological Studies
190. Orians, Gordon H.	University of Washington
191. Paabo, Svante	Max Planck Institute for Evolutionary Anthropology
192. Palmer, Jeffrey D.	Indiana University
193. Pant, Divya D.	University of Allahabad India
194. Patthy, Lazlo	Hungarian Academy of Sciences
195. Perrins, Chris M.	University of Oxford
196. Pettigrew, John D.	University of Queensland
197. Pilbeam, David	Harvard University

198. Pinto, Iraja D.	University Federal de Rio Grande do Sul
199. Rakotosamimanana, B.	The Malagasy Academy
200. Ramanankasina, Estelle	The Malagasy Academy
201. Ranganath, Hassa A.	University of Mysore Manasagangotri
202. Raup, David M.	University of Chicago
203. Raven, Peter	Missouri Botanical Garden
204. Reeves, Peter R.	University of Sydney
205. Rogers, Leslie J.	University of New England Australia
206. Roots, Betty I.	University of Toronto
207. Ruddle, Francis H.	Yale University
208. Runnegar, Bruce N.	University of California Los Angeles
209. Sahlins, Marshall D.	University of Chicago
210. Salt, George	University of Cambridge
211. Salzano, Francisco	Federal University of Rio Grande do Sul
212. Schaal, Barbara	Washington University
213. Schaefer, Matthias	University of Gottingen
214. Schluter, Dolph	University of British Columbia
215. Schmidt-Nielsen, Knut	Duke University
216. Schneider, Horacio	Federal University of Para Bragansa
217. Schopf, J. William	University of California Los Angeles
218. Schwarzacher, Hans G.	Universitaat Wien
219. Schweizer, Dieter	Universitaat Wien
220. Scudder, Geoffrey	University of British Columbia
221. Selander, Robert K.	Pennsylvania State University
222. Shagdarsuren, O.	National University of Mongolia
223. Sharman, Geoffrey	Macquarie University
224. Sharp, Paul M.	University of Nottingham
225. Sherwood, Nancy M.	University of Victoria
226. Shoenlaub, Hans P.	Universitaat Salzburg
227. Simons, Elwyn L.	Duke University
228. Sket, Boris	University of Ljubljana
229. Smith, Andrew Benjamin	The Natural History Museum London
230. Sokal, Robert	State University of New York Stony Brook
231. Somero, George N.	Stanford University
232. Southwood, Richard	University of Oxford
233. Srinivasan, Ramaswamiah	National Geophysical Research Institute India
234. Stanley, Stephen	Johns Hopkins University
235. Stearn, Colin	McGill University
236. Stetter, Karl O.	University of Regensburg
237. Strausfeld, Nicholas J.	University of Arizona
238. Szostak, Jack	Harvard University
239. Taquet, Phillippe	Museum National d'Histoire Naturelle

240. Tartari, Teki	Albanian Academy of Sciences
241. Taylor, Thomas N.	University of Kansas
242. Thoday, John M.	University of Cambridge
243. Tobias, Phillip	University of Witwatersrand
244. Tolun, Aslyhan	Boazici University Turkey
245. Torbjorn, Fagerstrom	Swedish University of Agricultural Sciences
246. Trinkhaus, Erik	Washington University
247. Ulfstrand, Staffan	Uppsala University
248. Uma Shaanker, Ramanan	University of Agricultural Sciences Bangalore
249. Urbanek, Adam	Polish Academy of Sciences
250. Valentine, James W.	University of California Berkeley
251. Vanzolini, Paulo E.	University of Sao Paulo
252. Villems, Richard	University of Tartu Estonia
253. Wake, David B.	University of California Berkeley
254. Walker, Alan	Penn State University
255. Wallace, Bruce	Virginia Polytechnic University
256. Wallace, Douglas C.	University of California Irvine
257. Watson, James D.	Cold Spring Harbor Laboratories
258. Webb, C. J.	Royal Society of New Zealand
259. Webster, Robert G.	St. Jude Children's Research Hospital
260. Wehner, Rudiger	Universitaat Zuerich
261. Wendorf, Fred	Southern Methodist University
262. West, Richard G.	University of Cambridge
263. West-Eberhard, Mary J.	Smithsonian Tropical Research Institute
264. White, Tim D.	University of California Berkeley
265. Wieser, Wolfgang	University of Innsbruck
266. Wiklund, Christer	Stockholm University
267. Williams, G. C.	State University of New York Stonybrook
268. Willaims, Alwyn	University of Glasgow
269. Wilson, E. O.	Harvard University
270. Winge, Helge	Federal University of Rio Grande do Sul
271. Wolfe, Kenneth H.	Trinity College, Dublin

APPENDIX III

Geographic distribution and ratio of returned questionnaires[9].
Asterisks denote states of the U. S. A.

Country, State, or Province	Number of respondents/Number of invitations[10]
Albania	1/1 = 100%
Australia	4/9 = 44.4%
Austria	4/10 = 40%
Arizona*	1/2= 50%
Bosnia-Herzegovina	1/1 = 100%
Brazil	7/14 = 50%
California*	22/30 = 73.3%
Canada	11/18 = 61.1%
Costa Rica	1/1 = 100%
Connecticut*	1/2= 50%
Denmark	5/8 = 63%
France	2/7 = 28.6%
Georgia*	2/2 = 100%
Germany	2/10 = 20%
Hawaii*	1/1 = 100%
Hungary	1/2= 50%
Illinois*	1/3 = 33.3%
Indiana*	1/1 = 100%
India	3/17 = 17.6 %
Japan	1/1 = 100%
Kansas*	2/2 = 100%
Massachusetts*	6/11 = 55%
Madagascar	1/2= 50%
Maryland*	2/2 = 100%
Michigan*	1/3 = 33.3%
Missouri*	1/3 = 33.3%
New Zealand	4/7 = 57.1%
New Jersey*	2/3 = 67%

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9 It is important to remember that these figures represent the portion of the total responses that could be identified by their geographic origin. 9.3% of the respondents exercised total anonymity by answering the questionnaire on line which provides no geographic information.

10 The denominator is a quick guide to the number of National Academy of Science members who are evolutionary biologists in the region.

New York*	5/7 = 71.4%
Pennsylvania*	2/5 = 40%
Poland	2/4 = 50%
Spain	1/2= 50%
Sweden	5/8 = 63%
Switzerland	2/7 = 29%
South Africa	1/1 = 100%
Turkey	1/1 = 100%
Texas*	1/1 = 100%
United Kingdom (including Ireland)	19/39 = 49%
United States (compiled)	57/94 = 61%
Utah*	1/2= 50%
Virginia*	2/3 = 67%
Washington*	1/2= 50%
Wisconsin*	2/2 = 100%

APPENDIX IV

Interview transcripts

The following interviews exist on tape and are reprinted here with informed consent.

Professor Richard Dawkins
Interviewed by Greg Graffin
June 12, 2003
Oxford, UK

G: Greg Graffin
D: Richard Dawkins

G: You said that the finest book you shall ever write is *The Extended Phenotype*. It's basically an advocacy piece which is my favorite kind of non-fiction, really. What is the goal of such work?

D: To change the way people think. And in the case of that book, it was to change the way personal colleagues in the field think. Other books that I've written such as the *Blind Watchmaker* and *Climbing Mount Improbable* could be said to be advocacies aimed more at lay people. Can I just add something on advocacy? I despise lawyers, and so I would hate to be thought of as an advocate in that sense which I take to be a professional advocate paid to advocate a particular point of view with all the resources at his hand, regardless of his own convictions. So I don't want to come across as that at all, but when there is a point of view which I think is true but which is misunderstood or under-rated or otherwise doesn't get a fair hearing, then I wish to use the skills of an advocate, to the utmost of my ability.

G: What distinguishes you from a lawyer is that what a lawyer is advocating for, say he or she is trying to get off someone that they know is guilty. Can you give me a little bit more about your kind of truth?

D: On the lawyer point, I have actually met lawyers who have admitted that. One particular case, was a young woman who was very pleased that she had employed a private detective who had uncovered evidence which conclusively showed her client to be innocent. So I congratulated her. Then I asked the obvious question: what would you have done if the detective had found evidence conclusively showing him to be guilty? And she said, "I would have suppressed it." The way she put it was that is up to the prosecution to find that evidence. "I'm not going to hand the prosecution a free

gift." So she saw it as an adversarial thing.

So I feel quite sensitive about it because I'm aware that there are at least two philosophical, I call them heckles. There's the one that says scientific truth is just white Western males' anthropology. And that, I think, is somewhat pernicious because it opens the floodgates to people who want a sort of license to accept anything. And it is sufficient to say that somebody feels something with a deep conviction or it feels right for you, so it's true even if it feels wrong for him, so it's not true for him.

G: Experiential truth.

D: Yes. And I do think that is rather pernicious. And you can come back to law to illustrate that. And I've done this in an essay in my most recent book *The Devil's Chaplain*. If I were being accused of a murder, and the prosecuting counsel said to me, "Were you or were you not in Chicago on the night of the murder?" I would get short shrift from the jury if I said, "It is only in the white Western sense of the word that I was in Chicago." In the culture of the Bongobongo, you're only really in a place if you are an anointed elder, etc. So if you want to quote that bit it's in a *Devil's Chaplain*, the essay is called *What is Truth*. Maybe I should refer you to that essay.

G: We can go on from there. Is it this quest for reality that drives your research?

D: Yes, I think it is. The other heckle is the sort of Popperian one which says you are only failing to falsify and so you don't actually ever prove something to be true. You just fail to falsify it. And I can see the sense in that, but common-sense steps in and once again, "Were you in Chicago on the night of the murder?" You would never mount a Popperian defense. The jury would say, "Were you or were you not?" It's a straightforward matter of fact. And I am a sort of naive realist in that sense.

G: How important is it then that biologists agree on the implications of evolutionary biology knowledge? In other words, how important is it that there are not alternative interpretations of evolutionary theory?

D: I think I am a bit out of the mainstream here because there are a lot of–especially in America–strong advocates of evolution. People like Eugenie Scott who acts as a kind of pressure group. She runs a sort of pressure group for collecting together all news items about the state of Kansas, or just the school board. And so she's a professional advocate. She's a scientist. But she's made it her life's work to propagandize for evolution, and she's got an office with a staff. Anyway, I raised her name because she is one of many who say something like evolution is no threat to religion. These are entirely separate things. And she's very, very strong on this and very negative to people like me who think it is a threat to religion. She thinks I'm rocking the boat, and in the context of American politics I see what she means because the last thing that

scientists want in America is to be thought to be anti-religious because they depend on tax dollars, etc. So it's very important to line up evolution, to make sure there is separation.

G: To create a comfortable place for it. Now, the results of my questionnaire showed just the opposite. Evolutionists in America are no different from evolutionists in any other country in the world in asserting their atheism.

D: I'm not surprised to hear you say that, and I don't think Eugenie would be either. I think she knows perfectly well that that's the case, but for her political purposes, it's not a good idea for that to be widely emphasized.

G: So that's exactly one of the motivations for my entire dissertation. And that's what brings us to the question of how important is it, if we have agreement of all the evolutionary biologists in the world at the national academy level and they maybe don't agree on the implications as far as it affects religion. If all we're talking about is "Well, evolution is this body of knowledge, but in America it's very important that it not conflict with religion whereas here in the U.K., it's ok." It says a lot about what science means.

D: That's where I part company with Eugenie because she is quite happy to say that she herself is an atheist. But I try to press her to say [she's] just a political tactician.

G: We need not go as far as Eugenie Scott because we've got Stephen J. Gould. I'm sure she's probably citing him as bringing up this idea that there are these non-overlapping magesteria. I think it was done as a compromise, and I'm curious as to [why]. Unfortunately, Professor Gould I can't ask. He died right before the survey. It is my goal to figure out how important it is among evolutionary biologists that there is some kind of unity within the discipline.

D: A good person on separate magisteria, and you may have talked to him already, I don't know if he is a member of the National Academy, is Jerry Coyne. Do you know him?

G: Yes, I know who he is.

D: I was very irritated about that Gould book. I think it is a load of complete nonsense to say separate magisteria really, for two reasons. One is that religion doesn't manifestly keep on its own turf. And he [Gould] would accept that, and he would say that the only kind of religion he's interested in is the bit about religion that does keep off science's turf, which leaves, for me to believe, just about nothing.

If you actually look at why people actually believe their religion–ordinary naive

people in the pew in church–it's because of miracles. It's because Jesus healed the sick, and Jesus rose from the dead, and the virgin birth, and all that stuff, which is absolutely flat scientific theory. Its erroneous scientific theory. It's making scientific claims, and that's what impresses people. And that's why people buy into it. And so the separate magisteria is dishonest.

Gould wasn't dishonest because he wasn't using it to bring people into church, but most of the people who are in church would not be there if they had to accept separate magisteria. And therefore, no miracles, no supernatural, no life after death, no healing the sick, no rising from the dead. All of that would have to go [because science explains those phenomena better]. And as far they're concerned they'd say, "Well that's my religion gone."

G: I think that's true. Among your colleagues is this idea of talking about the implications of evolution not often brought up because of the potential disagreement that might arise?

D: I'm not sure it is. I don't think it's for the political, tactical reason I was talking about. I think it's more that we've all accepted a kind of weak kneed tolerance that somehow religion deserves our respect, and so we must bend over backwards to give it every possible quarter that we can. And I think that bending over backward is the right phrase. You don't say, "Well, I don't believe in your religion, and I think it's a load of rubbish." You say, "I don't believe in religion, but of course I totally respect [your opinion]." Whereas you don't say that if you're talking to a right wing Republican. You don't say, "I'm not a right wing Republican, but I totally respect your beliefs."

G: You'd say, "You're full of it." So how does your goal to portray a picture of reality conflict?

D: I don't do the bending over backwards. And I get quite a lot of shtick for that because I'm regarded as a fanatic. I'm frequently described as a fundamentalist who is every bit as fundamentalist as creationists on the other side. And that actually does annoy me very much because there is evidence on one side and no evidence on the other. I may sound fundamentalist because I express myself strongly and clearly, but what I'm expressing is based on factual evidence rather than nebulous scripture and faith.

G: So if your colleagues think of you as not playing the game or dancing the dance because you're not bending over backwards, then that's kind of what I was getting at about agreement within the field that we all are on the same page in terms of agreeing on how these implications should be handled. You said it annoys you when you are portrayed as a fundamentalist, but do you think that some of your colleagues portray you like that?

D: Yes, I think some of them do. I don't think they do if they think it through. I think that there is a sort of immediate resonance that I sound fundamentalist. And I do get quite a bit of that from people saying "Thank you for taking the stand you do. I wish more people would." And I see it as an exercise in what feminists call conscious raising. One wants to raise people's consciousness to the mindless culture of respect, which we are expected to show to religion, but to essentially nothing else. Opinions that you disagree with–in any field other than religion– you argue robustly and you win the argument or lose the argument. But if it's religion, you are expected to tiptoe away. And I think we need to raise people's consciousness to the fact that we're doing that. They don't realize that they're doing it. People will say, "Why yes, that is what's going on. I am tiptoeing away. I bought into this view that because it's religion, you've go to respect it."

G: If someone wants to say there is no problem studying religion and evolution side by side because they are mutually exclusive or they are non-overlapping, then there are plenty of your colleagues that they could refer to verifying that.

D: Yes, Gould, Michael Ruse.

G: What you're saying is that they are tiptoing around the issue in order to maintain that position. That must really bother you.

D: Yeah.

G: But one you would think that it is really important that the entire body of evolutionary biologists understands that there is one reasonable way to think about this.

D: I would think that it's a bit different in America for the political reason that I mentioned in connection to Eugenie Scott. So it's not political expediency. It's not that we wouldn't get tax research money. Whereas there is a serious possibility in America that some Senator, some Congressman got up and said "Professor so and so's research is manifestly anti-religious. He's working on *Drosophila* and he's using it to" . . . . That actually could happen which it couldn't here. I think in this country what we have is something that is also present in America which is the weaker thing. It's the mindless respect. It's the tiptoeing around which is not for political tactical reasons. It's just a thing that's got into the culture. It's like the convention that you open the door for a lady. It's just a cultural convention. Just as it's polite to stand up when a lady comes into the room in some cultures. It's polite not to insult someone's religion, but you can insult their politics or their views on this, that or the other. Their football team or whatever.

G: How much of the knowledge that you've gained from evolutionary biology do you use in forming your world-view as opposed to other kinds of stories?

D: If you mean my world-view of human affairs, not as much as some people do. I've read the literature on evolutionary psychology and socio-biology. I'm kind of interested in it. But it doesn't spring to the top of my consciousness whenever I think about a human problem. If I see a child being obnoxious, I don't instantly think parent-offspring conflict. Some of my colleagues do. So I don't know if that's answered your question or not. If a child were to say to me, "Why are flowers so pretty?" Then I would say something about insects and pollination and things.

G: And ultimately, that explanation could be extended to what you said before.

D: Yes, I think it could. I mean I think my criterion would be: is this something the child could be fascinated by? Do I have the explanatory gifts to excite the child in pollination? You need to go back a bit and explain why cross-pollination is important and things. It's a difficult thing, and the child may be too young. But if I thought the child could appreciate it, I would do it because I think it would enrich the child's life to be told the true explanation for the beauty of flowers.

G: It goes back to what I said earlier about a quest for understanding reality. Once you have that picture of reality, is it your goal to share it with the public?

D: Yes.

G: I have children as well, and I appreciate what you were saying about sensitivity. You can't blurt out to a child the reality of reproduction or whatnot, but you can set them up to make them appreciate it later and more easily.

Here's another question on understanding religion. Do you think that the meme-gene synthesis is going to be the key to understanding religion? You handle them as two separate types of replicators but do you think the connection between memes and genes, of which there's got to be one–is that how we are finally going to be able to understand religion in a way that we can explain it?

D: If somebody says to me, "What's the Darwinian survival value of religion?" I'm inclined to say that's the wrong question. It's rather like saying, "What's the survival value of dominance hierarchies, peck orders in chickens or wolves or something?" You can't ask that question because a dominance hierarchy is a phenomenon that you only see at the social level. At the individual level it's a manifestation. It's an emergent from the fact that individuals learn who they can beat and who beats them. And if the individuals all do that, what you end up with is a dominance hierarchy. So you have to rephrase the question. Not "What's the survival value of a dominance

hierarchy?" But "What's the survival value of learning who you can beat and who beats you?" Once you phrase it like that, it's a different question. The answer becomes a different one. In the case of religion, I think you might rephrase the question: what is the survival value of having the kind of brain that lends itself to memetic exploitation? What's the survival value of having the sort of brain that is vulnerable to parasitism by self-replicating memes that have no connection with Darwinian survival in the genetic sense? Then if you asked me, "What would an example of that be?" I would say, "Perhaps, child brains are shaped by genetic natural selection to follow a rule of thumb that says believe whatever your parents tell you." You can easily see why in general that rule of thumb would have genetic survival value.

The world is a dangerous place. Children don't have time to discover by trial and error. It's too dangerous to discover by trial and error. Like, "don't swim in the river because there are crocodiles." You just have to believe what your parents tell you. If Darwinian genetic selection has programmed your child with the rule to believe whatever your parents tell you, then that is a rule for exploitation by parasitizing memes, which say that you have to sacrifice a goat to the "Great Juju" in the sky; and you don't know where that came from. Maybe it came from six generations back. Somebody made it up or whatever. But once it starts going down the generations, it will go on going down the generations because the child brain is set up with that rule of thumb, believe whatever your parents tell you.

G: And that's the connection–what I would call the synthesis–the understanding of the development of the child's brain–because in that lies the explanation of why the stories of religion are so predominant. And yet, that conflicts with the picture of reality that comes from science.

D: Yes, and it would be expressed by religion as what you can call "geographically arbitrary." In that area of the world they believe so and so. And in that area of the world they believe so and so. It's totally contradictory. It's just like different languages, but here they worship a sacred sun, and there they worship the moon, and over there they worship a sacred ferret or something.

I think it's a very accurate explanation. It may not be the whole explanation. I mean, you could then add things like "not only are child brains susceptible to parasitic memes, but some memes are simply better at spreading." A meme of life after death might have an advantage over an alternative that was less appealing.

G: Would you say that morality is completely outside of the discussion of evolutionary biology?

D: It's clearly not outside of a discussion of questions like "Where do you we get a moral sense from?" You can easily ask a Darwinian question, but you may not come up with a very satisfactory answer. But it's a legitimate question to ask a Darwinian,

"Where do we get our moral sense from?" And if we do a cross cultural anthropological study and discover that all cultures regard incest as immoral, then you're entitled to ask the Darwinian for an explanation. But one would be very reluctant to do what social Darwinists did and try to import our morals from Darwinism. Something like, "Anything that follows the Darwinian imperative of survival of the fittest is good." The worst I've ever come across is H.G. Wells.

G: Most of the public don't know anything about evolutionary biology, and yet most evolutionary biologists reject religion out right. If you accept that the public use religion for the purpose of explanation; and most evolutionary biologists reject religion–they use evolutionary theory to explain origins obviously and the lack of purpose in the universe. Do you think it's just a matter of education?

D: Well, maybe. There are a few people who have read it up. People like Duane and Gish who know what they are arguing against, and whether they are dishonest or not, I don't know. They actually have arguments against it. But I think the great majority of people just don't know what it is. They don't know what they are arguing against. All they have ever been exposed to is a religious world-view. [I like to] convey an optimistic message about education–that's why I write books like the *Blind Watchmaker* and *Climbing Mount Improbable*.

G: Those are for the general public?

D: Yes, and they are supposed to not so much give the evidence which other books do, but make it plausible. You may have difficulty believing that something is as beautiful as a peacock's tail or a butterfly's wing or a trilobite's eye would have come about without a designer, but when you understand how, it's actually a riveting theory.

G: I think so, too. In my questionnaire there was a question about naturalism. Do you think of yourself as a naturalist?

D: Yes.

G: In what sense?

D: Well, it's a very unfortunate word because to Darwin himself, naturalist meant somebody who went around the countryside looking at butterflies. But you are talking about the philosophic meaning now.

G: That's it. I'm curious what you think of when you hear the word.

D: I think of Dr. Doolittle, of Darwin and Wallace and Bates. It's a very unfortunate

word to use. And I think that you need to really insist that you mean it in the philosophic sense, if you do. So I'm an anti-supernaturalist. That's at least clear.

G: How is it related to atheist?

D: Atheist is a perfectly fine word. It's never going to win any friends. Certainly not in America. And so purely as an exercise in public relations, we probably do need another word.

G: Agnostic was a popular choice, also.

D: That annoys me because that's too much the separate magisteria. It's vulnerable to the retort, "There's an infinite number of things we have to be agnostic about." We strictly have to be agnostic about, well, Thor and Jupiter and Whotan for a start, but unicorns and dryads and nymphs and sprites and such [as well].

G: Anything that comes to mind.

D: Absolutely anything that comes to mind, you have to be strictly agnostic about. I like Russell's example of a tea pot in orbit around Mars. Yes, I'm agnostic about the tea pot, etc. So I think the point is that the burden of proof lies with the person who wants to believe in the tea pot or in the god. And it's not our business to say, "I can disprove it." It's just not interesting to go around disproving everything that somebody could possibly postulate like a tea pot in orbit or like a god. If by agnostic you mean tea pot agnostic, then I am a tea pot agnostic.

G: In what respect does naturalism entail belief?

D: Well, I just think of it as anti-supernaturalism. So I think it means a belief that we should not believe as if there are entities in the universe for which there is no evidence. It's very different from saying that I deny that there are any entities that we don't yet know about. I would never say that, because the history of science is littered with casualties of people who said that kind of thing. There are plenty of things that we don't yet know, but those are things which are waiting to be drawn into the embrace of naturalism.

G: Which is guided by the principles of verification and observation.

D: Yes. I would certainly choose [that] there are entities that we don't yet know. And I'm inclined–I think it's more of a hope than a belief–it's a hope that science will be powerful enough that that category will eventually become zero. I would like to phrase it as naturalist in the sense of including atheist. Nobody who is an atheist would

not be a naturalist.

G: Finally, if you could add anything on what is the use for evolutionary biology knowledge? What do we use this knowledge for? The social use of it.

D: I think my honest answer [is], I don't give a bugger for social use. I care about what is true. It is why we are here. It is why we exist. It is why all living things exist. It's why all living things anywhere in the universe, if there are any other, exist. What more do you want? If it does have any relevance to understanding of society, well that's a bonus.

G: For you does it have any significance for understanding society?

D: Probably, yes. But I wouldn't wish to say too much about that because that's the bit that other people will seize upon. And I want them to understand. I want to open their eyes to the fact that it accounts for that redwood tree over there. It accounts for lions and whales and kangaroos and bacteria.

G: And mothers punishing their children in the center of town . . .

D: Maybe it does, but I just want to downplay that. There are enough people out there up-playing it.

Professor George C. Williams
Interviewed by Greg Graffin
June 24, 2003
South Setauket, New York

G: Greg Graffin
W: George C. Williams

G: You were saying at lunch how your career ended up with discussions about evolutionary implications and how they affect religion. Can you add to that a little bit? Maybe suggest why you waited until the end of your career to address those implications.

W: Well, I certainly wouldn't say that waiting until the end of my career was advisory. Although maybe from a practical perspective it probably was because you had to be–my career depended on being hired by a university someplace and that happened in several places early in the game. I've been at Stonybrook for several decades.

I think, basically, it's my religious attitude that sort of took over, and I merely made use of what I knew of biology, but the ultimate question [became]: why is everything the way it is really? I was raised a Catholic, and as I grew up with the idea of god creating the world in 6 days, a few thousand years ago. All the usual Biblical stuff that people are taught. In my case, it was a Catholic elementary school, but then there are conflicts that arise. You have that Biblical view of creation, and then you learn other views of creation like astronomy and geology and so on. And I think by the time I was in the army . . . well, let me put it this way, I think it was fairly early in high school when I said "to hell with Catholicism." I mean, I still had to be on good terms with my Catholic family, so I continued the practices as they were expected. But in the army, I broke loose and forgot about going to church, that sort of thing.

I was raised on the East Coast, New York and Maryland. After I got out of the army I went to the University of California at Berkeley and saw very little of my family. My parents separated. I was raised in New York, that was where I went to that Catholic elementary school–then started high school there, and then my father lost his job. He was a victim of alcoholism and other problems. And my mother and sister and I had to go to Maryland and be parasites on her relatives for a while until I went into the army in early January '44. I was 17 years old, and I joined an outfit that sent me to Lehigh University to study engineering at university expense. I was in the U. S. Army Reserve Corps.

Well, after I made the mistake of turning 18, they shipped me off to basic training. But then, after basic training, they sent me to continue my engineer training at Texas A&M, where I was for five months, and then flunked out. That was the end of my education apparently. And then there were various places in the United States, because the army didn't really know what it wanted to do with me, but [the army]

finally sent me to Italy. I was there for eight months. November '45 to July '46. I got out of the army just in time to be accepted into the University of California. Why they accepted me, I have no idea, when I had nothing but Fs in grades at the last place I had been. But they goofed or something, and that's where I went. I got my A.B. degree there, started graduate school there.

G: How early on in your evolution or biology training did you start to recognize that there was some kind of conflict between what you'd been taught in Catholicism and what you were learning in biology?

W: That occurred to me many many years before. In fact, I was at Texas A&M and lost interest in becoming an engineer. One of the things I did was notice that they had evolutionary stuff in the library there, including a copy of Darwin's *The Origin of Species*, which I read at Texas A&M in '40 something or '44. At the University of California at Berkeley, I has a course in engineering from Ledyard Stebbens and that really anchored my interest.

G: In evolution?

W: Yes.

G: Did he talk about the implications of religion in that course? Or was it left up to the students to deal with? Was there any formal recognition that these things that he was saying might be controversial to religious people?

W: This was not emphasized, but it was certainly admitted.

G: So you were already well into your understanding that there were some conflicts, but when you started publishing you didn't write about it?

W: No, because these were personal reactions and not scientific stuff that I was expected to publish. So there was, fairly early in the game, another fundamental alteration in my ideas about evolution and about the importance of evolutionary ideas. When I left UCLA, just finished my work for a doctorate there, I got one year post-doctoral support at the University of Chicago from what was called the Ford Foundation. In certain practical ways, it was a mistake to take that position, but I did. One of the things that happened there is that I had attended a lecture given at University of Chicago–[the lecturer] was a termite specialist at the University of Chicago. Well, he gave a lecture on senescence and said that the reason that, as we get older, we're more likely to die is because the process of natural selection has designed us so that obsolete individuals are not going to stick around for an excessive period of time. So new ones newly subjected to natural selection should take over. It just hit me

that this is utter nonsense if I've ever heard it. Well, that was in late '54 or early '55, and it was really the inspiration for the 1957 paper on senescence that I published. It never occurred to me to worry about the phenomenon until I heard that explanation of it. I sort of had the feeling that if this is the sort of thing that can be accepted, then there's something wrong with biology.

G: No one had stated it clearly enough until you published those papers, probably. Switching gears for a moment, I want to talk about the questionnaire that I sent out. And I'll remind you of one of your answers. First of all, Paley said long ago, "If there is a contrivance, there must be a contriver. There must be a watch maker." Now, in the questionnaire, you said that creation out there–nature–implies a creator. In what form does this creator take for you?

W: The origin of that universe out there. Not just the physical events that produced what we've got, but where the physical events come from–who designed or what produced those physical events?

G: In that sense, you called yourself an anti-theist. What does that mean? Can you elaborate a little bit?

W: The idea is: let's define god as that which produced that universe out there. Now this means that theology can be a real science. You go examine that universe and come to conclusions about the designer and perpetrator and whatever you want to call it.

G: Would you call that a first cause then?

W: Well, I think that the term "first cause" may be a little bit too simple. There may be a collection of causes. But at any rate, I don't think we should imply that there was a first cause but then no subsequent influences on what that universe is doing. These are things you want to find out; you examine that universe. Do we need to recognize something is doing something to it now? Or is it simply following its own internal attributes to wherever they lead?

G: So an anti-theist, as you define it, means that you don't need to invoke a god in a theistic sense, who is constantly in touch with us?

W: Right, you don't need to do that.

G: How does this relate to deism then–the idea that there was a designer who created the laws, created the matter, and then stepped back and let the operation run?

W: I certainly wouldn't describe the origin of the universe in that way. That's too

specific an idea about what started it. The thing that really interests me is that if by designer you mean somebody who does something for a purpose, so the thing that is done, you examine it and see if it is really related to that purpose–and the only thing out there in that universe that does this, is living organisms and the attributes of living organisms. The classic example being that the eye is for seeing with. And I think that's a totally justified idea. That's what the eye is doing. It's precisely and elaborately designed for that function, but if you look at the design, you find that it is extremely well defined in the sense that quantitatively the different attributes are related to each other in a nearly ideal way, like the distance between the lens and the retina, and that sort of thing. In all these attributes in organisms, if you look closely enough there are some really stupid aspects that ought not to be if it were intelligently designed. And the backwards retina is the best really good example of that. And of course, lots of arbitrary things like why are there six muscles that move the eyes?

G: You only need four?

W: I think three would do it. In fact, I say this in the book and compare it to a photographer's tripod.

G: Purpose does play an important role for you. You think purpose is something that is a part of biological science?

W: Right.

G: And it should be part of the biological dialogue?

W: Right. And it should be, obviously, part of the philosophical dialogue, ethical dialogue. One of the main points I make is that looking at the way the mechanisms in real organisms operate, the inevitable conclusion is that god is evil because the thing that is consistently favored is selfishness. And it can have disastrous [consequences]–if people would just have a look at what's going on out there in the woods, the idea that this is something created by a benevolent god. I quote a couplet in Tennyson's poem about wondering where all those seeds–there are so few of them actually–fulfill what they are designed to do. There are enormously more impressive examples; fish especially. There are big fish that lay millions of eggs. Only the reciprocal of millions will actually make it. So the designer is obviously not a benign designer.

G: You say then, if you could establish that creation out there implies a creator. You say that that is a topic for theology.

W: Yes.

G: But our traditional theology is hell bent on establishing the designer as a benevolent god.

W: People, whatever they grow up with, are hell bent on establishing that that basis is the really good thing about theology or about the universe or whatever. And it's amazing how consistently people follow the religion of their parents. Even when there's nothing really fanatical about it.

G: What would a theological study look like if they came to the conclusion that you just came to, which is, that whoever the designer is, he sure isn't benevolent?

W: Ok.

G: Would that be a theology of love? Would it have to be redefined?

W: I think people in general may very well say that is not theology.

G: What I'm saying is maybe it is theology, but maybe that's what evolutionary biology teaches us. Maybe, once you jump to that level of explanation, is that the story that evolutionary biology is telling?

W: If you call the source of that creation out there, including what's out here in the woods and in Long Island Sound and so on, if you call that god, then you go and examine the creation and come to theological conclusions. And I think as I point out, that the theological conclusions would be that god is in fact almighty. That is undeniable.

G: That we all are subservient to those laws of nature.

W: Right.

G: Isn't that the same thing that William Paley did?

W: Yes, except that William Paley missed an important aspect of the design of organisms. He looked at those designs of organisms that can be readily subjected to natural selection in that quantitative relationships among features of organisms are optimized, but those specific relationships may be functionally stupid as I've given a number of examples of that sort of thing. So god is mighty and he is evil, but fortunately he is stupid, so we can outsmart him. In fact, there are a lot of examples of that sort of thing.

G: It was designed, but it wasn't intelligently designed?

W: That's right. It was designed by trial and error. Darwinian natural selection process.

G: Why do we need to talk about god at all then? Maybe the public would like it if we could incorporate a discussion of god into science, especially into evolutionary biology. But is it really god that we are talking about, or is it just "god" becoming a wastebasket term then for whatever created that nature out there?

W: That's right. If you simply define god as the creator, that's what you've got. Now, if by creator you mean the one described in the first book of Genesis or something, but why use that book and not something else. But if you try to find out about the creator by examining creation objectively, then it seems to me, you've got a perfectly reasonable way of establishing a religion.

G: If we assume that there were some shortcomings of traditional theology, and we mentioned a couple of them: how easy it is to miss the point of what we observe in nature; that religion isn't any good for modern life. But religion is probably still necessary for modern life. If it is necessary, then in what degree should evolutionary biology information be incorporated?

W: That's a good question. I think all I can say is that doing what you can to combat the evils of nature and, of course, the evils of human nature, human behavior, is a good idea. But I can't imagine that there's anything that would appeal to people the way that going to heaven appeals to people. But one of the things that bothers me about philosophy in general, and science and everything else, is that there's some awfully basic questions that are not looked at at all. You experience yourself. Everybody understands that there's that brain up there inside your head where these things are going on, but there's a totally different concept of mind and brain, and are we really totally devoted to the idea that the mind can exist only if that brain exists? Obviously, religion says no. When you die, your soul goes to heaven or elsewhere. There's absolutely no scientific idea that would support that. In fact, everything says no. The mind manifests itself no more once the brain is dead. But why should there be a mind?

G: Is it just a epiphenomenon of the material brain?

W: I can imagine tests that you can do to look at the mind concept. You go into a room and there are two computers. And you say, these are connected to someone else–or one of them is connected to another guy in the other room–the other's connected to an elaborate program to depict human response. So you go to one of them and say, "What's your name?"And the response comes back, "It's none of your goddamn business." But on the other one, "I'm Greg something or other." [The computers] go

on and on, both of them asking questions. I think within five minutes it will be pretty obvious [these are not humans communicating]. Ten years from now, it may take you 5 hours [to figure out that these are not humans communicating].

G: Because they're so much more complicated.

W: Because they're so much [more complex], and are you really going to assume that just because one of these people you're talking to is made out of little chips of mineral material, and the other is made up of human brain, are they really that different? If a computer can manifest itself in a really human way, can you really conclude that it's not really human? And then there's the time concept. Yeah, we know what time it is. Let's see, tomorrow is the next day, and yesterday is gone. But to what extent is this realistic? And when you consider there are all those billions of years that the universe has been here, what's the likelihood that right now you're going to be in your life rather than–the time concept–it's not something you're ever in control of theoretically. Maybe you are, but don't realize it.

G: It certainly is something they didn't have any reason to ponder these questions in even the middle of the 1800s. On the questionnaire, one of the first questions was: are you religious? And in this capacity here, I think you checked "yes, you are religious." But your religion is what we are describing here, which is purely a naturalistic religion. It's based on naturalism. It's not based on spiritualism in any way. Do you agree that as a naturalist it's unavoidable to talk about these philosophical questions? And theological even?

W: Yes.

G: So in what sense is design a necessary topic for evolutionary biology? You seem to say purpose is a necessary topic.

W: Purpose is always to maximize the representation of your genes in future generations.

G: And so what about design?

W: You're designed to accomplish that.

G: But you also say that you're not intelligently designed.

W: Right. Your design may be such that even though you are designed to maximize a representation of your genes in future generations, put you in an abnormal environment, like everybody is in nowadays, and your motivations may be completely

inappropriate for what you're really designed to accomplish. We're designed to accomplish things in the good old days, in other words, the stone age. Doing it nowadays, is another matter. And there's a tremendous amount of selection undoubtably for the abnormal traits now, but in another 20 or 30 years the selection will be for something else.

G: Is it purely cultural determinancy that decides who gets more genes into the next generation in human culture?

W: Yeah, if the culture includes taking you into priesthood where you're supposed to be celibate for the rest of your life, that's not going to maximize your transmission of genes. Of course, you can always argue that having a priest in family may help other members of the family sufficiently.

G: Have high status.

W: Yeah.

G: In another part of the book, you said, "One of the great delights of scholarly pursuits such as biology is that we can all form our own opinions on any issue." And you were referring to the eusociality in Hymenoptera. But how important is consensus and the implications that come from it? How important do you think it is that biologists agree on these things that we're discussing?

W: I presume that what they're agreeing on are things that at the moment look like the most promising approach to solving the problems that they're facing. But that doesn't mean that 50 years from now people won't look back and say those stupid jerks that did this kind of research instead of [something else]. At any rate, we're better off today than we were in previous years.

G: But on the question of evolution and religion particularly, it's a question that's been raised continually since before the time of Darwin. And it seems there is still no consensus. The only consensus we ever can agree on is that in general evolutionary biologists reject traditional religion, in general they are atheistic, and in general they don't believe in life after death. But if you start to ask them about social implications of evolutionary biology, it's almost all over the place. Is it important that eventually we come to terms with some consensus on that in evolutionary biology?

W: I think that, in general, when you talk to biologists about things, even what might be considered aspects of biology that are unrelated to what they're actually doing in their own laboratories, you'll get a variety of opinions, many of them not the least bit justified. And this would include opinions about the significance of what you're doing

to religious questions, and that sort of thing. Some excuse that they can come up with or it's not something that they have to worry about in order to get something published or in order to get a grant.

G: Very practical issues. But in terms of ethics–one of the large things to come out of evolutionary biology is an ethic of conservation, biodiversity, preservation of diversity–those kinds of things. Are those topics necessary outcomes of evolutionary biology or were they just added on? Can we add on, can we take our own ethical personal interests and apply evolutionary biology?

W: Yes, I think that probably is just normally done. The concept of conservation, for instance. There are all those millions of species out there subject to extinction, is that good or bad? Well, I think almost everybody says, "Oh that's bad. We don't want to cause those extinctions." But in what sense are they bad? The earth will have no more species than the moon does, but if you wipe them all out, the good and bad concepts are a bit difficult to deal with.

I think the pain and suffering and unhappiness is bad. And almost everybody would agree with that at least most of the time. So let's minimize that. And this includes psychological pain like the death of somebody you've been with for many years or somebody you've admired. These are motivations that it would be nice to be able to do something about.

G: Not predation on the Serengeti Plain. That's not suffering like you are describing right now.

W: Well, predation I think in general is. But here again, if you go out into the woods and shoot deer, those deer are losers in the game. They're failures. That's damage, that's bad, but it might be even worse if you didn't because they'd be starving.

G: A long term suffering.

W: Yeah. And so, god set that up that way, and so he's really the one to blame. So let's go after him, and alter his creation in some optimal way, which you can maybe figure out and maybe can't.

G: Since we are the stewards of nature, could we maybe eliminate all predators or at least all suffering from overpopulation?

W: Yeah, that would be a desirable goal.

G: What if we could substitute prey items to carnivores on the Serengeti to eliminate the suffering of the gazelles?

W: That's something that people can legitimately decide, I say.

G: It would be interesting if that religion ever became popular. These would be the kinds of pursuits that would be legitimate pursuits. That would be an interesting world.

W: Well, I think it might be rather frustrating.

G: Although how many times have we dabbled with predator-prey interactions and created an ecological disaster like in the Great Lakes? I don't know if we're smart enough. In that sense, we might be dumber than the creator.

W: Oh, I don't know. Nobody's ever that dumb.

G: You do have one of the most interesting world-views of anyone I talked to and anyone I've read. How much of evolutionary biology is actually used in constructing your current world-view?

W: I think it's the concept of natural selection. In [my latest] book and so on, I talk about the universe. It's this local planet that I'm really interested in and the things living on it. It's the idea that the only thing we can find that seems to be designed for a purpose is parts of organisms, and the purpose is always maximizing the success of that organism, and this always means an enormous amount of lack of success and suffering for other organisms. But do plants suffer? We have no evidence for that, but in fact, you have no evidence for another human being suffering in a way analogous to yourself because there's no way to experience it. You just observe it, and they are reacting in the way you would, so you figure they are feeling the way you would have felt and have the mental attitude that you've got. But there's obviously no logical proof of that.

G: So you would explain to other people, if they asked you to pontificate about what we see in the world, you would use almost exclusively information from evolutionary biology?

W: Yeah.

G: What part of that would you use to form your morality or your ethical position?

W: The rules that I would use would be to do things that minimize the sufferings and disappointments and so on of other people mostly, but also other organisms to whatever possible extent that you can do that with any practical application.

G: So you would say by nature we are set up this way, but we have to strive to

minimize the suffering that nature has already imparted on us? So the old argument you can't justify any bad behavior and say it's natural to be doing this.

W: Because if it's natural behavior, it's bad. It's evil.

G: That's good.

W: It's designed to maximize the evil of your activities in the Stone Age. But ideas from kin selection and so on that maximized fitness a few thousand years ago can be applied to people you see on television, like starving Africans.

G: Through empathy, you mean? Because you empathize with them?

W: Yeah, even though in the good old days, they would be somebody on the other side of the stream you live on or the next cave over. Probably relatives.

G: They might be genetically related.

W: Yeah. But nowadays, you see somebody on television, and it may have exactly the same effect on you emotionally. It may motivate you to do things of benefit for that individual which you think may be of benefit to that individual like donating money to some charitable organization or something like that.

G: So that's completely unnatural, but morally right.

W: No, it's completely natural with respect to your response to what you see, what you perceive.

G: That's a good point. You're limbic system thinks it's natural.

W: Exactly.

G: You're being fooled by the television.

W: Yeah, and the people who designed that scene to be shown on the television. They've edited and changed and shown it because it will do them good because they are producing things that are supposed to be emotional impacts.

G: What is the justification for these morals? That's where the question ends up.

W: Oh, the justification is always, you're doing something that will minimize pain and disappointment, and maximize comfort and joy and so on.

G: Because the justification from theology of living a moral life is of course god told us to do it, and it's the only way to get to heaven. Or you're mimicking the life of Jesus, who was a saint. My lack of religious training is showing. There were other justifications for that morality.

W: Yes.

G: In your type of religion, the morality has to be minimization of suffering as identified by what we see in nature.

W: Yes.

G: When you were most active in your research, was it a quest to understand reality that drove your research? Did you want to figure out the truth about the natural world?

W: Yeah. Sure. What else?

G: Some people do it for money. Some people do it because they think they can carve out a niche. I don't think a lot of philosophers would say they're doing it for reality.

W: And they're not. They're doing it for money in the sense that what you're doing has to result in getting money to live on at least.

G: I just mean the primary motivation in your teaching when you teach students. Are you motivated to try and depict reality? Does the world reality bother you?

W: No, I think that's true. And to try to give them the ideas and facts that would be most helpful to them if they become biologists or medical doctors or whatever.

G: Although a lot of pre-meds now don't have to take any evolution. And even when I was teaching it about 10 years ago, you could get into medical school without taking comparative anatomy.

W: I was a teaching assistant in comparative anatomy at UCLA, and all those dozens of would-be MD's.

G: They all had to take it. That's good. But Professor, it seems that you have this unique world-view. Most of it was formed by your knowledge of evolutionary biology. I'm trying to understand if you think it's important for other evolutionary biologists to advocate a similar world-view. Because Stephen J. Gould, for instance, said that he erected the idea of non-overlapping magisteria of science, saying religion addresses these kinds of issues; and the two should never come to meet. Well, that's not what a

lot of scientists think, and especially evolutionary biologists who are dealing with some of these unavoidable philosophical questions. So is it important that there is some consensus?

W: Among biologists, you mean? No. I'm sure there are general rules if you look at the thousand most important biologists today. Most of them–they may not use the term–but most of them are atheists really. They never make use of any concept of god to explain anything or to recommend that they do this or that. But I think that if you ask them real philosophical questions or religious philosophy, you get a considerable diversity of answers.

G: My study showed, so far at least, most of them are interested in this question, and I'm lucky for that otherwise I wouldn't have much of an interesting topic to talk about, but the first thing you said is right. There is spectrum of feelings about, or opinions about the overlap of science and evolutionary biology.

W: And old scientists in general.

G: I prefer to call them highly respected.

W: But you know–totally irrelevant comment–but the National Science Foundation has gotten worried recently because of the average age has been going up, decade after decade for quite a while now. People live longer. So in the good old days, you elect someone to the national academy, and in ten years he's dead. Now it will be 20 years later or more. So that's part of it. But I think it was also the age at which they were elected has gone up, so in other words, you have to be there for a longer time doing things that will get you elected to the national academy.

G: I don't see why that would worry them, though.

W: Well, I think it may–if you assume that in some ways younger people will come up with better ideas then older people do. And you also want a younger variability in everything except their scientific capability. You want that to be top notch for the whole crowd, and unfortunately, it isn't. There are people there that I think should never have been honored in any way.

G: Just a couple more questions. The word naturalist. When you hear that word, do you describe yourself as a naturalist?

W: The term to me usually means somebody who is walking around in the woods watching the birds, the flowers, and the insects or wading around in tide pools. But I think that the term is used in many ways, but I'm not inclined to argue in favor of one

over the other.

G: If you were called a naturalist, you would assume it's just because you've done a lot of field work.

W: Yes.

G: But what about naturalism as a belief system?

W: Ok, that's another matter.

G: Does that bother you? Is that less comfortable?

W: I'm less comfortable about assigning a meaning to it. Naturalism. It could mean that someone worships nature or something like that which I don't obviously.

G: No, I guess it could mean that from an external perspective, if you were an anthropologist studying evolutionary biologists, and you saw the behaviors–the rituals that they live their life by–you see them going out into the woods and collecting data, going to meetings and sharing that information, [etc.]

W: I call such people field biologists. That's one of the terms I frequently heard and maybe used.

G: But the thing that unites them is an understanding of nature that they take almost–there's belief in that–they have a belief in the natural laws or they have a belief that what they're observing is a depiction of reality. And in that sense naturalism is a purely descriptive term as opposed to people who put their faith in rituals, whereby they go to a church and pray to a cross or whatever. So in what sense does your study of nature entail belief? What do you have to believe in, in order to do evolutionary biology?

W: I guess I'm believing in my own capability of picking up information and interpreting it in a functional sense like why do some many species of birds breed around here in the springtime, but not other times of year? There's all these generalizations that ought to be explained by the evolutionary concept of natural selection.

G: And you believe you're seeing a pattern?

W: Yeah, I believe I'm capable of getting an accurate view of what the pattern is really like. Now, that's optimistic.

G: But underlying that is a belief in what you were saying before. There is a pattern to nature, a design if you will. And there's a creator that started it even though that creator that you described is it's almost like you can't give it any features.

W: Yeah. I would not describe it [in a way] that would be recognized as something you'd seen in a religious artwork or anything like that. In fact, I think, really I would assume that my approach to religion or to the definition of god and that sort of thing would come up with something [different]. If there was a group of people that did that, their depictions of god would be totally different from any that we've got right now. He wouldn't have a halo.

G: No, and probably very offensive to the people who do worship god now.

W: Yes.

G: Can I ask you one last question? This is the capper as they say. What is the use for evolutionary biology knowledge?

W: Well, one use is that evolutionary biology knowledge is of very different kinds–but there's the history of life on earth back to however many hundreds of millions of years you have to do it. And I think that's just satisfaction of people's motivation to understand this world we're in. And what it was like a thousand years ago, or a million years ago, or a billion. And why has it changed? What's the process of changing it, and to what extent is [it changing]? In fact, I think most of Steve Gould's ideas were pretty good. There's some of them that I totally object to. He says, "Go back a billion years. Set up things exactly like that. A billion years later, things are going to be totally different from what they are now simply because there's so much due to blind chance." I mean, ultimately, some molecule was–if you change its directions by one degree - it's going to hit the next molecule differently, and pretty soon all the molecules in the world are going to be in different places from where they would have been. All the mutations occurring in all the organisms are different from where they would have been. So history, in that sense, is totally unpredictable.

G: And evolutionary biology is really the only science that is addressing these kinds of things.

W: Right, as far as I know. Now, I presume you could say the same thing about astronomic phenomena. Alter direction of a star by one degree and its–go back and look at that galaxy a few million years from now, and the stars will all be in different positions.

G: But we are a lot more intimate with life than we are with planetary orbs.

W: Yes, we're much more stuck with these things on earth than with what's going on up there.

Professor Richard C. Lewontin
Interviewed by Greg Graffin
June 25, 2003
MCZ, Harvard University, Cambridge, MA

G: Greg Graffin
L: Richard C. Lewontin

G: If you don't mind, I'd like to ask you about one of your essays where you talked about institutions of social legitimation, and you acknowledge that religion is one such institution. Could it be that evolutionary biology is also an institution of social legitimation? And, in that case, the most celebrated members are the high priests wielding their ideological weapons.

L: Well, the short answer is yes. Look, it's perfectly obvious that evolutionary theory is invoked over and over again to tell "just so" stories about how we got to be the way we are and how that makes us more fit. It is a form of justification of a whole variety of social phenomena which we may find destructive in some way or another, but they increase our fitness. Look, there's a long [history of] literature on the difference between men and women and how evolution has established male hierarchy and so on. And if it's natural, there it is. You can't do anything about it, so you might as well relax and enjoy it. I think this kind of stuff goes on and on. Ed Wilson made a living off it for a while. Then we have evolutionary psychology. We have Mr. Pinker, and so on. Everyone is trying to tell us that first of all, they have a view of biological human nature. But if you ask, "What is the description of human nature?" They give some description of it. And you say, "What do you do about the people who don't behave in that way? Are they not human?" I used to have arguments with some socio-biologists about will to power, or aggressiveness or xenophobia. And what do you do about A. J. Musty who spent his whole life in jail not to do those things? And their answer is a wonderful one which they got from Freud that [it's] just [Musty's] form of aggression. You see? They'll say he's not an exception.

G: What about behavioral variation? Is that an explanation?

L: If you take that view, then what appears to be a variation is really a transformation of an underlying common thing, then the variation is not interesting. So, if A. J. Musty is really just as aggressive as anybody else, but his form of aggression is to be heterodox and refuse to do the things that he's expected to do, why he's just like the guy who shoots somebody. They're different manifestations. And that's a form of psychological reasoning I think we got from Freud–that love is hate, and hate is love. Things become transformed into their opposites at a surface level, but underneath they have the same [cause]. So look, sure, evolutionary theory has become a very important

source of legitimation. Of course, it has.

G: Then the people who have the highest status among the evolutionary biologists are the ones who are the most often consulted?

L: Yeah, but that's a complicated issue because the first question you have to ask is: highest status with whom? How did they achieve that status?

G: Well, I was choosing members of national academies around the world. Using that as a criterion, it's arbitrary.

L: It's not a question of arbitrary. No, that's not the point. I think people who are members of honorary societies like that are members for many different reasons. Let's just take the national academy of sciences. There's a heterogeneity, and the sources of the person's prestige comes into it. First of all, the organization lends prestige to the individual. But the individuals reciprocally lend prestige to the organization. It goes on in this way. Look, let me be very specific. Ernst Mayr once grabbed me in the corridor. "Well," he said, "I've got them all." I said, "What do you mean I've got them all?" He said, "I'm now a member of every honorary society in the world. I've just been made member of the Academy of Ling Ching." Now, Ernst Mayr has spent a large part of his life telling everybody that he is the most eminent living evolutionist. And then people say, "Ernst Mayr the most eminent living evolutionist." Now on what basis is Ernst Mayr the most eminent living evolutionist? Has he given us new principles of evolution? Has he given us a truly heterodox point of view that has really challenged us yet? He hasn't done any of those things. I mean I find his books boring, to tell you the truth. His theory of, claim about speciation, and the famous classical mantra about speciation, I don't think he invented any of it. I think Dobzhansky invented it. So what I'm trying to say is that prestige arises partly from public relations, and some of those public relations arise from the individual's own entrpreneurial activities. Look, we have counter examples, very interesting counter examples.

Let's start with a person who never achieved status or prestige in our field, a man named George Price. I don't know if you know of George Price. He was a theoretical biologist who was associated in one way or another with the Galton Lab in London. And [he] is really the person who laid the foundations of the theory of kin selection, of a whole variety of views about the way natural selection operated which other people have made more of. And nobody ever paid any attention to George Price because he was so heterodox. He put everything into terms [we] couldn't understand. He came to see me once in Chicago to explain his way of seeing natural selection. And I said, "Yes, yes, yes." And I wrote him off because I didn't understand what he was telling me. Years later, lightening struck. George Price committed suicide.

He died. He was an isolated person. A couple of people at the Galton had the sense to encourage him as they could. But he is a person of no prestige who,

nevertheless, had he had prestige in the first place, or had he been in a standard academic academy, he would have had a very powerful, direct effect on evolutionary theory. Then, you have the intermediate case of Bill Hamilton, who was no place until somebody of great prestige made something out of him. Now, that isn't to say that Bill Hamilton was an intellectual nobody. But I'm saying that he was socially a nobody in our field. He had no legitimacy. Until somebody with legitimacy said, "Hey, you've got to pay attention to what he's saying." But Bill Hamilton is a junior version of George Price. So It's more complicated. That's what I'm trying to say.

G: I understand, but if someone accepts the role as one of these people, then all of a sudden, the public is going to notice them more.

L: So now we're talking about facing out to the public.

G: Basically. I think, ultimately, that's what science is.

L: It is consumed. There is no question about it. But scientists have their own icons who are never revealed to the public. Many of them, the public [has] never heard of. Even [scientists] that we would think . . . again, it depends on what public you mean. There's various "public."

G: But if biology is just a free for all, and anybody can pick and choose what they want, the only way to oppose that is by a free for all. I mean, anybody who wants to write a book, anybody who wants to justify anything can pick and choose from the biological literature. The only way to oppose that is to have a body in place of people with some authority who can counter those pickings and choosings.

L: But there will be people who are also saying the opposite.

G: That's what I'm interested in.

L: For the brief time I was in the National Academy, I think so was Ed Wilson. So, who is the poor sucker to believe? R.C.L. or E.O.W.? They're both people of immense recognized prestige if you mean being members of a national academy. Full professors at Harvard, blah, blah, blah, blah.

G: So how important is it then that evolutionary biologists agree on the social implications of their science?

L: I don't think it's important that they agree. Because I think what really matters as far as the general lay public is concerned is not how much institutional authority you have, provided you have a minimum amount of institutional authority which gives you

access to publication, to speeches, to talks, to the press and so on. You can't just be Mr. Joe Blow. But once you have that social block on which you can stand, and if you know how to write, then you can publish all kinds of books that can make you very famous. I mean the most recent example you have is this guy Pinker who doesn't know shit about biology. He's just become a professor at Harvard. He's an auto-inflator of some kind. Why would anyone pay attention? His books sell very well, I understand. He doesn't even have any of the standard signs and emblems of status in biology. He's a psychologist.

G: Which brings up an interesting question, which is that in order to know something about biology, what if you just study neurons? Is that biology?

L: Yeah, biology is tremendously heterogeneous. And a biologist doesn't know what another biologist does.

G: I don't mean to pick on one thing you said.

L: I'm a co-author on a textbook of genetics. I wrote four chapters of that book. I couldn't write the rest of it. I'm incompetent to write the rest of it. And I'm supposed to be a geneticist. Ok?

G: So what if someone says R.C.L. doesn't know shit about genetics?

L: Well, a lot of genetics he knows nothing about. That's correct. Only about what he reads in his own textbook written by other people.

G: Back on this idea, the high priest idea, the only reason I bring it up is that it seems to me if there is a problem which it seems you might acknowledge; that people are picking and choosing from biology as they see fit. There's got to be some established authority that says this is as far as you can go.

L: Does there?

G: I don't know. That's what I'm having a problem with. Because biology by its nature encompasses everything humans do.

L: That's right. That gives a licence to every Tom, Dick and Harry to be an authority on everything. Yeah, I understand that. So the question is, look, first we have the question of the establishment of canons of evidence, and what Evelyn Keller calls different epistemological cultures involved. My chief accusation against people like Wilson is that they tell "just so" stories. And what do I mean by that? It means that you say, "Well how do I explain the eyebrow? Why do we have eyebrows?" And then you

tell a story which might be true. There's an epistemological view here. We don't know if it is true. And we don't know how to find out if it is true. And we tell a story about selection, in the past natural selection, and you choose a mode of explanation. If you're a hyper-selectionist, you choose the one which says that everything about us has been chosen by natural selection. The challenge is then, smart guy, please explain the eyebrow. And you think a minute and then you tell a story which could be true. Now, I was brought up partly as a Popperian. I mean, I've gone away from Popperian. But I was brought up as a Popper. That is to say, the first question one should ask is: is it falsifiable? If it's not falsifiable, you've got to think again. That isn't to say that you're not allowed to say something is unfalsifiable. But you certainly should call into question what you're doing. And if your whole method of explication is, in principle, unfalsifiable, you should feel very uncomfortable. I do.

G: So the degree of plausibility in a "just so" story . . . ?

L: They're all plausible.

G: Some more than others.

L: Ok. Alright. But even some things that are true are not very plausible. So plausibility is a weak [measure of validity]. You've got to have a minimum of plausibilities, so that people will swallow the story. Beyond that, everybody can play the game. I mean, I can just sit back and make it up as I go along. And kin selection helps us. We can ridicule those stories. Let's say the famous story of altruism. How does reciprocal altruism arise with non-relatives? Well, it arises because if you have the genes that make you an altruist, and everybody else has them, if you save a drowning person, then the next time you're drowning, that person will save you. And then you ridicule that story by saying, "God forbid, I should have to be saved from drowning by somebody who I had to save from drowning in the first place." So that's where that is. And that comes and goes in biology. It reached a peak when Ed and Bob Trivers went out to California. And a whole school of people were operating. And then the whole weight of nonfalsibility, of making it up, not having any genetics, never finding genes for these things, slowly pushed on them to the extent that they went and did something else. And then we had the birth of evolutionary psychology, which is socio-biology by another name, and they decided to quit that and go into conservation.

So careers were built and very successfully. Ed, from being a world expert on ants, became the world expert on what's really important. And that truly made his career. Look, I have to tell you, that it's relevant. There's a lot of personal stuff here, but I can only speak in examples. I'm just trying to speak in examples. I'm not trying to bang him, but these are examples.

Ed and I and Dick Levins and Bob MacArthur and a couple of other people sat on the porch at Bob's parents' compound in Vermont for a little private meeting. And

Ed said, "You know, we have a big problem, all of us. We were all the students of the most famous people in our field. Dick, you were a student of Dobzhansky. Robert was a student of Evelyn and Hutchinson, and so on. Our problem is that we have to replace them. We have to become the next generation of the big wheels, and we have to find some way to do that." And I was kind of shocked by that. It had never occurred to me in this explicit way, that my career goals had to replace, in prestige and position, my professor. But he had that. So that drove him. And if you've got the kind of personality for which that works, you do it. It's hard not to do it, especially when there are no rigid canons of evidence. As I keep saying, the papers published in *Behavior Genetics* would not be accepted in the *Journal of Animal Husbandry* because they have very clear rules about statistics. They're very pedestrian. And that's American pragmatism. I'm an American pragmatist.

G: So maybe some of the evolutionary biologists who have written about some of the social implications of Darwinism have done it because they really believe it. Not just because they are career motivated?

L: I don't think Ed is exclusive. I think Ed believes everything he says. I'm not saying people stand off in deliberate cynicism and make it up. They are motivated by ambition, but they believe what they're saying. They can't live with themselves if they don't believe what they're saying.

G: Do you feel that the discussion of morality or ethics is appropriate for evolutionary biology?

L: Not for me. I've never written about evolutionary ethics. Again, because the implication is that something has created genotypes which make us ethical. Whereas I think people are smart. Maybe natural selection made us smarter. I'm not sure about that, but we're smart. And one of the things that smart creatures can do is to see what kinds of behavior make stable lives and secure lives, and what kinds don't. Why is everyone against murder? One explanation is that genetically, we have genes that make our nervous systems such that we're against murder. That's the sort of socio-biological view of evolution. Whereas I say the people have been smart enough to see that you [can't] tolerate everybody killing everybody else when they feel like it. So you make rules against it, just in order to stabilize it. And I think the best example is the incest taboo. Now, I'll tell you a "just so" story which I made up. We're told that the incest taboo is in the genes because close inbreeding is bad. And so we've been selected to avoid close inbreeding. My "just so" story is this one. If it were really true that I had a genetic aversion to incest, then why would I need a taboo? I just wouldn't do it. We don't have a taboo against burning yourself up. We don't need a taboo because most people don't want to do that. Why do we have almost universal, in fact extreme, social rules, almost everywhere as far as I know, against marriage between

persons of close relations. In some places, we have much stronger ones. We have totem groups in which you must marry outside of your totem group, even though people within your totem group are not all that closely related. I think the answer is pretty clear.

G: You think this is because of consciousness?

L: No, it's a recognition that marriage, in addition to being reproductive, especially in hunter gatherer societies, is a very, very important structuring element for resource sharing. And when times are tough, we have the potlatch and all these things where people share resources. Now, and one of the purposes of marriage–and this was recognized in medieval Europe–is to extend as widely as possible the network of mutual obligation. So when times get tough, you can live off your relatives, so to speak. Now, that's my "just so" story.

G: I appreciate it. But it assumes that rational choice is a dominant feature in human behavior.

L: But it doesn't have to be individual choice.

G: Institutionalized, sorry.

L: That's right. Somebody gets up. I live in Vermont. We have town meetings. Somebody gets up and says, "Well, we ought to do this. We ought to do that." And other people say, "I don't think so." And we talk it over. And in this case, because we live in a certain civil structure we have a vote. But you don't have to vote. Or I'm the chief, and I say, "You know, I think we ought to do this." And people say, "Probably." I think they come to agreements.

G: That's what I'm wondering about. So in that kind of social setting, it's okay to have chiefs making decisions. But in evolutionary biology, this high status group–it's okay to have that unity of opinion.

L: It's not whether it's okay. We don't have it.

G: I wondering if we could foresee a time where we might have it.

L: Well, if we're going to have it, I want it to be my kind of thinking.

G: But you're part of a group in Vermont where sometimes you have to accept others' thinking.

L: Yeah, I think they do crazy things sometimes. And I speak against it, and my authority is zero. No, no, look, what I'm trying to say is that if I had to choose, I would exclude from biology people who do not have extremely rigid canons of evidence because I think it's positively harmful. However, if you took my point of view, and I were living in 1859, I would have said "Darwin is full of it because he's just given me a lot of 'just so' stories," you know?

G: That's a good point. How do you recognize when there is a truly novel whim?

L: It's just time. I don't any longer spend a lot of energy writing against evolutionary "just so" stories. I've never written a review of Steven Pinker's book. I never will, and so I'm tired of putting out those fires. Now, my view is, I can't stop these guys because that's the way to sell books and become famous. It'll pass because it will not be fruitful.

G: Because it does not offer sufficient explanations?

L: No, it explains anything. It's got to do more than explain. For me this is very important, if all we're asking is whether the theory explains the domain of interest. Sociobiological theory explains everything. That's what worries me about it. But does it lead to knowledge about concrete and material things which then are discovered to have been behind it all the time? Look, we have examples. Barbara McClintock, years and years ago, was talking about jumping genes–genes jumping from one part of the genome to another. I heard her say those things. The only [reason] she was tolerated was because she was very, very famous. She was one of the first women members of the national academy. And people said, "Well, if Barbara says it, it's probably true." And some people who came up with that kind of stuff are ridiculed and pushed out of the field because they didn't have the prestige. She had prestige. And then it was discovered that, in fact, there are these concrete material molecular events which produce movement of genes from one part of the gene to another.

G: Transposons.

L: Transposons. Yeah, transposition. She discovered transposons but didn't know it. Because she had the gall and the prestige to rub people's noses in phenomena which were heterodox and insisted that there was something going on there. And other people like the Lindegrants, who were working in the East, who found all these strange segregation ratios. People laughed at them and drove them out of the field. Even though it turns out later that they were right.

G: So it has to do more than explain?

L: No, I think most of us are smart enough to think of a natural selective explanation for anything. No, it's not that. It's that it has no offspring. If 50 years from now people are writing a book like Pinker's book or socio-biology all over again and haven't got any closer to any concrete realization. Where are the genes? How do they act?

G: Or the gene-culture co-evolution that Wilson talks about.

L: If you can't make it concrete, then most biologists don't pay any attention to that at all. I mean, they [Wilson and Pinker] give us a bad name among biologists. It's a question of pragmatism. Most biologists are classic American pragmatists. If I can't pour from one test-tube to another and transform the organism, it's bullshit. Look, I believe that humans probably will be extinct before we understand the human central nervous system. That's very hard, but these stories have made no contribution to unpacking the mechanisms of the human nervous system. I'm a mechanist materialist, and most biologists are.

G: That sort of sounds like you would champion something that Ernst Mayr has done–his great contributions were his field biological studies.

L: Yes, he was a very good ornithologist. I've got nothing against that. He's not a fool. I should only be as accomplished as he is by his age.

G: So how does that differ from physics or astronomy?

L: It doesn't. The phenomena are much more complicated.

G: That's it?

L: Much more complicated. And therefore, there is a strong possibility that we will never have a decent story for them.

G: Because physics and astronomy have sort of run out of stories as well.

L: Yeah, but those systems are so simplified. I mean, as I keep saying, if you tell me the mass and the speed and motion of a planet, all I have to know about is motion. But there's no three things that you can tell me about a living organism that can tell me all the things I want to know. I have a mantra. My mantra is "organisms are the nexus of a large number of weakly determining forces, and that makes them very hard to study." Because the only way we have to study things is by holding everything constant and varying one thing. But you can't do that with organisms. And the other problem is, if you could manage to hold everything else constant and vary only the one thing, you might get the result which had nothing to do with what happens when everything is

varying together. So organisms are very hard. Genetics has been very successful because it can concentrate on a bit of the organism without paying attention to the organism as a whole. In that sense, it's more like physics.

G: Would you agree then that biology does a better job than religion in explaining a lot of explaining human nature.

L: How I would decide it's a better job?

G: I don't know. I'm interested in your opinion on that.

L: Well, I think religion does exactly the same job that socio-biology does. It's just as good, no better, not worse; if the criterion of the explanation is that it has an answer for all questions. But the disadvantage of religion is that it blatantly postulates entities which no socio-biologist has to postulate. Namely, mysterious forces and god. Socio-biology is much closer to me than religion is because socio-biology is totally materialistic. Socio-biologists are materialists. They're just trying to generalize one of the forces that occurs on material objects into the one that explains everything. But they're materialists. So if I had to choose between the Pope and Ed Wilson, I'd choose Ed Wilson every time.

G: That's the interesting thing, if neither one is better than the other.

L: In one respect. Can they give you an explanation for everything in their domain? In fact, socio-biology is better than religion because I don't know of any religion that doesn't say, "The ways of god are mysterious." [If asked], "How do you explain the terrible suffering of babies, and so on and so forth." [Christianity] has to say, "Well, we don't understand god's plan." No socio-biologist ever says that. They have an explanation for everything, but of course, their domain of explanation is much smaller, so it's easier. Socio-biologists are not called on to explain why [there are] injustices in the world. The word injustice doesn't appear there.

G: It's redefined . . .

L: Yeah, you don't even talk about it. Why do babies die? Well, I'll give you a biological explanation of why they die. Why are people what we could call nasty and cruel? They go killing babies and burning houses. We have an explanation for that. Religion is in more difficulty there because religion adds questions of justice and so on. And biological theories don't have that in there. There are biological theories of justice that have the following form: people think X is just because. Not that it is just because, but people think it's just because. Because they recognize that justice is a social construction. There is no justice outside of people. Socio-biologists want to

explain [the evolution of the concept of justice] as a consequence of natural selection. Now, I don't. That's the difference.

G: I was never raised religious. I had no bias. Life started making sense for me when I started studying biology in high school and doing field work in college. The things that maybe religion would have explained or made me think about early on didn't exist. I played baseball instead.

L: Sure, but a biologist does not explain why we think some things are just and other things are unjust. Some biologists might try.

G: For me, it's the old "shit happens" slogan. Biology does give us evidence for that, that some unfortunate things happen.

L: But what makes them unfortunate?

G: Because they might happen to me.

L: Okay, so if you're a Rawlsian, you say "what I mean by just is things that I would like to have happen to me." Okay, fine. But that's psychology, which is a manifestation of a biological organism, but there's no molecular description going on.

G: Jumping topics a little bit, I've read your essay on the Human Genome Project. And one of your contentions is, correct me if I'm wrong, that the gene-culture co-evolution in socio-biology theory could make progress if the Human Genome Project could start to map some of the products of these genes to somehow show a cause-and-effect relationship to behavior?

L: Sure, but that's not the Human Genome Project. That's a problem of relating the physical structure of the central nervous system. And that has nothing to do with the current state of biology. That's the problem. It's the false reification. Yes, the Genome Project may, or at least the study of genes and development may, eventually tell us a lot about the way nerve fibers hook up, and maybe some of the difference between you and me is the result of different genes causing our nerve fibers to hook up. A god appears in my dream and tells me a complete story, I am still missing the thing I need, which is okay, now you've described the nerve structure. I don't even need the genes. Let me just describe the complete physical structure of the central nervous system or however it got there. I want you to tell me how to look at it and decide what ideas will come out of it, and I don't know how to do that. So we're no further ahead.

G: So is it hopeless? Or is it one of the things that we will never know? Or is it something that given enough computer assistance we may accomplish?

L: Look, we have had many, many metaphors for the mind after all. We had the brain as a telephone exchange. I have a poster on my wall at home of an old German educational poster from the '20s. Phone and operators, you know.

G: Oh, that's funny. 12 networks?

L: And then we had the hologram as a metaphor. Now we have the computer as a metaphor. And they've all crapped out. I mean, the issue is a very old one in the philosophy of mind. And that is "what is the mapping?" How do you decide? Is there a one to one mapping between the shape of ideas and the shape of the central nervous system? We don't even know if it's one to one. After all, in the computer–the location of the information in the computer is not always in the same place. In RAM, it keeps moving around all the time. So if you want to use a computer metaphor, can we think the same thing on two different days and have it in two different places in the brain? I don't know the answer to that. It's a very interesting question. And we know some things. So that's where the action is. The action is the mapping of a physical structure onto thought, not of genes onto the physical structure.

G: Yeah, that's a good point. Edelman and Tononi, in their book *Universe of Consciousness* [give] a purely materialistic definition of consciousness which is why I was drawn toward it. But in that kind of analysis, it doesn't really matter which neurons are firing, what matters is the brain activity that comes from a certain thought.

L: But what does brain activity mean?

G: That's what I'm wondering. So if you could understand it in terms of gene products . . .

L: But aren't the gene products way back where it's not mapped? Suppose I'd never heard of genes. The confrontation is between a physical structure, a flux of neural discharge, and your idea about religion. Between the idea and the material object. And I don't understand why we have all this concentration on genes when the real problem lies at a more distal end. Suppose, it turned out, for example, that the structure of your central nervous system was totally and 100% fixed by your genes. Suppose they were, and I could show that if you tell me your genes, I can tell you down to the neuron what the central nervous system [does]. How much further would we be in understanding this discussion while you say one thing and I say another? While you change your mind, and I change my mind. That's where the action is. I mean I don't want to push the ghost in the machine.

G: Back on the Human Genome Project–so it's creating this map, and what this map means can't be understood by the public of course, who has to fund it ultimately. Thus,

I'm interested in your opinion or idea that the biologists who are doing the interpreting might overstate what is known to keep the funds coming.

L: Of course, they do that all the time. I agree on that.

G: Is it possible that we could see a new essentialism on hand where biologists are talking about a nature that doesn't really exist?

L: I haven't thought about it in that way. I have to think a little more about it, Greg. What [they're doing] is creating a narrative about DNA which places DNA in a position of the master molecule. It's a narrative of biology which begins with DNA and says everything else in the body is a servant of DNA. DNA is self-replicating. DNA makes proteins. It makes everything. It makes everything we are. Sid Brenner once said at a big hearing, "If you gave me the complete DNA sequence of an organism and a big enough computer, I could compute the organism." That is the narrative that does the work for them. They don't have to have anything supernatural. They only have to say that in the hierarchy of purpose and control, they don't use the word purpose, but function, in organisms. We are nothing but, as Mr. Dawkins would say, lumbering robots created body and mind by our genes.

You can tell the complete opposite narrative. I like to do that [with my students]. Ask them to think about that. Proteins make genes. You can't have DNA without enzymes to put it together. And proteins make the structure of the organism, and the genes are nothing but a library [in which] the proteins go and look up things because the problem for an organism is as follows–a developing organism has to make proteins that are not yet present in the cells. A fertilized egg already has a lot of enzymes and structural proteins, but there are one hell of a lot of proteins which are not in there. So it has to make them. But how can it make them unless the formulaic recipe is available? So the function of the genes is to sit there as a recipe book so that the proteins can refer to it, and it has to have an index. It has to have ways to fit the thing [together]. So the genes are not telling us what to do. They're lying there doing nothing, and the proteins are coming along and looking up what they have to look up at a particular time. And they're making the new proteins. I think it's as simple as that. Proteins, in principle, have the information necessary to replicate themselves. Once you give me the amino acid sequence of a protein, I could invent a way to copy that protein. That's what prions are for. But the one thing they can't do is to make proteins that aren't there yet. So they have to have this look-up library. I think it's as simple as that.

Now, that's the alternative narrative. But biologists have made up a dominant narrative, and most of my graduate students believe that. I've been arguing with Jerry Coyne for the last three weeks about that, and he says I'm just being a Marxist unwilling to take any kind of hierarchical view of the world. So I said, "Okay, I'll tell you a hierarchical story. Proteins are in charge."

G: Yeah, it's still hierarchy.

L: So that's where I am on that. there is a certain mystical [element]. [For example], Jim Watson's recent book is *DNA: The Secret of Life*, a mystery of a mystery. People talk about nature. But I don't think journalists are the big offenders. I think the big offenders are the ecologists in the ecology movement [who] believe in a mysterious nature, a harmony of nature, which is just being violated. People who talk about nature and reify it. Well, reify it–that's the wrong word.

G: Deify it.

L: They deify nature. The wisdom of nature. Things that are unnatural are therefore evil. Or things that are evil can then be shown to be unnatural, and so on.

G: Did this culminate in the Gaia Principle?

L: Gaia, yeah. But you don't have to be a Gaiist to believe in that. Every time I pick up a container of soy milk and read on the side what the producers are saying, I hate it. They're against genetically modified foods not because there might be some unknown things that are going to happen, but because it's unnatural. And all those plants like corn plants are natural. That's where it's coming from.

G: I see. And that does appeal to the public's craving for dualism.

L: Yeah, that's religious. Absolutely. Even though, you don't invoke god there is this thing that [contains religious undertones], even if you are a complete evolutionist about it. If you say, what I mean by nature is what has happened to nature before human intervention, you nevertheless take that set of historical events and make them good. Or right. Or just. As opposed to the corrupting effect. And the word corrupt is used in corruption. This goes back to the 19th century romantic movement of Britain, of Dante, Gabriel Rossetti and Blake. All of those people, for whom the dark Satanic mills . . . no, I think the dark Satanic mills were very important. What's created by human culture is corrupting. It's the Garden of Eden which is the ultimate, even if god didn't make it. Maybe, I'm pushing it too hard. But that's the way I see it.

G: I'm wondering, what is the use for evolutionary biology knowledge?

L: Well, it certainly does make a world-view if you take the sociobiologists' view point.

G: There are two questions. One of them is your personal world-view, and how much of it is informed by evolutionary biology? Is evolutionary biology playing a role?

L: I don't think that evolutionary biology as a science plays a role in my world-view. No. My answer to that is no. But do I think it is useful to study evolution? And I think the answer is yes because the world-view that we want, that I want, is a materialist world-view. And everything true that we can learn about nature adds to our understanding of the material world. And that's desirable. So evolutionary biology is useful only when it says something that is true. And we could have a discussion about how you decide something is true.

G: In a Popperian sense.

L: In a Popperian sense. And every statement that can be made by evolutionary biologists is true in that sense. [This] adds to the pile of rocks which is the knowledge of the material world and may further convince people that material explanations will explain everything.

G: In that sense then, there's no need for canonical religion.

L: And therefore, there would be no need for canonical religion. In the sense of explaining the world; not how in the sense of "Well, I feel insecure if I don't have a religion." I can't deal with that.

G: Well, then you've got nature. You've got Darwinian . . .

L: But I don't want nature any more than I want the man with the long white beard.

G: Is that why it doesn't play a role in your world-view?

L: No. That's right because nature is a human construct. The concept of nature is a human construct.

G: Right.

L: There is a real world out there. Obviously. But that concept of nature is a human construct just like god is a human construct. And I go along with Lewis Beck who said, "Anybody who believes in god can believe in anything." That's literally true.

G: Who said that? Lewis Beck?

L: The Kantian philosopher. But anyone who can believe that natural selection has molded us down to the last pimple, it's not a question of believing in natural selection, it's believing that that explanation is responsible for everything. That's a religious canon. I'll sum up by saying I don't know what to say to people who say to me, "Well

you just start out as an *a priori* materialist. Just like I start out as an *a priori* deist." I say, "Yeah, that's right. End of discussion." You have to make up your mind whether you're going to describe the world in material terms and assert that everything is material or not. And if you're not, then the sky is the limit. I mean the advantage of my system is that I'm bounded. I can't make it up. I'm not allowed to make it up. Whereas if I were a deist, I could make it up.

G: Did that occur to you at a young age?

L: I was brought up in an atheistical family. My father thought is was all bullshit.

G: So you were able to, at a young age, construct an understanding of the world based on a material point of view.

L: Well, at a young age one doesn't pretend to understand it. You live in it.

G: I remember at a very young age asking questions mostly of my brother because he was older than me. And I remember asking what happened or something about the moon and how old the moon is. And he said, "It's probably about as old as the earth." And I said, "What happened before that?" He said, "There were other moons." I said, "How long does time go back?" And he said, "There's always been time." So at a young age I realized . . . I think at a young age we start to construct a view of nature.

L: My experience is that the demand for religion which is said to be universal or almost universal–that hasn't been my family experience. My father came from an assimilated Russian Jewish family that came to the United States is 1870. He had no religion whatsoever. I had no religion. My wife was raised as a Lutheran, and when she got to the age of 13 she said, "Oh, come on."

G: I've heard that from a lot of Lutherans.

L: She just lost it and became a materialist. Our family said, "Well, you two, what are you going to do about your children. One of you comes from a Jewish family . . . " In fact, we were both atheists. The question never arose. I have four sons. The issue of god, religion, never arose. It isn't that we had to engage in some discussion of it. It just never arose. The closest was one of my kids went to an Episcopal school for a while because we wouldn't get him into public schools. He was too young. And he came home and said, "We have a Christmas pageant." And Mary Jane said, "Oh, what goes on there?" And he said, "Well, there's this man and this lady and they have a baby. And I'm an angel." And Mary Jane said, "What are the names of these people?" And he said, "Well the man's name is Joseph, and the woman's name is Mary." And Mary Jane said, "What's the baby's name?" "Well," he said, "I'm not sure, but I think it's

George."

G: That's great. The life of George.

Professor John Maynard Smith
Interviewed by Greg Graffin
June 13, 2003
University of Sussex, Falmer, UK

G: Greg Graffin
M: John Maynard Smith

G: I'll start with a book that you wrote with a Hungarian colleague. You said that today's society is being transformed by machines that convert not forms of energy but forms of information. Information is obviously a theme running through that entire book, but fundamentally how would you say that humans are different from the most sophisticated computers that we have?

M: You'll have to forgive me if I have speech problems. I don't know if you know, but I have a serious lung condition. It's okay, but I just get breathless. Now, well first of all, let me say about that question, I think that is a question about philosophy and not about science. Not that I object to that, but the sort of naive answer has to be that I am certain that I am conscious. I have ideas, feelings, etc. I assume that you are because you look like me and behave like me and so on. I assume that information transfusing with genes or not. And this is a fairly important distinction.

G: I read a book not long ago by Edelmann and Tononi called a *Universe of Consciousness*. This was sort of the theoretical foundation upon which I based my knowledge of consciousness which is really a special kind of mechanistic interpretation of consciousness, but it is materialistic nonetheless. It just talks about thalamo-cortico feedback that goes on, which theoretically, I guess, we could build into computers in the future. Is it just consciousness that you would use to distinguish computers and humans?

M: Well, I don't know how I would use it because I don't know how I would decide. Suppose we do make computers that are in many ways more and more in their behavior like animals or humans. They are confined by the way [in which they] can answer questions and so on.

G: They can even say I know that I am conscious, maybe.

M: Maybe. That's right. How will we know if they are conscious in the way that we are? And I think it is a very hard question to answer because clearly one could if there was any point in doing so, design a computer that asserted that it was conscious. You know? And yet, I wouldn't believe it, and yet I might. There might be a context in which I might change my mind.

G: But as a major transition in the history of life, do you see that possibility any differently from what happened during the cultural transition?

M: Well, different in a continuity sense. You really ought to be talking to Hersh, my Hungarian friend, because he and I are actually going to do a second edition of the *Major Transitions* which we just agreed, but for health reasons he is going to do most of it. And anyway, he's now interested in doing research on evolving nanotechnology things. Something that I just don't feel competent to think about. But I think it's clear to both of us that the likely next major transition is one [involving] electronic devices–at the moment there are prostheses standing on our desks–we don't have to carry them everywhere with us. And [these devices] are increasingly becoming things that we carry everywhere with us. Some people seem to be hardly alive without their mobile phones and things. But at the moment, the actual communication between the machinery and ourselves is pretty old fashioned in its methods. We talk to them or we type on them. We don't have direct connection between nervous systems and the circuitry of our computers. It would not at all surprise me if we came back in 50 years time, that we'd find out that we do. I don't know–I don't think scientists are good at predicting the future. It's not our job. Whether if we come back in 50 years time we will find all or most humans have electronic prostheses which extend their sensory capacities, their thinking capacities and are part of the circuitry of consciousness or whether we shall come across some graveyard full of human beings and civilization run by little electronic gadgets.

G: The reason I'm interested in this is because information is such a transforming process as you say. Religion serves as an information source for so many people. From the work I've done, I don't see that information affecting most evolutionary biologists. That made me start to wonder: is it possible that they are using a different source of information to form their world-view? This is where the opinions come in. I'm very curious how you form your world-view. How much of it is actually formed by your knowledge of evolutionary biology versus other sources?

M: Well, I don't know. Let me be autobiographical for a moment if I may. I was brought up in the Church of England which is a curious sort of church because it doesn't believe in anything very much. It's curiously un-theological, and it's also more like a social club. But I was brought up within that church, and I did believe there was a god. I think the important thing emotionally was that it promised me an immortal life which seemed attractive and still does. Not that I for one moment believe it to be likely. So that was my initial background. I started reading about science for reasons that I find it hard to put my finger on. I wasn't learning any science in school. Did no science at school at all. Mathematics, yes, but not science. It was a perfectly ghastly English public school, and I do not recommend anybody to send a human child to that place.

G: What was it called?

M: Eton. Eton College. It is the top English public school, probably. It was awful, so it's not obvious to me why I became interested in science, but I did. I think, part of it at least, was a curious twist as so many things are in people's lives. I realized that there was one person who my school masters really hated, and this was a man called J. B. S. Haldane, whom you've probably heard of. And they hated him because he was not only a socialist and an atheist and all these things they didn't approve of, but he was also one of them. He had been to Eton. He was a traitor. And I remember thinking anyone who they hate this much can't be all bad. So I went and got hold of one of his books which was a collection of essays called *Possible Worlds* and he completely blew my mind. It's a mixture of blasphemy, of fascinating science, of political radicalism and so on. And it led me to seek him out and work for him. Or at least sit at his feet and learn, in the first instance. But at that time I wasn't thinking of ever meeting him. It was just that he opened my mind to a world that I didn't know about. And the science and the atheism came in one packet. If you have time, get hold of *Possible Worlds*.

Let me just talk for a moment [about that work]. The first essay discussed a world created by intelligent organisms other than people, and it considers the world created by barnacles, and they sit on the surface of the rock, and they stretch their arms out for food. They talk to each other, and they can see, which is a bit misleading. They can exchange information about what they are seeing, and they divide objects into two categories: the real and the imaginary. The real are the things that they can touch with their arms. And the imaginary are the things that they can see but cannot touch. And this is clearly in Haldane's mind an analogy between the sort of practicalities of science and the mysticism of religion. And then some mathematical barnacle pointed out that if two people see the same imaginary object, and they do the appropriate sums, they can calculate when the object is going to change from the imaginary to the real, and by god, it works. So they throw away all the idealist philosophy about there being unreal things, and just settle down to a scientific world outlook.

And then tragedy. Somebody points out that if you put certain values into the directions in which they are seeing things, you come to the conclusion that there is a real object underneath the surface of the rock. This cannot possibly be true, because everybody knows there's nothing underneath the surface of the rock. So they go back to being idealists. Imagine a boy of 15 with no science reading this! It completely blew my mind. There really are people like that out there. It was great, but I fairly quickly abandoned the Christianity. I've never had the least wish to go back to it since. It was a bit of a wrench to admit to myself that the whole belief in the afterlife was something that I would have to abandon, but not a serious wrench. Since then I've been a simple minded atheist. But the science and the anti-religion came together as a package.

G: And yet, the Church of England, ultimately, gave Charles Darwin a place at Westminster Abbey.

M: That's just part of the fact. They don't actually believe in anything.

G: They believe in fame. Notoriety.

M: Yes, it's a social club.

G: Yet, they didn't like Haldane.

M: Well, I'm sure there are some of them who have beliefs, but what they didn't like was the socialism and the blasphemy at the time. They didn't like the blasphemy at all.

G: Do you think that the key to understanding religion might be found in being able to link the information in genes with the information in memes?

M: Well, it obviously lies on that sort of frontier. Curiously enough, my colleague David Harper and I are doing a proof of a book on the evolution of animal signaling. One of the things that we discuss is the origin of religion. And we probably pick out rather different features as the characteristic features that constitute religion. As we see it, religion is a process in which ritual–dressing up in funny clothes, music, oratory of one kind or another–the language has to be effective and so on–and all sorts of ritual practices are used to generate a set of communal beliefs. First of all, a sense of we are us, and they are them. In some way this is a major cause of killing in the world at the moment. You have to look at Israel or Northern Ireland.

The question is where does this come from and are there analogous processes going on in animals? I think that one can see the seeds of it in animal behavior. There's a lot of communal display that we see in animals that people don't discuss because we don't understand it. Essentially, I think we have to look for a way in which a ritual practice of one kind or another, communally carried out, instills emotional commitment in people. You can find cases in which similar communal activities create emotional commitment in animals. I think there is an interesting analogy that warrants working on.

G: Could it be that evolutionary biology and the knowledge that comes from it serves as a suitable replacement for traditional religion? It certainly has for me because I was never raised with any religion.

M: Yes, the trouble with it is–I think if I had a particular area where I'm unclear in my mind about how I see things–is that I–in common with almost all human beings–have beliefs about right and wrong. I don't think they are just simple, selfish beliefs [like]

"don't tell lies because you'll be caught." They go a bit deeper than that, and I'm sure that I acquired them through the kind of processes that I'm describing, as part of religious teaching. I wouldn't go so far as to say that I think there has to be a theological belief before you can acquire such a moral outlook. I think you have to acquire it through education. I don't think we're born with it. We're born with the ability to acquire it.

G: Is morality even a discussion for evolutionary biology?

M: No, not very greatly. These communal displays that animals go in for have been staring us in the face for years. I don't think we've really thought about it. It's very odd.

G: That's another good place for evolutionary biology.

M: Oh, I think so.

G: Do you think it's crucial for evolutionary biologists to show some unity of opinion on the implications of their science in order that evolutionary biology be taken seriously by the public? Can each one read into it what they see fit?

M: I think we have a big choice, and I don't really know that one choice is right and other choices are wrong. We can either get very committed to the political moral implications of what we are doing or we can just say "I haven't time for that, I'm too busy doing the real work." Or a little more rationally than that, we can say, "Look, many of these questions we think about have a specific scientific dimension, but they also have ethical, moral dimensions." This is particularly true with genetic engineering, for example. You can't decide whether we ought to or not clone people unless you have some sort of means for deciding what is right and what is wrong. But it's not just a question of the facts. It depends very heavily on the question: If you clone a human being, what is the probability that a human being will be seriously handicapped physically? But that's not the whole answer even if the answer is, "No, it has no effect on the kind of human being it is." I can still understand people saying, "Yes, but it's wrong." I can sympathize with that view, and I don't even share it. I don't think it should be settled by scientists. I don't think it's our business to decide, [to] lay down the law.

G: Along those lines, what is the use for evolutionary biology knowledge?

M: Curiously enough, that is a question that I don't often ask myself about science. I mean, I have rather special reasons for not doing, but I do science because I'm curious to know the answer, and not because I want to do good. I spent the war

designing airplanes, and after the war, I remember thinking "as long as I don't kill anybody from now on, I'm not doing any serious harm."

G: The war must have played a large role in your ideological decisions.

M: That's a big field. Of course it did for all my generation. But I doubt it would have come up much different if there hadn't been a war, if you know what I mean.

G: Do you call yourself a naturalist?

M: Well, look, there are two meanings. In one sense, I am, and in another sense, I'm not. In the sense that I am a naturalist, is that I love bird watching and collecting plants and gardening, and I am miserable that I can no longer go for walks. So natural history is a very important part of just my enjoyment of the world and always has been. It's also an absolutely essential part of my science in the sense that I have quite an extensive knowledge of natural history, and I often start from a problem in natural history. Something I don't understand. If I see something or I read about something that seems to be puzzling, that's the start of a piece of science. That's certainly the origin of all the stuff I've done on game theory--seeing animals do things that didn't seem to make sense. So in all those senses I am a naturalist. I'm not a competent field naturalist and never have been. And I have very poor eyesight, and eyesight is very important in the field. You have to be able to see things.

G: Does it entail belief in any way?

M: No, I don't think so. I think it just entails familiarity with the natural world, knowing a lot about it.

G: Consider someone who is raised on William Paley for instance. Could they be a very competent field naturalist?

M: Oh yes, and many of them were.

G: Can naturalism, if we think of it as antithetical to natural theology, can it be used as a belief system? Does it help us interpret what we are seeing in nature?

M: Well, there's no question that evolutionary biology helps us to interpret what we are seeing in nature. It is an alternative explanation to the Paley explanation. The Paley explanation wasn't silly. It was just that there was a better answer.

G: Why would you say it is better?

M: Well, it is unnecessary to make a series of unconfirmable and implausible assumptions. It's testable. If I give it an explanation in terms of evolutionary biology or some feature of natural history, it's testable. If I explain it as what was in the mind of the creator, it simply isn't. It's just a question of what you think was in the mind of the creator.

G: Is being testable, verifiable, is this a better picture of "reality" or is that a word you shy away from?

M: No, I don't shy away from it. I would call–it might sound old fashioned these days–but I would call myself a Popperian as far as my understanding of the nature of science is concerned. The difference between a scientific theory and a theory that isn't scientific, is whether it can be disproved.

G: And if it can't be disproved, then it is reasonable to suggest that that's the way the real world is.

M: Well, if you've tried to disprove it and failed, and it's still disprovable tomorrow, it's reasonable to suppose in the meanwhile that that's the way the world is.

G: How does this impinge on the distinction that a lot of your colleagues have made, and I don't remember what you indicated, between atheism and agnosticism?

M: Well, I think it does. If I was really pushed, I would have to admit that I am an agnostic. I don't think the hypothesis that there exists no creator can be disproved. Maybe god made the world time equals zero and pressed a button. It doesn't seem to me a useful hypothesis. I'm not sure what it means, but it isn't part of science. It's not something you can test and disprove.

G: So do you think there are entities in the universe that are beyond the grasp of science or science will eventually be able to understand those things as well?

M: I don't know. I generally don't know. I don't know whether we are going to provide an adequate explanation of consciousness. But I have to say, I don't think we have yet.

G: Do you agree that most of the public doesn't know any evolutionary biology, and they basically use religion for origins.

M: I'm not sure that's true in Britain. Television has had a quite considerable influence in the sense that the natural history programs on television are so good. They really are incredibly good. The photography is out of this world.

G: And popular as well?

M: And popular. So most people have heard of evolution. They know what it means, and if you asked them whether they thought it was right they would probably say yes. I don't know. I think many people over here would say that they do believe in god and that they do believe in evolution.

G: True. The god isn't as significant as some of the other things. The belief in miracles is very high in America. The belief in the devil is very high in America.

M: Scary.

G: These are the kind of things that show the public in America hasn't been watching David Attenborough.

M: But I think people in this country have been watching David Attenborough.

G: Do you think it is a question of education? Aside from the fact that you can be an evolutionary biologist and still believe in god. Do you think that those conflicts between evolution and religion are more hype maybe? Is there any real component to it?

M: No, I think they're actually deep. I think that evolutionary biology in particular is a major reason for the decline in faith in this country. And probably elsewhere, but certainly here. On the other hand, you're probably going to talk to Richard Dawkins. Or have you?

G: Yes, I talked to him yesterday.

M: He and I argue about this sometimes. I don't think he is more atheistical than I am, but he is a much more public atheist than I am. I'm inclined to think that it may be counterproductive telling people that they've got to choose. Particularly because I am an agnostic and not an atheist. I don't see why, for many of them, they're not happy believing in both. Richard seems to feel that it's our duty to point out to people what rubbish it all is. I don't. And I'm not sure why. I'm not saying I'm sure I'm right and he's wrong. It may just be a temperamental thing.

G: There's someone in America named Phillip Johnson, very right wing. His interests are in creation science really. But he believes that in order to have a reasonable conversation about it, one side has to be right. I think if there is a conflict, which you acknowledge there is profound conflict, then the only way to resolve it is by traditional Hegelian means.

M: I think I may have a rather private personal reason for avoiding religious conflict, public debate, about religion. When she was growing up, not when she was a child, my sister became a believing Christian and took it very seriously. I mean she spent ten years working in a hospital in Calcutta in considerable discomfort and danger, for the church, and I did not want to quarrel with her. I did not want to say things that would upset her, and I still don't. Actually, I don't think they would upset her at all now. I think she is quite resigned and tough.

G: Obviously, family comes first. That's a good point.

M: I certainly couldn't convert to religion or my wife would leave me, which would be a real pity after 60 years.

G: Finally, this is just sort of an aside, could religious thinking be an evolutionarily stable strategy? Those who think otherwise have much lower fitness in our culture.

M: Well, I think that something along those lines is true. Yes. It's related to this question of ritual and the conviction that I'm a member of this group and I will defend it.

G: Ritual as social cohesion.

M: I think it certainly could be treated by game theory approaches. Increasingly, it is. The hard question is how much one has to suppose that there are innate moral–I don't want to call them beliefs–innate moral feelings in humans, but I don't see any reason or principle why there shouldn't be. But you know the experimental psychologists have been studying a phenomenon they call–what do they call it? A form of altruism–the tendency to punish transgressors and so on. It appears in human beings and is not rational. People will punish even when it doesn't pay them to do so. And it's so much a cultural universal that I wonder whether it is a matter entirely of social condition, and it may indeed be, to some extent, that we have an instinct to punish those who behave contrary to the ethical standards of the group to which we belong.

G: And are we special in the ability to overcome those instincts?

M: We clearly have a greater ability to modify our behavior and not to follow our instincts. I think that has to be true. But I think there is an enormous area for research there that needs thinking about.

G: Of course, it will hinge on the limbic systems and feelings of pleasure.

M: I think it will.

G: To me that's a good character for evolutionary analysis.

M: If and when this book ever sees the light of day, you might be interested in what we have to say. Religion is discussed in the last chapter.

G: I can't wait. Is there a release date?

M: I hope towards the end of this year. Oxford is going to do it.

Professor Ernst Mayr
Interviewed by Greg Graffin
June 25, 2003
Bedford, MA

G: Greg Graffin
M: Ernst Mayr

G: As the person who has done perhaps more than any other person in the 20th century to define Darwinism, what is your reaction to the questions as book titles that have come out such as *Can A Darwinian Be A Christian?* or *Finding Darwin's God*? On page 77 of your newest book, *What Evolution Is*, you talk about how it would be hard to understand Darwinian evolution if you don't abandon essentialism, which is really the foundation of the Christian idea of the soul.

M: According to a Christian, every word was made by god, a creator, and a Darwinian can explain, he thinks, that everything in the world that we see and can study can be explained without god. Therefore, a Darwinian cannot be a Christian because these opinions are incompatible, one thinks. But there's a trick to it. There are some very well known Darwinians–one of them was Dobzhansky, another one was David Lack in England–who were bona fide Darwinians. Nobody questioned that. [In fact], they were leading evolutionists, and both of them believed at the same time in a personal god. Therefore, somehow or other, even though the two viewpoints seem to be completely incompatible, some people in their thinking and their feeling can bring the two things together and believe simultaneously in both of these things. Now, don't ask me to explain that. I consider this something that cannot be explained.

You know that, I suppose, Dobzhansky every evening before he went to bed, got down on his knees and prayed to god. There he was, at that time, probably considered America's leading evolutionist.

G: What does that say about essentialism which is a very important philosophical idea that one must abandon in order to embrace Darwinism?

M: I just go to these two simple statements of a creationist, of a Darwinian, and say they are incompatible.

G: In *The Growth of Biological Thought*, you mention the plague of dualism. And this to me was very satisfying because dualistic thinking was possible up until the time of Darwin. But Darwin destroyed it. Do you think monism is a better alternative in the way that Ernst Haeckle envisioned it?

M: I think most Darwinians find that their explanation of the world is more or less

complete, and therefore, it doesn't need a second explanation in addition to the scientific evolutionary one. Now, I think we might have to make a detour here because we've come into something, which we go back to all the time, which is probably the source of all the difficulties, and that's the concept of religion. Now, what is religion? And people like Julian Huxley have struggled with this problem. And he has said, "Well, I look at the world, and I look at man, and in a very subjective way decide that everything has happened in this world . . . the most admirable thing basically, is the human species." And there's nothing quite like it. This can give you a basis for a religion because you can say, as a Darwinian, evolution has produced this basically admirable creature, *Homo sapiens*. So, let it be my aim in life and my religion to see to it that this admirable species is being maintained or if possible improved. Anything that leads to this objective should be the basis of my ethics.

G: So in that sense, ethics can come from a scientific pursuit just as easily as it can from a religious pursuit? According to that idea, evolution is a religion?

M: Yes, except for Will Provine, I don't know a single atheist who isn't religious . . .

G: In that respect.

M: Yes.

G: Why call yourself an agnostic instead of atheist? If you can be an atheist and still use evolution as your religion?

M: If you define atheism quite rigorously as a person who is not a theist.

G: Why call yourself agnostic if it simply means no evidence for, no evidence against? You're not making much of a statement, are you?

M: Well, evidence for, no. There's no evidence for a god. And an agnostic is the one who especially emphasizes all these unknowns that he will never understand. I'm agnostic about all these things, but I do not have any evidence that they require personal god, a creator and so forth. So I'm agnostic in that sense.

G: The idea of monism versus dualism is something that is very important to me. In the conception of evolution as a religion, is there any room for dualism in that kind of a world-view?

M: Even though we cannot explain everything with the science that we have, there aren't any forces that are outside science. That's probably a way to put it. I don't know how the monists define their monism, but that's approximately how they do it. And I

think this is the standard belief of most scientists.

G: What is your belief on that?

M: I'm a straight monist.

G: Yet, there is something in the idea that mankind is special; the Julian Huxley view that the human species entails some kind of special evolution or some kind of special treatment as opposed to the rest of the animal world. There's almost a hopefulness in there that borders on suggesting that there were some special evolutionary forces at work to create this exalted species.

M: Darwin wouldn't have liked that.

G: No. And that's why I think even in the view of someone who uses their naturalist religion, they still have a tinge of dualism in their thinking.

M: I wouldn't be surprised.

G: Would you say that Huxley's view entailed some of this dualism?

M: I'm not so sure. He thinks that–I think–he thinks that mankind is, indeed, something special, but within the forces of Darwinism.

G: Is it possible to be an evolutionary biologist without addressing any philosophical questions? Or is it difficult to separate evolutionary questions from philosophy?

M: Well, you see, this leads into a very interesting business with respect to myself. I, for 50 years now, have been fighting the idea that you can make a philosophy of biology based on physics and logic. [Right now], I have a manuscript floating around between publishers, in which I particularly emphasize that biology is, to such an extent, an autonomous science that as a philosophy just based on the logic of physics is not sufficient, is not the basis for a philosophy of biology. And I haven't worked this out in the end of my novel–I'm too old for that–but somebody will write it. That's why I hope, one of these days, that somebody will develop the philosophy of biology which is different from the philosophy of science of space and physics. It will not have any idealistic components. And the mere fact that, for instance, essentialism doesn't exist in this kind of philosophy of biology and dualism of natural laws and genetic programs–that dualism doesn't exist in inanimate nature, but is and will be an important component of philosophy of biology. All this makes a philosophy of biology, in some respects, quite different from a philosophy based on mathematics and physics and logic. And there's one thing in particular, and I haven't solved that in my mind:

biology consists of two branches and this is usually overlooked. One is the functional biology, and everything in functional biology ultimately can be reduced to the same forces and principles as if I am in physics–physiology, etc. And you have another biology, evolutionary biology, in which you deal with phenomena, and principles, and processes that don't exist in physics. And yet, a philosophy of biology would, to a large extent, include this kind of phenomena–evolutionary phenomena–because they have to be taken care of by some part of philosophy. They cannot be taken care of [or addressed] by the philosophy of the physical sciences.

G: Is it a special kind of cause and effect?

M: We need a special kind of philosophy of biology. If you look at the books on philosophy of biology like Michael Ruse, David Hull, or Kitcher or Sober, or all these people–they all start from the physics of mathematics. And they all lacked a training in biology. None of them is a biologist.

G: Most philosophical questions since philosophy began are asking biology questions without being expert in biology.

M: Exactly, exactly.

G: How do we reconcile that?

M: Well, we are just unsatisfied. When I read what these people write, it isn't a philosophy of biology.

G: If a young student in junior high school comes to you, and asks you, "What should I learn to become a biologist?" Would you tell that student, "You cannot do biology without understanding these philosophical questions"?

M: My practical, or empirical, conclusion is–and that's in some ways pretty disappointing–you have to be raised as a young naturalist who really understands nature. Now take a person, like George Gaylord Simpson. Do you know his life history?

G: Not very well. I know his most famous books.

M: Ok, well, I'll tell you a little story. The biological species concept, is my special stance–that's what I've done. I've written 62 papers [that address the] theory of the biological species concept. And a little while ago I wrote again on the subject. I looked up the species concept of Huxley and Dobzhansky and Stebbins and all the other founders of the evolutionary synthesis. And species definitions all made sense with the

exception of Simpson. It was a definition sort of put together from pieces of other people's definitions, but it didn't gel. And I said to myself, "Why does he produce such an inaccurate species definition?" And I came to the conclusion that he had never been a naturalist who really knew species in the field. He had only worked with fossils, and they usually work with general orders of species, and different species is somehow a typological concept. So, I went through his life history, and it turned out that when he went to college he was an English major. I checked whether he had an interest in bird watching or butterfly chasing or anything like that, and no, he hadn't been interested in nature at all. It was in his senior year in college that he got interested in geology, and so on and so forth. So it confirmed my view that unless you are a young naturalist you will never understand the species, and that is still my feeling. All these people that come to species definitions without really knowing what species are, because they never had any background, like Michael Ruse. He was trained as a mathematician, and he doesn't really have a feeling of what species are.

G: So sound biological insight is something you can only get through doing field work.

M: That's what I said. It's an empirical way. You can't get it through study and philosophy.

G: And yet, the questions you ask in biology from doing the field work are philosophical questions.

M: Yes, they are. They are.

G: And that's why you say we need a new philosophy of biology?

M: That's what I'm saying. Yes.

G: The education process requires–to be a biologist–it requires a different sort of scientific training.

M: Michael Ruse is a good example. He was trained as a mathematician. He was not trained as a naturalist, and he has studied biology since. And he has been working a whole lot, and yet, when you look at his philosophy, his principles and beliefs and whatnot, they just don't quite come out as that which a good biologist would do.

G: I feel the same way when I read his books.

M: They have several troubles. For instance, with a very simple thing which is that in a biological species, no two individuals are the same. We've got six billion humans, but no two of them are the same. Now this a physicist can't understand because a sodium

atom and an electron, all the units, they are all identical.

G: Even a geneticist, who only studies genes, has a hard time with that statement.

M: Yes, yes, yes.

G: Many people in evolutionary biology grew up with religion. Do you think that might have colored their interpretation of nature?

M: I've never been able to figure out Dobzhansky because he was a straightforward evolutionist, never questioned natural selection or anything, and he prayed to god. It just didn't make sense to me. Now, when I talk to people about god, I have to find out: do they believe in god or not? Because if a person believes in god, that obviously gives this person some comfort. It's something very precious to people to be able to believe in god. It's the last thing I want to destroy. So, I normally refuse to argue with anybody about god because only once somebody challenged me–he almost accused me of being a bad person because I didn't believe in god and so forth. He said, "Now, why don't you believe in god?" And I–without going into detail– just cited all the things that go on in this world like genocides, and earthquakes and all these other things, and then he sort of broke down–this really bothered him. So I have never, ever done that sort of thing again. But if a person doesn't believe in god, then I can discuss freely why I don't believe in god because of all these horrible things in this world. But to believe in god, you have to believe in where god puts the half billion souls that every year go up to heaven, and where is this place where all of these souls are? [One must consider] all the impossible things that Christians believe and you are supposed to believe. So [the foregoing] two reasons are why I cannot possibly believe in a personal god.

G: So you feel like you're kind of bending over backwards not to bring it up with people if it's going to hurt their feelings.

M: Oh, yes. Exactly. I have full respect for people who believe in god. That's what they chose for their life guidance and all that. It's their business, and I don't want to interfere with that.

G: But they also choose it to form their world-view. That's part of their world-view. How does that interfere with the young student coming to you asking you how to become a good biologist?

M: I say nothing about god. Now, there is one of the professors in Riverside, and I couldn't give you the name now. Anyhow, this professor in Riverside gave a course on evolution, and they gave a questionnaire to other students in his class asking: do you believe in a personal god? Do you believe that the world was created by god and so on

and so forth? Are you an atheist? He got the whole–well, philosophy, religion–of every student he ever had, and then he gave his course. Then he gave that same questionnaire to all these students to see whether taking his course had changed in their thinking. The shocking thing that he found was that virtually all the students had still the same beliefs at the end of the course as at the beginning of the course. So it is something very fixed if somebody has a religious belief.

G: You weren't raised religious when you were very young?

M: Only very mildly. I think both my parents were probably agnostics. But every once in awhile, we went to church together. I was confirmed in the Lutheran style, but when I was about 14 or 15, I said, "That's a lot of nonsense," and gave it up.

G: Do you remember if it interfered with your ability to be a naturalist? By the time you were 14 or 15, you were already interested in nature.

M: Yes.

G: And do you think that you gave it up because of what you observed in nature?

M: In my case, it was simply all this hocus-pocus didn't fit with my scientific attitude.

G: So by 14 or 15, you were reading Darwin.

M: I didn't read Darwin, but I read Haeckel.

G: You mentioned earlier the idea of type specimens. We still hold type specimens, any museum we go into. Is this a holdover?

M: The word "type" is really the wrong word for this.

G: Shouldn't we call it a "mean" specimen? Or something like this?

M: No, there is a perfectly good word for this. It's the reference specimens, you see. For instance, many types of birds–not many, but quite a few birds and mammals–happen to be albinos, but at the same time they were a different species or subspecies or something like that. And even though they were not typical species at all, because they are albinos, they, nevertheless, are a type because you can see from the proportions of the toes or the bumps on the teeth that that's the thing. So, that specimen has nothing to do with being typical.

G: But it's a holdover from the days of essentialism.

M: Yes. Of course, of course.

G: It was supposed to be close to the essence. Was Ernst Haeckle still an essentialist?

M: In many ways, he was. Yes.

G: And that's what got him in trouble. It wasn't his monism that was such an offense. It was probably the essentialism. Wouldn't you say?

M: No, he pretty much was an atheist. And he fought the church–very deliberately fought the church. He attacked the Catholic church. He thought the church was a bad influence on people. I've never really studied Haeckel's life, but I'm quite sure that he thought that most wars were done for religious reasons and things like that.

G: Do you think that group selection is a new kind of essentialism whereby the essence is now a group characteristic?

M: Group selection . . . Darwin had it perfectly right in *Descent of Man* in 1871. And then this fellow, George C. Williams, got it all messed up. You have to, first of all, recognize that there are two kinds of groups. One is the casual group. [For example], do starlings pick a certain roost for the winter for the evening and have no relation to each other? They just happen to be feeding in the same field, and so they fly to the same roost. The casual group which has no interaction. The fitness of an individual of that group determines the individual's survival, [and] the group has no influence on that.

But you have also the social group like, for instance, the hunter gatherers of human beginnings. Some social groups had a greater cohesion. They invented the idea of having monitors, gods who watched for a certain group that had special devices [or] special behaviors that would make the survival of that particular group more successful than if they didn't have these social behaviors and all that. Such a group that has these special things is a social group, and that social group definitely has a higher survival value, a higher fitness, than a casual group. So there is nothing wrong with group selection, but you have to figure out whether it is the interaction of the members of the group that is responsible for the higher survival.

G: So they can fall into one or the other category?

M: I think you can always figure out that–small family groups are usually social groups. They help each other interact, and so forth. Most larger groups are definitely casual groups.

G: Switching gears, how much of your world-view is actually created by knowledge of

evolutionary biology? Or maybe, you use other stories from your past, or other mythologies to form your world-view. How much is due to you evolutionary biology knowledge?

M: Well, this goes back to my family, to my mother. She had this what you usually call Protestant ethics: being generous, being helpful, being cooperative. All these things. My mother always thought of how she could help people who needed help and so forth. It was definitely a religious thing and not an evolutionary one, and yet it fit perfectly well into the Darwinian thing. You find that if you look at some of the other religions of the world–for instance, Buddhism is the most appropriate one–they have ethical principles that go extremely well with evolutional views, so it's very difficult to [quantify]. On the other hand, amongst religions, there is an intolerant component that is quite incompatible with an evolutionary point of view. In the early middle ages, when they had a lot of religious wars and things like that, they did the most cruel things in the name of god.

G: Of your current world-view–your ethics were determined by your mother?

M: For many many years, I have at least, in principle, gone along with the Huxley principle–Julian Huxley. Being that the way I should live is to make this a better world for mankind, and doing things for the benefit of the human species. And that's an evolutional world-view.

G: Is morality a discussion that falls under the umbrella of evolutionary biology?

M: You see, morality starts with the social group, and that is the thing that is so often overlooked in discussions of the subject. It's the social group that develops a morality. And if the group gets too large there is no longer any advantage of a social group morality. At that point, the philosopher and the religion founder and so forth enters the picture. He picks up the morality that is dominating and controlling the small group and applies it to the large group. The religion founders, Jesus or Moses, or Indian philosophers, they all sort of observed functional groups and dysfunctional groups and based on that observation, the principles of ethics that they adopted for their religion [arose].

G: Today, with so much mixing, where the small groups have become assimilated into much larger groups, the morality no longer applies.

M: That's typical for big cities, the population of big cities. There's very little morality. Well, you see that the point is that even in a world population, you have subdivisions, and you have nations, and even within nations you have subdivisions. Usually, there's some leader. Some philosophy givers, some religion givers. And they see to it that we

don't have complete chaos. And then of course, the nature of nations in the political sense, they establish laws and so forth, and that takes care of things. In my opinion, it all goes back to the small group–social group–which in order to hang together has to have certain ethical principles. Now, there's some very nice work done on the Yanomamo Indians in South America. It was those groups that had a group cohesion–as the group got bigger and finally had to split because they got too big for being run by one person, and other tribes of these people fought within each other, and went downhill. There is a great deal known now about group size and ethical principles.

G: How important do you think it is that evolutionary biologists agree on the implications of evolutionary theory?

M: You see, for instance, this is a famous thing. In an early essay on Darwinism, the question was asked, "How can Darwinism support altruism? Because after all, fitness only helps the individual. And if the individual selfishly works for its own advantage that doesn't lead to a better world." And then that's exactly why the social group came in. There you have an organization that deals with more than one person and can lead to improved fitness of a group of people because there is cooperation and altruism among them, and that's the famous business of what is the target of selection? Well, the basic target of selection is the individual, but then you have things like this social group which is more than one individual. And then you have superimposed on that sometimes the species, which is advantageous.

Mankind is the most horrible example because when the certain tribes came into North America they exterminated a lot of the mammal fauna–the Pacific, from Madagascar over to Hawaii, and all other groups. The Polynesians, as soon as they arrived, exterminated all the larger animals that occurred in these islands and all the floral species, so that you do have, and also at the lower level–for instance, in Hawaii–a lot of introduced plants [that] have resulted in the extinction of native Hawaiian plants. Even in the Galapagos, this has happened. So you do have a level where species advantage is overriding social group advantage and individual advantage.

G: And that is an important example of where biologists must agree.

M: Yes. They are working very hard now. You see, in the Galapagos, for instance, they have just succeeded on one of the islands to kill the last pig. The pigs were very bad because they took out the eggs of the giant tortoises. There are still some islands where the pigs exist. One of the very important islands just managed to kill the last pig.

G: Finally, I wonder if you could tell me what you think the use is for evolutionary biology knowledge?

M: Well, I think that there are two things we have to distinguish. In all conservation efforts, you run against people when you say . . . take this example, protect the birds of paradise. Then comes the anti-conservationist who says, "Why, what good are they? I don't give a devil about the birds of paradise. If I can cut down the forest and produce more beef, that's better than protecting that forest for birds of paradise." And then you get the other party, who [assert] the other possibility, who say, "Oh but this is part of god's world."

G: God's handiwork.

M: I love the diversity of this world. I feel that one species, mankind, doesn't have the right to exterminate part of this creation, this wonderful evolutionary development, and that we must do our part to preserve what nature, what evolution, has produced and has produced for our enjoyment. So, obviously, I'm a member of that second party, and I constantly work, and I always have since I was about 18 years old, for conservation and for the maintenance of biodiversity.

G: So the use of evolutionary biology knowledge is as a foundation for this principle that you believe in?

M: Yes.

G: So the use for evolutionary biology knowledge then is a foundation for an ethical outlook?

M: Of course. Also, the principles of evolution have taught us so much of plant breeding and domestication and cultivation–it's all evolutionary principles basically.

G: So it has practical elements to it. But the most important one is the one you mentioned first.

M: I would say, if I'm asked to be honest, yes. But in order to be able to sell it, one has to be able to emphasize the other.

Professor John M. Thoday
Interviewed by Greg Graffin
June 11, 2003
Cambridge, UK

G: Greg Graffin
T: John M. Thoday

G: Why don't we start with what you were saying about how it's as irrational to be an atheist as it is to be a theist?

T: Well, it's disbelieving. I mean believing that there is not a god, you have as little evidence for that as you do for believing there is a god. You have no evidence for either. And these are areas where, frankly, you've got to be something like a logical positivist. You can't answer the questions except by an act of faith, and if it's an act of faith, it's just as much an act of faith as saying there's no god as saying there is god. And it doesn't help. But of course, I know perfectly well that most people–a few of us seem to be odd [and] find agnosticism impossible. But it's called sitting on the fence, of course. But it isn't sitting on the fence in this case. It is positively saying that this is no area beyond which knowledge doesn't go. Except it's some kind of knowledge which is certainly not the sort of knowledge that you're playing with when you are doing science.

G: That's what I'm interested in. As a scientist, is it feasible to erect a theory or a hypothesis for which you cannot collect verifying evidence?

T: You can do that. Of course, people do. Don't they? And they publish books on them and think they are doing science. But if I think of an immediate example–you know about Hoyle and Wickrammerigh Singh? They say that DNA is so complicated, it couldn't have happened through natural selection. It must have come from elsewhere.

G: I do know about Hoyle's extraterrestrial idea.

T: Which is only the same way as saying it came from god, isn't it? The funny thing is they've erected a great theory, but they haven't looked at criticism of it. The argument is exactly the same as the argument used against Darwinism so often with the vertebrate eye. The vertebrate eye couldn't have happened by accident which assumed: a) that the vertebrate eye is no good if it isn't perfect, and none of them are; and b) that variation doesn't happen. Well, variation does happen.

If in fact, you look at bits and pieces, you see eyes starting with eye spots in unicellular algae and more complicated diploids. And a whole series of branches with different kinds of eye. Well, that's what happened to enzymes. [Do] you know Pat

Clark's work? You wouldn't, but it is very important because what she did was to set up a bacterial situation where she presented an environment [in which] none of the existing enzymes were properly capable of coping. And within a few generations, the enzymes had changed their specificity. They changed their sequences.

G: True adaptation.

T: Yes, true adaptation, which makes total nonsense of Hoyle's original premise. And yet they built a theory on it.

G: I've heard of references to Frederick Hoyle's extraterrestrial theory of how life began, but I don't know what book it was published in.

T: Oh, in *Nature* and places like that, you know. Well, they made a lot of fuss about it. And of course, here is a man of very great distinction, and almost certainly we're spending rather more money on space exploration as a result of this being in the back of people's minds. Anyhow, I think with the question you are asking, it is perfectly legitimate to speculate beyond the bounds of knowledge. But it is not legitimate to let that speculation be more than speculation. It's not establishing truth. I suppose I'm a Popperian in the sense that science can disprove things.

G: I would like to address that, in the sense, that an atheist has something to disprove if there was any positive or verifiable evidence of god. It would simply be a restructuring of our thinking.

T: Most people who try to do this - I think Fisher made some effort to, and other people have made efforts to look into the efficacy of prayer. But of course, even if you found that prayer was effective, this doesn't have anything to do with god. If the prayer was effective, it could have to do with the motivation of people.

G: True. I think the neurophysiologists may hold the ticket to our future understanding of prayer.

T: Yes, and of course, we're getting on rather nicely with neurophysiology. I don't know how it's going on now but the *Drosophila* neurophysiological genetics was really nice looking stuff.

G: Well, knowing the genes of *Drosophila* that are responsible for their behavior is what you are referring to?

T: But there again, of course, I would repeat: sequencing them tells you nothing. You've got to go from the sequencing to find out how they work. And well, I don't

know whether this is relevant, but it worries me a bit. It always has. I am interested in trans-specific variation which I think is far more important than intraspecific. It's what's used by evolution. But the difference between dumb and bright people is more interesting than the difference between us and chimpanzees genetically.

G: In terms of intelligence.

T: Yes. And what is interesting about us and chimpanzees is how many genes are in common. But we knew that anyhow without having to sequence anything.

G: Right. You could merely compare the morphology, couldn't you?

T: Yes. Well, that's how evolutionary studies began.

G: It was shocking to me when I was looking at those reprints. That was 50 years ago. The one in the proceedings of the symposium. It seems like you were pretty far ahead of the curve in what you were talking about in terms of quantifying fitness. What was novel about your approach back then?

T: What was novel about my approach? Well, in a way it wasn't quite novel. I recognize it derives from Darlington. I think I was very luckily. I went to the John Ennis summer school where Darlington and Mather and all these people [were in residence] in 1938. And I came back just stimulated. And then Darlington's book, *The Evolution of Genetic Systems*, came out. And lots of it is wrong. Half of what Darlington wrote is wrong, but it was brilliant. And it just really set me on. I went then into war, and I spent the whole war thinking about the meaning of variation. I couldn't do anything else. The basic reason is interesting because in the '60s, we were all accused of not being interested in political matters and so on and so forth. The question I was asking myself all along was: what is the reason why democracy is any good? It was a political question I was asking, but I came up in the end with a feeling about the role of variation, which is in all those papers actually. The last one, I think that almost the aphorism of what life has to do, can only be done by generating random variation in the long term, I think, is pretty sound.

G: You said that if it is a designed universe then . . .

T: Then it's designed with a chance element. Yes. Well, this may be a paradox, of course.

G: Not if you accept . . .

T: It only appears to be.

G: An evolutionary world-view teaches you to understand probability, I think.

T: I was never a mathematician, but I think I understood what statistics was about.

G: When you say it–a designed universe with chance built into it–you're talking about chance in the sense that it defies probability or something that is unknowable?

T: No, it's the need that is unknowable. As I say in that thing, organisms cannot predict the future, so they cannot know what they will need in the future. We can a bit, but not very well. Then you have to say, the only way to do this is to preserve the means of generating random variation. That is chance. And the price we pay for that is all the genetic anomalies and everything else, but all populations that have ever existed will have generated undesirable variation for their time. Otherwise, they never would have survived environmental change.

G: The problem was the middle part of the 20th century was full of speculations about progress and what not, and you cited Alister Hardy's book or that review, and you think that he, along with Julian Huxley, to some degree, was interested in suggesting that organisms could somehow render predictions.

T: No. I reckon I improved upon Julian Huxley because Julian Huxley's argument about biological progress effectively said that that which has happened is progress. This is not a logical argument. And the funny thing and rather sad [thing is], just before he died, Stebbens wrote a book on biological progress and doing exactly the same thing. That I can't stand. Especially since there was some literature he should have referred to. He was a very nice chap. I knew him quite reasonably. Best person you could ever find to go on a botanical trip.

G: What you were able to show?

T: It's how I define fitness. Actually, Waddington called it Thodayan fitness rather than Darwinian fitness in some book of his, which was rather good. I defined fitness trying to make it a global concept. This is not denying Darwinian fitness as Fisher and Haldane and Wright would measure it. But taking into account the longer term. So I should have called it long-term fitness. You don't think of the difficulties of your title when you produce it in the first place. It's 50 years ago. I was a bit surprised. The other thing was 35 years ago. I wrote one other article on this topic. Natural selection. It was on neutral evolution in biological progress. It's in *Nature* somewhere [where] again I applied it and showed something funny, actually. Lots of people criticized me. I pointed out that if the genes were truly neutral, you cannot call the change gene frequency evolution because it makes no difference to the economy of the organism. And therefore, I classified "possible neutral," "conditionally neutral," and "neutral" in

certain environments not in others. [I] pointed out that those conditionally neutral mutants would be progressive because you would be carrying variation that wasn't impairing the present fitness but was there for future [generations]. But several people were furious with me. I suppose probably–what's his name? The Japanese. Kimura. I suppose Kimura may have been furious with me for pointing out that if his evolution was all that he said it was, it wasn't evolution. Now, people think this is carping criticism. It's nitpicking. But it isn't.

G: You define fitness back then as the potential . . .

T: The probability of surviving for a long time. I didn't specify a long time. I did actually specify 10 to 60 years, which was a mistake because I was criticized for it.

G: The point is it was based on a probability.

T: And it was based on Darlington's discussion of variation and the appreciation that, except in the cases of ecological polymorphisms, and so on, which all get built in, the in-breeders, as Darlington discussed it, had no future. Some of the theoreticians deny it, but that's because they don't include recombination in most of their theories. But out-breeders carry a burden. They were segregating. It was called "load" later. Their recombinational load. This thesis was really rationalizing those burdens, and they are burdens.

G: How has the view of fitness changed that?

T: Well, as I say, I cultivate my garden now. I'm not up in things. But frankly, I don't think the views of the mathematical geneticists have changed very much. If you go to mathematical theory, you have a vested interest in it. However, I, frankly, have always felt that the thesis I produced–I think, it says so in the Darwin centenary volume–that it reverses Thomas Henry Huxley's belief that you have to have ethics working against biology. I think that it leaves you with grounds for ethical views. This is apart from altruism stuff. It's derived from Fisher, but Hamilton was a student of mine actually. He's dead now. You know him?

G: Yes, very famous stuff.

T: Yes. Apart from the fact that there was this argument, and natural selection can promote an altruistic view. It depends how you look at it, doesn't it? If you show that this can be produced by natural selection, then what's the argument against your saying you're being conned by your biology and into behaving stupidly for yourself?

G: Or unethically.

T: No, stupidly, because natural selection can build in an altruistic attitude, and you do those things at a cost to yourself. You're being conned. And I think you're conned by most of the priests.

G: But as a foundation for ethics?

T: I think in principle it must be possible. It's getting rather more philosophical than I'm probably capable of being. I don't know. Because constructing a program for behavior from it is difficult, isn't it? After all, your classical religions are "thou shalt not."

G: Prescriptions for ethics. True.

T: What I would say is that for myself, I have never felt that I needed to hand over my responsibility to god. The concept that one is responsible seems to be there.

G: In the world-view that you have, whatever that might be, how much of it do you think was influenced or derived from your knowledge of evolutionary biology versus other sources?

T: Well, this is very difficult. It depends on what you mean by my knowledge of evolutionary biology. I mean, I think I really derive it from the study of variation which is a very small part of evolutionary biology. Nothing from my knowledge of the course of evolution has any effect that way.

G: When I look at the world, I interpret almost everything from what I learned in evolutionary biology. Of course, I have a different upbringing. I was not brought up in the church. I was never baptized.

T: I was, but there came a time when I was about 16, when I read a hymn to myself that we were about to sing, and it said, "Lord, we love thee. We deplore that we do not love thee more." And I said to myself, "Anybody who can write trite dreadful stuff like that, killing the English language, is unfit to talk to me." And I ceased to be religious for the rest of time.

My parents were both botanists. My father's background was Puritan. Neither of them were particularly religious, but of course, built up on the Puritan ethic which we all come from. And the funny thing is, I got interested in plants from a very early age. Eight, and so on. How they worked and all the ordinary stuff that was in all the descriptive mechanisms of seed dispersal and insect dispersal, and elegant devices for doing this. I suppose that's because my parents were botanists. Animals didn't interest me.

G: But it sounds like a lot of your understanding of the world, which you incorporate into your world-view, would come from a biological background.

T: Yes. Certainly, the whole concept of evolution as one has it, leaves one with, as Simpson said in that thing, "No room for gods, except as first cause."And that's where I say it's illogical to be atheist because that is saying there is no first cause.

G: What is the use for evolutionary biology knowledge?

T: It affects your view of what you're living in. That thesis, the first one, components of fitness, it's a funny thing, but I had a student once who came from lowly origins. And indeed, his headmaster said, "You won't be fit to go to University at all." He ultimately became my research assistant. [He] helped me [with a lot] of research and he's a professor in Australia right now. He said that that paper made him understand why he was different from other people, and made him accept it. So I changed his life.

G: Right.

T: Is that enough answer?

G: It's a good answer. Very good. I agree with you.

T: If you think about the amount of jealousy and envy of the whole human race, just to accept that people are different. We're all different. That should be a transformation.

G: I agree with you. That's what it has done for me. Then how important do you think it is that evolutionary biologists agree on the implications of their science?

T: Frankly, I think it would be highly undesirable if they thought they agreed when they don't. I'm not sure it's so important that they agree. What's important is that they discuss it rationally. They discuss their disagreements rationally. But of course, they all have vested interests.

T: There it is. That book of Hardy's–Hardy was really trying to bring religion back through a different back door. Have you read that book?

G: *The Biology of God*?

T: No, that was a later book. The first one. The [book] which I reviewed.

G: No, I didn't see it.

T: Well, he was literally invoking a basic built-in unconscious knowledge of all organisms that were ever going to be. The funny thing is that he didn't try to do it with plants. That's leaving out rather a lot of evolution.

G: But the idea of compatibilism is exactly what I'm getting at when I ask you if you think the implications of evolutionary biology must be agreed upon by the people who do evolutionary biology at the highest level?

T: They ought to be able to agree that if you decided some ethical prescriptions could be derived from evolution, they would all be able to agree that they were the same ones. Look, I don't know whether it's possible because, after all, I came to a conclusion exactly antithetic to Huxley's. And then, 20 years later Stebbins produces the same sort of thesis as before. And actually, I think most people don't think about these things very much. If you come to the conclusion that you can't solve a problem, you change, go to something else. And possibly you have sat going to church with one hand and doing science with the other. And the right hand does not know what the left hand is doing.

I've always envied Thomas Henry Huxley for the one occasion where he was most famous because, time and time again, I've thought of the right thing to say the night after.

G: You mean the Wilberforce comment?

T: Yes, but I had a terrible meeting by various people who set up a forum on the social responsibility of scientists. It became one of these things like Daniel Webster facing the Devil. I really wanted to criticize one chap. I'm not sure if he's still alive, and I thought of what I should have said the night after, which was they were talking about IQ as a matter of fact–that he had really prostituted his talent. That's what I thought he had done. And he was a great orator. And I should have said, "I'd rather have the IQ of a monkey than prostitute the talent that you did today." It goes round you in the night. These people, these glib people, they catch you all the time. How do you like Stephen J. Gould?

G: I'm from a paleontology background so I like a lot of his work.

T: Well, I would like to do that to him. Again, I thought of it after the meeting. After his talk about cathedrals, you know. Pointing out the hole in his argument–he was talking about a cathedral as if he were a paleontologist and as if it were only a skeleton. And he was leaving out the function of the cathedral. He was even leaving out the function of the roof which was to keep the rain out. Now, if it had holes, it wouldn't function. That was the foundation of his whole argument. You can enjoy that when you read him again.

G: What does naturalist mean to you?

T: Well, I suppose I started as a naturalist interested in plants. Maybe absorbing interest. That's all it means. But you would distinguish between a naturalist like Stebbens or Ernst Mayr, who went out into the field, and they're interested in all the birds there are. From someone who is just interested in taking an old-fashioned comparative anatomy [view], just exactly how a butterfly's mouthpart works in order to get honey out of a flower. I count myself as an experimentalist, really. Rather, a theoretician. These were theoretical papers I wrote.

G: So a naturalist?

T: Well, I don't know that he [as a naturalist] is initially looking for explanations. Is he? When he finds problems, he has to find explanations. But a naturalist is interested in the whole flora and fauna. And he likes to know it. And you find it is very difficult sometimes where there is an area that you do know like you might know the British flora. And I don't very well, but you might. And you are talking to somebody about something, and it's relevant that they have no idea of anything.

G: I'm wondering if naturalism is a system that entails belief? Is it a belief system?

T: Being a natural historian, I shouldn't have thought so. Well, of course, you're looking at the wonderful works of god.

G: In the William Paley sense, that's right. Or if you don't want to call it god, then whatever the first cause is.

T: If you are at that level, I think you're not in the level of first cause. You're at the level of causes that are going on now. That's why you want an interfering in god. Alright, you may call it nature, then your general causal sequences aren't what [we're] talking about.

Paley must have believed in constant intervention, talking about the design of an individual animal like the design of a watch. It implies a watchmaker. I think that's the argument I really refute.

G: And among your contemporaries who you consider naturalists; are they people doing the field work?

T: Well, no, because I never did any field work. I knew Philip Sheppard and ecological geneticists, but I actually [spent] most of the time when I was actively experimenting, tied to my microscope several hours a day, five days a week for four years. [That was for] my biggest experiment. This stuff is peripheral if you see what I mean. My actual

research work most of the time was on *Drosophila* selection experiments, and the location of polygenes and disruptive selection. I think a lot of people think we cooked it somehow. We got with the right designed experiment, we got the population of *Drosophila* into one test-tube hardly mating at all.

G: Right, sympatric speciation.

T: Now, lots of people have repeated that. I wrote a paper explaining why we were just obviously lucky. It had to be there for it to happen. The right genetic variation to start with. Both characters that you're selecting for [are] bristle number and for mating preference. And then, no dominance, because otherwise one side's progeny would be just like the other, and so on. I wrote this paper in *American Naturalist*. I'd showed how difficult it was, and so it was impossible to happen in nature. But I think Ernst Mayr was here a few years ago and [was] asking me why I thought this experiment worked and nobody else could do it. But if you do a selection experiment starting with eight flies, and somebody else goes and gets eight flies someplace else, what is the probability that they will produce the same results? You don't expect the same results. You expect each foundation of the population to produce a different result. You don't expect everything to work. We just tried it with an extra experiment to a bigger one than we were doing to explain things more precisely. And it worked.

G: We've covered almost everything. We'll end it with a metaphysical question if you don't mind. It's the idea of reality. And once again, is it a quest to understand reality–the way the world really is - that drove your research? What was your main motivation?

T: I don't think I would have put it as generally as that. My main motivation was I had a problem and I was interested in it. You want an example? I started one of my biggest experiments–of course I was trying to teach something–and I suddenly realized that it conflicted with something else I was trying to teach. It's all in Dobzhansky and so on that evolution has to keep things up, has to get rid of mutants that are decaying–that's one thing. Ordinary complementary gene action was another. You take two stocks of *Drosophila*, neither of which have wings, and you cross them and they have wings. Well, I suddenly said to myself, "If in fact, you had two stocks of *Drosophila* in bottles for the last 30 years, they should have decayed and they shouldn't have good wings when you cross them." So I started an experiment and crossed them, and they had good wings. So I started an experiment to change everything as much as I could by selection to see if the wings deteriorated with the rest of the background changing. In the end, the experiment was never exploited in that way because it produced actually interesting results which I had to follow up. That was my second *Drosophila* experiment. The first one I never published because the culture went wrong and cooked it, but I was selecting for variable variegated eye position. In this case, I got a question, and I had to

answer it. I never did answer it.

G: You said earlier, it was a quest to understand the truth about these organisms. A lot of people shy away from the words "the truth" and the word "reality." People don't really like to talk about that, and I'm not really sure why.

T: I have certain thoughts on this. I used to be a radiation cytologist, and when I first began in 1939, '40, I only had a monocular microscope. That's all they could afford. I spent the day looking down it with a bright green light with one eye. After that, I would [leave], sort of feeling quite botty. And I realized if I shut this eye I saw red, and if I shut that eye I saw green, and the two together were giving me the right color. Then I complained, and I got a binocular microscope. The result [was], instead of for two hours with this thing, for about a second I would see red and then [my sight was] normal. So therefore, I concluded, I am imposing my normal reality on my experience, because my experience is not a normal light. It is a red light, and I am normalizing it. You brought the whole problem of hypothesis and fact there.

G: But it didn't change your conclusions from what you were observing?

T: No.

G: To me that's the key. If it changes your conclusions, there is a problem.

T: It changed the way I thought about the meaning of meaning. Yes.

G: Everyone has got their own subjective experience. That's true.

T: It made me realize, of course, that the only reason why we both say "red" when we see those flowers over there, is because we were taught to say "red" when we see that color [over there]. But you might be seeing a frightful dirty brown.

G: But I don't think that really matters.

T: It's more a linguistic phenomenon, isn't it? But it does affect one's concept, how acceptable anything called truth is.

Professor Tom Eisner
Interviewed by Greg Graffin
Ithaca, NY
May 27, 2003

G: Greg Graffin
E: Tom Eisner

G: What does it mean to you when someone calls themselves a naturalist?

E: Somebody who is willing to go to nature without preconceiving a problem to work out, but is willing to respond to events as they happen and file each in the appropriate place in the memory bank. It's not that you can't be a naturalist if you do the reverse. If you start as a naturalist, you don't start with a bank account full of questions and theorems and beliefs. You just pick things up because there they are, and you're wondering what they're all about. That's why you pick up a beetle when you're three years [old], and you put it in your mouth. That's your first experiment.

G: Do you think there is something very innate in being a naturalist?

E: To begin with, the phrase that I mentioned–which is not to go to nature with your project, [but to] experience nature without learning any formal science–that is usually the way the naturalist gets started. The science and the unity among the diversity of events, that comes later. But just plain curiosity without asking yourself why you've got that curiosity, that's how I would denote a naturalist. I always ask graduate students, "When did you get interested?" And if they tell me that they find a lot of coins in the city because they're always looking at the ground in front of them to see what's crawling there, then I classify them as naturalists. Then I don't really worry about their C in organic chemistry.

G: Do you think that this entails belief in any system? In other words, to be a naturalist later in life, does it require some kind of belief in that which you are discovering and how that somehow fits into a system?

E: Well, that depends. I don't want to generalize because, to tell you the truth, I haven't really thought the question through. But my own way to go at it is still very much the same. I usually start problems on the basis of an observation. So for me, when I go into the field and do experiments, there are questions that come up serendipitously [from] previous trips. I'm always going somewhere to finish something and to find out two or three other things before I leave a field site, I'm sure that I'm packed two days in advance and I take two days where I just stroll totally unburdened by [thinking], "When am I going to pack up the microscope and fit it in

the trunk?" I just want two days of pure exploration. I even took a feeble attempt at institutionalization. I taught a course called Discovery and Follow-up. That wasn't the full title. There was a third word in there. Exploration, Discovery and Follow-up, which lasted two weeks. I would take about 15 students. I would release them on the first day. Then we met in the evening. Everyone would say what they had discovered, and you could spot pretty quickly the seers versus the non-seers. Not the smart from the less-smart. That has nothing to do with it. But then they would follow up, and we had something like two dozen papers coming out of those courses. Maybe that's a slight exaggeration, but let's say fifteen papers. But for some of the students, it was an experience in self-learning and about what one can do.

G: I had a similar course at UCLA that was called the field biology quarter, and Martin Cody taught it and Laurie Vitt taught it, and they would take us out into the field and do the same thing. The first year I went, we went to central Mexico to a tropical deciduous forest. They just let us go out for the first week with no instruction. We spent six weeks down there.

E: My course was always too short.

G: The first week was searching the trails really. And I ended up being the only student who did a nighttime walk, and so I did a great study on *Atta* ants down there. And like you said, I had no experience with ants or sociobiology at all. It was the one thing that really grabbed my attention. And I ended up getting an A in the class and it gave me a lot of confidence to go on and do more field work.

I never had any formal religious training, so the mythologies that are normally constructed for children, that of course they're taught very young, I wonder if they will forever be biased when they go out into nature. Is it possible to be a naturalist in your way if you can't see nature because you are biased by the religious teachings?

E: To me the mystery was always that you had to invoke some invisible force because of the order you saw in nature. I never saw order in nature, I saw nature, basically, as [my] surrounds. I became secondarily [aware] of the physical reality, so it wasn't organization that struck me. I think that came as sort of an automatic perception, but I always wondered why, as most agnostics say, there had to be some superior force. I don't see that. I don't see the need to invoke the concept of free will. And I'm satisfied with evolution as a supreme explanation where you might need to fill in some figures beyond the decimal point at the twelfth level, but the major thought is there, and it is utterly believable. I once, in an unguarded moment, made the statement: why not believe in a god that created the process of evolution? And I should have said that in a way that didn't imply that I believed in them. I just said, "Why doesn't anyone, who sees this order, give god credit for having done the ordering or the mechanism for creating the order?" And this was in a *Time Magazine* interview, and I never lived that

down. It was the only time in my life when I listed my phone off the record. I got a terrible offensive and aggressive phone call from a reporter at the *Washington Times*. I only found out later that they have fairly strong religious persuasions. But that quote–I've decided ever since then, I would never speculate why others don't believe in that or the other thing. It's just when I've cornered myself, I say I am not an agnostic, and there is a difference.

G: I agree with you that there is a difference. And you'll be interested to know that in the questionnaires that have come back when given the option for the question that said, "What is your belief system?" They were given the option to choose atheist, naturalist, or other or agnostic. Atheism is leading the way among evolutionary biologists. But this idea of naturalism as a belief system, you are an atheist, but you are a human being like everyone else, and therefore the way the mind works entails belief. Do you feel comfortable with that?

E: Yeah, belief comes with disbelief. We can consciously disbelieve something, and I wouldn't even be thinking of the concept of god if it weren't for the fact that it is brought up in my surrounds. It's brought up in conversations. It's brought up as a source of inquiry, so I state my beliefs by saying that I disbelieve, but I usually say this conversation isn't going to get us anywhere. And, ultimately, its your business and my business, and we don't need to exchange that. I'll tell you something which will be very relevant to your thesis.

There was a time in the big Introductory Behavior course that I started with Steve Emlen, where the last lecture would be an open for all, hands up and questions [about whatever the students wanted to know.] And what we would find out by doing it that way was that we would get to know the extroverts better because they would be the ones to raise their hands. It was a course of 400 students. It was unfair, so we did, for a while, ask [the students] to write down on a piece of paper what they thought were the most important questions that they wanted to ask us faculty members in the course, and we would group these by demand, take the most popular questions and answer those. So we would do it democratically. And we also said we would take the most interesting ones, even if they were only representations.

So we take by majority vote the questions which were the prevalent ones and then add a few other ones. [Among] the three most [prevelent] questions were: Do you believe in god? Do you think evolution is a theory? And how do you feel about experimenting with animals? And to my great surprise, my colleagues, one by one, answered these questions. And I went in there intending not to answer the question whether I believed in god, clearly asking about evolution and clearly asking about animal experimentation. And all my colleagues answered about religion, and they all turned out to be disbelievers about mysticism. In other words, they said that there's no question when it has overwhelmed this order, and therefore we're driven to this thing. And I looked at the class and said, "It's none of your business what my religion is. I

believe this class is called neurobiology and behavior. It's a scientific course. I'm willing to deal with what is scientifically testable. And my religious belief doesn't come into it." There was standing applause from the students for that answer, which was quite surprising. But I had very good standing with the students. It was a popular lecture, so that helped. But I was surprised that none of my colleagues shared that view and that they also, in one form or another, answered with what I thought were rather wishy washy statements on belief.

G: I would say, then, that example supports the idea that the public is very comfortable keeping religion separate from science. But what I'm getting at, and it's purely from my own experience, is that science has a lot to say about religion, and I believe that scientists, as important members of our social group, almost do a disservice by not sharing their beliefs because they are steeped in verifiability, testability–all the things that religion used to have dominion over. So I'm wondering: what is the use for evolutionary biology knowledge?

H: It gets you to the question of origins. I would say that in the physical domain it's the big bang, and there isn't much of a problem there. For some reason, it tries to inquisition you–there is no such verb–nobody is trying to burn you at the stake for keeping god out of the original part of the universe. It's when you get to what led to humans when you find people–this is one other reason why I'm not comfortable with the image of god, and I am least comfortable with the image of god as the image of man. That sometimes becomes my weapon when I look at my opponent and say, "Are you really so convinced of the perfection of man that you are willing to invoke a deity that created man in his own image and so full of faults?"

The individual finds himself very, very unfairly challenged when you take that tact because it's a trap. I know the question is very hard to answer. I don't play the religious game anymore. I just don't get involved in the arguments. My involvement with the Bombardier beetle, which happens to be one of the selected entities that couldn't have evolved in the minds of creationists. I find that I have to answer that, and I won't get into a debate with a creationist because you can't play ping pong with a baseball bat. It just doesn't work. And so, I'm willing to discuss with you why I said that I am atheist. But for example, I would not take that discussion to any other level anymore because I think it's a losing battle. We've gotten away from those questions in the last section of the course, but not because of that. I mean it just happened, and none of us fought to reinstate them.

G: You say the use for biological knowledge, evolutionary biology, is that it gets you to the source, it gets you to the origin and ultimately the origin of human beings and the origin of culture.

E: It explains why organisms have such overwhelming similarities, which suggests a

common origin because we become very conscious of the difference, but the fact is that it is relatively easy to define an organism. You have to invoke organization, and you have to involve the capacity to evolve. And you've got a wonderful scientific edifice of beliefs of which evolution is very much a part, and it's fantastic to create order in a random sort of sloppy kind of a way, which is what evolution is all about. It becomes very unappealing to those who think of god as the creator of order and of rules when in fact, natural selection operates a lottery game, weeding out a tremendous amount of error in the system, so it attributes to god all kinds of faulty details of mechanism, which the real believer does not want to entertain.

G: But do you feel that the story of evolutionary biology could compete with the traditional theologies as an epic myth?

E: Well, it's having a hard time competing if you look at the numbers.

G: Let's just assume that there's a new race of humans at the moment, and somehow they get to pick and choose instead of having it rammed down their throat by their parents.

E: Well, in order to maintain a good open mind–because horizontal gene transfer was something that did not come up until recently–so we thought we had the mechanism of evolution down pat. You have more offspring that could possibly survive, which means that imperfection gets weeded out, but horizontal gene transfer is not a part of the game, and now we know that there can be transmission of genes from lineage to lineage, not just down by parental descent. So providing the evolutionist admits that he doesn't have the details of the mechanism down straight because surprises may still be in the making, having the broad course should be as satisfying to the disbeliever as having a theoretical image for god for which there is no evidence at all to bolster his or her belief in creation and conservative religious precepts.

G: And then evolutionary biology knowledge would serve to form that mythology in that sense.

E: It's hard for me to understand that people who discover evolution late in life don't find it so compelling that they give up their religious beliefs.

G: A lot of scientists filled in the biographical page, which was optional on the questionnaire. Since a lot of the evolutionary biologists were baptized and then started learning about evolution later in life, I asked them if the learning of evolution had any effect on their beliefs, and many of them said no. Some of them said yes.

E: This is very interesting because I gave up the idea of god before I learned about

evolution, so it did not come up as a conflict between evolution and creation. I had four years of biology in Uruguay and never heard of evolution. I picked up–I still have my copies–on the sidewalk of Montellaro, on Tuesdays when one of the bookstores always had paperbacks on the sidewalk–I picked up these three volumes of Origin of the Species (in Spanish) by Charles Darwin, got to about page 50 and decided it was not an important book.

G: That's a book that doesn't exactly grab you from the start.

E: Evolution to me was a fantastic discovery, and it was in the comparative anatomy course that I taught with somebody who went to UCLA. It was a small college that was taught by mostly G.I.s coming back from the war. His name was Balcon. He was a mosquito taxonomist. He worked for the museum at UCLA for the entomology department. He took comparative anatomy as a fervent evolutionist, and that was a compelling eye opener. I mean, that made me decide that maybe biology was something that I could spend my life in. The ear bones. You could trace the fish right down to a mammal. Notice I said down to a mammal.

G: So here you are now, one of the great senior scientists in the country.

E: I deny that, but go right ahead.

G: And you have a particular world-view, and I'm wondering if you had to balance it out, what percentage of stories do you use from the knowledge you've learned from biology versus stories form other sources in order to form your morality and your ethics?

E: That's a question that's also difficult to answer honestly because you always would look for something sounding pretty compelling because you know where the ethics rules stand. My edifice of values came very much from my parents. My father was a scientist but didn't know anything about evolution. He was a physical chemist by training and then went into the pharmaceutical industry because when he left Germany he had no other options. But my mother was an artist, a very good one, and both my parents came from musical stock. My mother's father, my grandfather, was a well known organist, and my father's music was really so powerful that my father really should have been a musician. So music became a major spiritual outlet, and I mean spiritual in the sense that everyone has part of a daily existence totally detached from science. You'll respond to feeling. You'll have scientific explanations, but you don't give a damn about them when you're feeling. So I found in music what I think is what some people find in religion which is an uplifted feeling where you want to say, "Hallelujah" and just vent this exhilaration. And I don't think I needed anything else. I mean music, science, intimate personal relations, and love of children just gave me all

I needed.

G: So if you listen to people like Joseph Campbell, for instance, who talks about the importance of mythic stories and creating our world-view–and of course he says that myths can come from anything not just religion, but one of religion's greatest contributions is that it has for so long provided these myths that we can live by. Is it offensive in any way to say that the evolutionary epic or myth serves certain purposes? Maybe music serves certain emotional needs. Since evolution was a story that you came to it later in life, was it a story that helped you make more sense of the world?

E: Sure, part of it. I think that with evolution you've got an explanation of continuity with change with very specific end products which are available for studying right now. You even have a fossil record. You have some indication of what didn't make it. And I find with physicists, I would like to have a parallel. I would like to have an explanation of why there was time before the big bang. What do they mean by the beginning?

And it's not that craving here for religious insight. I want hard facts. Maybe an explanation where the question isn't being asked to the extent that I would like to see it asked because in that case one would hear it debated all the time, and one would hear it come up all the time. I have a feeling if the physicists ever have an explanation of the slow time course of the beginnings, and they insist on this being taught in schools, they're going to be having the same problem that we're having in schools.

Evolution on top of it all, it tries to bring in a short term explanation for the last few minutes of time and, in particular, of course, the creation of humans. That's the big challenge. This obsession with having to differentiate ourselves from nature, of lifting ourselves above nature, has such calamitous effects on the misuse of nature because somehow we're always forcing ourselves as the ordering entity, and we are rightfully entitled to that by being in the image of god.

I see so many negatives to religion that my disbelief is based in part on what I consider to be the arrogance and destructive nature of the conclusions that so many derive from their religious beliefs. I mean, that's where I really break with the religious community. Don't get me wrong: I don't equate all Christians with the Christian right. There are right Christians. I wrote a recent article on one of the most religious people I've ever known, my wife's uncle who was in the opposition to Hitler in Germany in World War II. I'll give you the article before you leave. So I've met people to whom religion was not only of overwhelming personal importance, but who did great things with it.

When I mention that religion is being misused, in so much of biological explanation, in opposition to evolution, for example, I will never deny the strengths that came to Bach by virtue of religion and his edifice of religious music which to me is not religious music. But it's the music of religion. I don't know if all of this made sense.

G: Oh, sure it does. It's great.

E: But you see, I became an atheist already in Uruguay without knowing the first thing about evolution.

G: I think that says a lot, actually. It explains why so many scientists in the questionnaire basically said the same thing that the impact of evolutionary biology really didn't have much of an effect on whether they were believers or not.

E: And my family is in a very mixed state right now because my mother was Lutheran, my father was Jewish. Both of them were atheists. My sister married a Catholic. My nephew is a Jesuit with whom I get along absolutely famously. I got married in a church because my wife was religious when we got married.

G: Those are just social practices that have nothing to do with faith.

E: Yeah, and if she wanted to get married in a church, that was fine with me.

G: I'll end it with this, and that is the question of reality. Is it a quest to understand reality that drives your research?

E: It's curiosity. And if you want to equate curiosity with wanting to understand reality, then I'll concede it.

G: I would only because I'm very biased toward neurophysiology, and when you say the word "curiosity" the image that pops into my mind is something going on in your head that is common to all human beings.

E: I don't know where it comes from. I don't know to what extent it was cultivated. I'm sure that my father's influence on being a scientist was important. I don't really want to give myself credit as being an elucidator of constantly wanting to explain for the benefit of humanity how something came into being, how it works, or what might be its implication. I mean, the problems I pick are usually quite trivial. And it's amazing how far we've taken problems that really are quite trivial. I've never really discovered any rule in nature. I've discovered odd things like a beetle that clings with its feet, another one that sprays at 100 degrees Centigrade. So I'm driven by [the question], "Isn't that interesting?" And to find that I can get tenure on that basis and get paid on that basis and get government grants for 50 years, those have been the mysteries for which I need religious explanation.

G: But in terms of actually–to get metaphysical for a minute–when you make a discovery like that, you are adding to a great catalog of empirical knowledge that

people forever will be referring to as this is part of the real world. And I'm wondering if–there are some people who would say, "That's not real. That's just an illusion." There are people who debate about what reality is. But is part of the belief in naturalism, the belief that we can contribute to that catalog?

E: Ok, there are several things that I believe in. One, there's enough of a level of curiosity, even in the most–I don't want to say least educated–the places with the least recourse to school–there is that level of curiosity. So I think we are curiosity driven. We also learn from experience. You don't sit on a hot stove twice. You burn your rear once. And science is essentially the discovery of predictability in the world around us and of why something is predictable–unraveling cause and effect.

I believe that very definitely gathering empirical information is acceptable to the population at large because we base our decisions on predictability. But I also have another [belief]. When somebody becomes mystical and says that this is going to remain permanently outside of the realm of human explanation, I call this the physicists' syndrome. It's more than once that I've known older physicists who will come up with an argument where there are some things that they can't explain–like late in life when they're getting tired of physics–they all turn to the human brain, and they find that in the five years they are giving to the problem, they can't explain the human brain in full, so they decide that it's outside of the range of discovery, and they become vitalists. I saw this in Victor Weiskopff who gave a wonderful lecture at Cornell, but at the end of it, he started listing the things that would remain–he became a total vitalist. And my attitude, as a biologist, is that we haven't been smart enough so far to figure this out, but that doesn't mean it's outside of the realm of scientific explanation. What's more, it's bound to be if we ever get smart enough. And what does smart enough mean?

Well, take a look at the history of science. Science has been the field that has come into being through observation and through the extension of our sense. The extension of the senses has been a major thing. Just look at how the electromagnetic spectrum [for example]. We discovered one bit of it at a time. Somebody came along and said, "It's all the way from cosmic rays to radio waves." Every domain in between–the x-rays, the microwaves, the ultra-violet rays–were discovered indirectly by techniques that have enabled us to see to the left of ultraviolet and to the right of the infrared. We created instruments that expanded under the capacity of our senses.

And with each such expansion came the phenomenal increase in knowledge. We postulated about the existence of molecules because they were phenomena that could only be explained with particulate matter. But once the microscopes extended their vision to the infinitesimally small, there, by god, they were. By the same token, there were predictabilities made about pulsars. I mean I'm getting on very nebulous footing where I don't know the facts, but these were predictions that then led to the actual discovery. So I have tremendous faith in scientific capacity. I have much less faith in the speed with which these culturally revolutionary things can be incorporated

into the daily activity of humans and dealt with in politics and so forth.

G: The destructive elements, you mean.

E: The destructive elements and even the new. Just look at the religious barrier to stem cell research which pisses me off personally because I'm a possible beneficiary with Parkinson's. There is where I find I become very conscious of the dangerous aspects of religious power. It's misuse of religion.

G: You've stumbled onto a very good cause for why I am concerned that if scientists don't meet religion on the same level and do battle with religion, they're going to lose because scientists are the only people who can offer an equivalent kind of story for people to believe in, for young children to gravitate towards, for people to find purpose in life. I think they're the ones who need to be heralded. Right now, the theologians, as you said, would like to discount the important findings.

E: That part is disturbing. But I still remember Carl Sagan deciding that if we are really going to save this planet, we'd better get the religious forces on board, and he made this heroic effort which has resulted in a film, which I don't know if you know–I forgot the title of it–but my friend Henry Kendall was instrumental in getting it started–it was basically an interview of religious figures and asking them about the future of the planet, particularly the end of biological entities on the planet.

And it's born of the philosophy which I've had endless discussions [on] with Ed Wilson where we said, "Look, why don't we make our peace with the anti-evolutionists? Why don't we not argue with them about where they came from and whether they're evolved?"

Let's agree on one thing: [we've] got an abysmal future. And we better amalgamate our forces and see if we can save what's left. It's a very constructive attitude, and politically I adhere to that. And I think this film, which I can get you a copy of, is a good film. Some of the people [in the film] are so likeable that I sometimes say to myself, "Gee, did I really have to give up god? I'm missing out on all these people." There's a wonderful woman discussing Judaism. And the church, and New York where they have the annual blessing of the animals festivity. And I could see myself attending that. I'm missing out on a lot of fun.

G: But those aren't going to answer the questions . . .

E: My father's advice was celebrate all holidays where you get gifts. Forget the ones where you forgive your enemies or atone for your sins. This is really quite a good video.

Professor James Crow
Interviewed by Greg Graffin
June 30, 2003
Telephone interview from his office in Madison, WI

G: Greg Graffin
C: James Crow

G: Can you summarize for me one of the goals that you have when you are teaching the facts about evolution?

C: Well, my goals are really to teach as much information and as much about the subject of evolution and genetics as I can cram into them. I haven't any goals as far as what the students' attitudes should be after finishing the course. I try to reflect an interest in the subject itself and in the research that's going on in that area.

G: For stimulating them in that sense?

C: To make it seem as if evolution is an actively studied field. Not something that's dead.

G: I see. But the information, the knowledge that you hope that they carry with them, is that something different from the knowledge that you would expect? Let's say the uses of knowledge that you would expect from a professional working in the field?

C: No, I don't see much difference. I haven't placed great emphasis on practical aspects any more than they naturally come up or on what attitudes towards these would be. I've usually stayed pretty close to the subject.

G: Right.

C: But with a large number of illustrious examples.

G: Speaking philosophically, what do you think the use for evolutionary biology knowledge is?

C: Well, I think anything that will help us understand our own origins is helpful, and I think it brings a perspective to much of our life. In particular, I think it brings a perspective to medicine. I think an understanding of our own evolution as an explanation for certain kinds of diseases is well worth knowing. And I have stressed that in my courses when I've taught them. Evolution is such an overwhelming subject that I can't help but think it has a big impact on students' thinking about everything

else, too. Everything has a history, and evolution brings that out.

G: You call it overwhelming. Can you say some more about that?

C: Well, it's certainly one of the great generalizations that science has to offer. By now most of the literate world takes it for granted, but what a shock this must have been when Darwin first proposed it. And what a shock it is to many people still.

G: Do you spend time in your classes talking about that aspect, the shock?

C: Yes, I do say something about that. Now, I don't usually emphasize this much in the course, but once in a while I mention that this certainly was the death knell for the argument from design.

G: Isn't that funny how we would all expect the coffin to have been buried long since, but it's actually still on the surface.

C: It's still very much alive. My experience with students is quite different from what Will Provine has reported. Of course, he makes a particular effort to ask what the students' views of evolution and religion are. I have ordinarily, in my course taken evolution for granted. And I haven't raised any questions about any doubts. I have had one or two students–one I remember specifically–who said that although she would learn the material in this course, and she found it interesting, she wanted me to know that she didn't really believe it. That she would nonetheless answer the questions correctly. And she was a good student. That's only happened once or twice. And I have hardly ever faced any skepticism on the part of students, so I don't know whether I'm different, or whether Wisconsin and Cornell are different.

G: Well, Wisconsin's much bigger–you have a much larger body of students.

C: The other thing I should say is that most of the students in my class are science majors.

G: Yeah, that's another one. That's huge. You brought up a very interesting point. The issue of belief. In general, I'm interested in your opinion on whether this student who says, "I don't really believe any of this, but I think I can get a good grade in the course. I can do this without belief." What do you feel about biology–evolutionary biology and belief? Do you have to believe in the implications in order to be a good evolutionary biologist?

C: I think you could be a good technical evolutionary biologist and have philosophical beliefs of almost any sort. It's small details and mechanical. I think one could be a

good researcher and not give much thought to the broader philosophical issues. That's not satisfying to me, however.

G: Right.

C: My own views are atheistic.

G: But how does that correspond with your ideas about the importance of evolutionary biology knowledge?

C: Well, I suspect that a study of evolution for some people destroys their religion or makes it hard, especially if they had strict old testament beliefs. Actually, although these are good questions and I've thought about them, they're not the kind of thing that have ordinarily arisen in my classes. I can't say much from the stand point of experience. The students in my class either share my philosophical views or they don't say anything about it. And it doesn't come up. I haven't really tried to parade my views either besides through the subject matter.

G: Is that because you don't want controversy or because you don't want the melding of those implications with the more practical aspects that you were talking about?

C: I don't think I would say that it's just for reasons of avoiding controversy. But just the way I teach evolution, I insist they take it for granted, and I haven't even bothered offering the classical evidence for evolution. Most of the students who I encounter already have had biology courses, and they've encountered the traditional arguments for evolution. And most of them I assume–but I don't have many such discussions of this–most of the students, I assume, have already come to grips with what their own views are. I have had students in class say that they did not find evolution incompatible with their religious view. But their religious view is a pretty liberal one which doesn't seriously conflict with the Old Testament. And I have sometimes said, more often in private discussions with students than in class, that I find it impossible to distinguish between a universe which is purposeless and a universe made by a creator which makes it look purposeless for us. And I can't answer that question.

G: So the deist god is not much of a god.

C: Well, it's my own private views which I don't parade. But if a deity isn't capable of doing more than that, it isn't really my idea of a deity. There's a great statement by Hume, I believe it is, that a deity has to be all-wise and all-powerful and something else, and if he doesn't have those few properties why call him a deity? But these are more my private discussions with you than anything that I ordinarily have with students. Needless to say, with hundreds of students I have all sorts of conversations,

and once in a while they hint at that type of subject. But as far as the classroom is concerned, it doesn't really come up.

I've had some good times with Will Provine, who has, as you undoubtably know, some strong opinions. And I think in general I tend to agree with him. I'd find it hard if I were religious. [However], I'm not sure that there isn't some intellectual ground that permits a person to have some sort of a belief in a deity and yet accept evolution and all of science.

G: One of the most interesting thinkers on the topic that I've come across is George C. Williams, who has a position called anti-theism, which I'm having a hard time categorizing, but it's potentially a deist position. He just assumes that whatever is responsible for that creation out there, we should call god. And it's kind of a null–it's almost a nondescript way of allowing people to believe in god, but it's essentially a deist position.

C: I think other people besides Williams have had similar views. They can stand in awe of the wonder of the universe and if you think of that as a religious experience it's all right with me, but it's not my take on it.

G: Switching gears, what about the idea of evolutionary biology as sort of religion itself in that it satisfies most of the basic things that traditional canonical religion satisfies for people who are brought up in a complete absence of traditional religion, which is more and more common these days?

C: Julian Huxley had ideas at least something like that.

G: Religion without revelation.

C: And I know that a number of people [who] were taught religion in their childhood. When they gave it up, they had to have something else substitute for it. For me, I've never had that urge although I grew up in a religious family. And I don't remember when I actually gave it up. It was gradually. But I've never felt the need for a secular religion.

G: Was there a moment that you remember or a particular book or an important discovery that you made at a young age that precipitated your giving up religion?

C: No, it didn't happen with one event.

G: Was there anything particularly that stimulated you to study biology for the rest of your life?

C: Well, I just liked science and liked biology especially well. And genetics especially well among biology. I went into it out of just liking the subject. And not for philosophical reasons. But I can't remember when I didn't accept evolution. It was just I can't remember not ever doing it. As soon as I heard of evolution it seemed reasonable. And that goes way back into grade school and high school. But I never thought about it much, one way or the other, with respect to religion. And then my religious, or non-religious views, just gradually grew in high school and college.

G: Just out of curiosity, were you raised in the Midwest?

C: The Midwest and in a Quaker family. So if I were going to be religious . . .

G: That's the place to do it.

C: Actually, Midwest Quakers are sort of a curious mixture of George Fox and Puritan Quakerism and Southern Baptists.

G: So the world-view that you have constructed for yourself, presumably the one that you would share with your relatives and loved ones if they came to you asking questions for advice, how much of that do you think you formed from evolution?

C: Well, it played a role. I think I would have come to the same views anyhow. I think the strongest argument to me all along has been why should I believe in a god that permits as much unhappiness and sin and is still supposed to be all powerful?

G: And do you think you can see that in nature?

C: I suppose it is to some extent. But also just the depravity and unhappiness is a good share of humanity.

G: I think it is readily apparent in humanity because we can empathize with it. But do you think that some of our value judgments might be reinforced by what evolution teaches us?

C: Well, that's certainly true later in life when I started studying evolution. But I think in the early phases when I was really deciding what my views on religion were, it really had to do with human experience. I've been aware that evolution is far from a perfect process. And that's part of what makes in fascinating.

G: I agree. So in what sense do you think that ethics and morals should be–or are they–decoupled from an evolutionary perspective?

C: To me, they're decoupled. I did read and had some sympathy for Julian Huxley when he was saying we should try to derive a system of ethics from evolution, but the more I think about it, the less satisfied I am with that. I don't want to drift into the position of saying what is, is good. I think our ethical principles really have to come from outside science. What science can do, however, is tell us what happens if we follow different ethical explanations. And I think that's the big role of science.

G: Is that social science.

C: Social science and biological science and all kinds of science. I also think that our human nature is a product of evolution and that's part of my interest in trying to study–I'm interested in what evolution can teach us about human nature. And it's going to teach things that we're uncomfortable with, and that doesn't mean we should perpetuate them. It's society's business to take us as we are and make us into a coherent, amicable group.

G: So you're suggesting that the people who have to craft a civil society should be very well informed?

C: I think so. Yes. We have all sorts of human tendencies that are undoubtedly a result of our evolutionary past. And the better society understands those, the better society we can construct.

G: Which is interesting in the sense that a traditional theological view would be–in the sense that evolution and religion are at odds with one another–we would probably have a much different social construction if it were dominated by theology.

C: I suspect that's true. I think my ethics, my personal ethics, arose partly because of my Quaker background. I don't doubt that. But I forgot what I was going to say.

G: You maybe bristled at the notion of evolution and religion being at odds.

C: I think they are at odds to a large extent.

G: And particularly if we are to have a body of respected leaders who are going to craft our civilized society. The degree to which theology rejects evolution I think could have quite a strong deleterious effect on what you're saying.

C: Yes, I think so, too. I think those theologies that reject evolution are making a mistake. Well, take the kind of example that would come up. If our evolutionary studies tell us that males are naturally promiscuous and want to have a monogamous society, that's a societal decision. But knowing, if this is true, the fact that men were

promiscuous would tell you more about how to deal with it than not knowing that.

G: I'm interested also in evolution as an important narrative, but a narrative that is based on verifiability and one that's based on truth in a sense.

C: Truth with a small "t."

G: Right. But as a mythological epic in the same sense that other mythologies have served to form a world-view for other civilizations. In that respect, again, thinking of it as a mythology of verifiability, a theologian might say that if science can't explain something, we can ascribe it to the work of god, but a population geneticist of gene frequencies might say if we can't explain it, we can ascribe it to the work of genetic drift. Now in what way are these dissimilar?

C: Now, one of the reasons I don't like to call evolution a religion is that it doesn't have any mythological aspects. It doesn't have any revealed truths. It has only what in principle is verifiable. I realize a lot of evolution so far has not been verifiable, but it's not because we don't try and not because the methodology doesn't lend itself to try to do that.

G: I want to clarify. I agree with you that I have a hard time calling it myth, but I don't want it to be merely semantic to call it mythology. To me, evolution is basically a story that is told by people who are looked at as authorities in some way, and the only difference is that this mythology differs from the mythologies of Greece or whatever in that this is based on a Popperian methodology of verifiability and empiricism. So even if you don't allow for that construction, I'm interested in how they differ from the theological explanations of things that we can really never verify. The reason I bring up genetic drift is just because of the way it's characterized in most of the modern textbooks of evolution. The idea that selection is differential reproductive success that happens for a reason whereas genetic drift is differential reproductive success that just happens.

C: To me that's more or less equivalent to the definition of random in physics or biology. And my feeling about random is that it has causes, I'm sure. I'm sure if we had enough physics and chemistry, we could predict genetic drift. I don't expect it to happen. But I meant in principle. So to me, random usually means that the causes are too complicated to fathom. I could say the same thing about some religious views, too.

G: Right, a theologian would probably say that about god. It's just too complicated for science to ever understand.

C: And as a scientist, I don't ordinarily try to understand it, I don't expect to be able to.

I have some sympathy for the view that E.O. Wilson talks about with *Consilience*. That although science can't account for all of the world, it accounts for an increasing amount every year. And whether you regard it still as a very tiny amount or as rather large amount, I think, is a matter of how one views the universe. But I do think that society is a subject that is increasing all along, and I've been interested in the fact that philosophy, which used to encompass everything, still does it in some ways, but more and more of what used to be called philosophy is now called science.

G: Yes, definitely. In fact, you would have been a philosopher in the early days of the enlightenment.

C: That's right. I might have been happy during the enlightenment. The idea of consilience of all sorts of knowledge is an appealing idea today.

G: Nowadays, you have to have a niche. Right?

C: That's right. It's hard to be a generalist now. One of the things, before you go on, about myself–and I expect [the same thing is true of] most of the other people that you talked to–99% of my life has got to do with minutia, you might say. That is, I don't stop to think about broad philosophical, religious, those kinds of questions. I simply attend to the day to day business of the research problem. And well, I heard, to go on a little bit, I heard J. B. S. Haldane say one time that he practiced much better science since he was a Marxist. But you know, I've read a lot of Haldane's papers, and I can't see whether being a Marxist made any difference. Two and two is still four whatever your views are. And I have the same view about people who may claim that they get some religious associations with their scientific studies. To me, they're rather separate worlds.

G: But how suitable is evolutionary biology for someone–picture someone like me. I was raised without any religion whatsoever, but when I started studying evolution, the world made more sense. And it certainly gave me a theoretical foundation to go out and do my field work. The field work is really what made the world start to make sense to me. But without the evolutionary biology theoretical framework, that natural world wouldn't have made much sense to me.

C: I totally agree, and it's the same thing for me. I think nature study is no better than stamp collecting if you don't have an overall view of some sort.

G: In that sense, do you think that evolutionary biology is suitable as a replacement?

C: Well, my father was a Quaker and an evolutionist and religious. And he didn't find anything incompatible between them. He thought it was possible to have a belief in the

supernatural and still believe in evolution. We never had too much discussion about this because we sort of agreed to disagree about it. And I've [not] been sympathetic with that view in recent years at least.

G: Did he have a copy of William Paley?

C: I don't know. When I was talking to my father, I didn't know who William Paley was.

G: What does it mean to you when people refer to you as a naturalist?

C: I think of a naturalist [as one] who has much more day to day knowledge of nature than I have. I'm pretty much an armchair or desktop biologist rather than a field biologist. So a naturalist to me is someone who actually goes out into the field.

G: And what about naturalism as a philosophical position–the position that nature, however we define it, can be understood by scientific principles, and that that's all that exists out there as opposed to a theistic view or spiritualism?

C: Well, I want to be careful not to say that I think that that is all that there is. Something like music. I don't know how to analyze that scientifically. I can certainly construct chords and do mathematics in music, but that seems to be pretty far from the essence of it. Or poetry. So these are realms that, at least for the moment, are outside the realm of science. And yet, I don't want to say they are unreal. My intellectual life and my deep beliefs are based on science, but I spent a lot of time listening to records and playing music, and I can't claim that I have a scientific reason for doing that. It's purely emotion. I guess I should go back to something else. Among the philosophers–I'm not a very deep philosopher of knowledge–but among the philosophers that I read a lot, I've always liked Hume. And I thought he gave the right answer to Huxley's view to trying to derive an ethic from evolution. Crudely speaking, he said that most of the thinking that we do is to justify what we've already decided to do for emotional reasons.

G: I think that was way ahead of its time.

C: I think it was, too.

G: If neurobiology continues explaining the emotional component in behavior then the answer will be had.

C: I'm fully confident as a biologist that we'll have as deep an understanding of emotions in the future, maybe now not far, as we do of behavior, or intellect, or other

aspects that seem to be more capable of scientific study.

G: Maybe, we can explain your emotional connection with music in the not too distant future.

C: I wouldn't be surprised. And I'm aware, as you are too probably, of the very high correlation between people who like science, particularly people who do mathematics, and people who also do music. And as a amateur performing musician, I realize that there are things where an ability in mathematics and an ability in music are not uncorrelated. For example, the ability to keep time without measures and to do complicated rhythms. That's partly mathematical. And pitch discrimination is too.

G: And construct chords. That's interesting pitch discrimination. Being able to hit a note is never looked at as a form of intelligence. But I think it should be in a sense. Although that might be harsh, too. I mean some people can do it, and some people can't.

C: Well, that comes awfully close to [occurring] in all the non-trained. In my experience at least. There are people who if you say, "A flat" can just do it. And others, such as me, for which it is totally foreign. You'd have to tell me "G first," and then . . . . We're getting away from it, but there's a woman here in our psychology department that studies pitch discrimination in infants. She finds that very young infants when they first begin to hear things, what sense of pitch they have is absolute. Then as they grow up it becomes relative for most people.

G: You could easily construct an evolutionary "just so" story about that as well.

C: I can. The ability to distinguish between men's voices and women's voices is a very important thing for an infant. And it's a "just so" story, but "just so" stories are all right with me because 90% of the time they're correct. I'm impatient with people who disparage "just so" stories. It seems to me that much of what we know in biology really is a "just so" story, and you reason that a stomach is there to digest and by golly, you're correct. And the lead that we get toward mechanistic understanding from a "just so" approach–maybe that's not the way other people would think about it–but to me I just didn't like complaining about "just so" stories.

G: But even though it is a little off the topic, the idea of pitch discrimination being all or nothing, there's not a lot of variation if it is controlled by a gene or a suite of genes.

C: I bet it turns out to be a suite of genes. But so far as I know, it isn't known. There are people who identify pitches with colors. And it's interesting to me that in our hearing sense, pitch is a continuous variable. On the other hand, in science we have

colors, red, green and so on, and those are part of a continuum, too. It's just that our understanding of it compartmentalizes them.

G: Why are minor chords sad?

C: I don't know. That's interesting. They are though. Now whether we're taught that, or whether we're hard wired is for the future to decide.

G: And what possible evolutionary "just so" story would be very interesting. To think of Cro-Magnon or *Homo erectus* having any concept of major or minor is ridiculous.

C: Well, if I were going to become an anti-evolutionist–if I want to make arguments against evolution–the existence of someone like Mozart or someone like Romanujan, these complete outlying people, are hard to explain by any hypotheses, evolutionary or otherwise.

G: Yeah, but you just gave me a really good idea. If somebody wanted to discount evolutionary explanations, and that is just what we touched on. What possible evolutionary explanation could you give for minor chords being sad? And yet, it's cross cultural. You could go to southeast Asia although some of that music is so discordant–they use a different scale of course. Certainly throughout Europe, which is probably most of the music we think of anyways, across the board they will say that's a sad song.

C: I'm trying to think of what the Japanese do, but I realized that Japanese music now has a strong influence. But I was interested in how Stephen Foster was so popular among the Japanese when I was visiting there.

G: Yeah, that's definitely based on an adoption of Western culture, I think. Last question, I'm interested in your opinion on this: how important is it that evolutionary biologists agree on the implications of evolutionary theory?

C: I don't think it's very important because there's a lot of disagreement in the evolutionary world just about different theories. In fact, debating whether Steve Gould is a fool or a fate or a genius. And how important group selection is, and whether, and Gould seems to think, whether you have to have a different set of rules for macro evolution than you do for micro, which I don't think myself. So I think in some branches of science, it's been possible to produce a set of definitions and stay with them because physicists certainly use force and acceleration in a very precise way, and I agree. But I don't see very much agreement among biologists. I think maybe it's in the nature of the subject rather in the nature of biologists.

I have a friend who is–I don't really know what his views are–but he just

doesn't think that natural selection is sufficient. And he is constantly asking me–he's a physical chemist himself. He's constantly asking me for definitions, and then he'll mess with these definitions for a while and then realize that they're consistent or they're not very good or we can find exceptions.

G: So you don't think that for education purposes it's necessary for evolutionary biologists to have a consensus of opinion?

C: Certainly not a detailed one. I guess a broad consensus, or a general belief in natural selection. I think we have that anyhow probably.

Professor John T. Bonner
Interviewed by Greg Graffin
July 1, 2003
Phone interview from his home in Nova Scotia

G: Greg Graffin
B: John T. Bonner

G: In the preface of *First Signals*, you had originally written a large section on philosophy but then decided to discard it. Can you tell me why?

B: I'll tell you why. I sent it to my good friend Evelyn Fox Keller who is a philosopher as well as a historian as well as a biologist as well as a mathematician. And her comment was either cut it out or make it much longer. So I took the easy way out. She didn't disagree with any of it. But I realized after, since then, and particularly reading some of her stuff, and her latest book, which is a lot on explanation, that what she was telling me was if you're going to go into the subject you ought to do it the way I do: completely in depth, and thoroughly, and not just hit a few points.

G: What I find most interesting about it is the fact that in your writing mode, you felt it necessary that these philosophical issues should be raised, or at least are implicit. In what sense can biology proceed without addressing philosophical issues?

B: Well, of course it [proceeds without addressing philosophical issues] most of the time. [When] you don't ask more of the facts than the conclusions that come from those facts. But there are so many philosophical ways of looking at [biological problems]. I think the biologists in general exclude philosophy. I do myself, actually, as you just pointed out. But it's silly to think that your method of [studying] a subject [can ignore philosophy entirely]. But the idea that you can do [philosophy] and experimental work at the same time, is simply not possible.

G: So is it because of a self-imposed restriction then that they simply don't go into? Or you would rather not go into those things.

B: There are two reasons why I don't go into it. One is that they would interfere with my main message, and my main message being one that is purely biological. And two, I'm not terribly interested in the philosophical aspects, and when I dabble I get my fingers slapped by someone who really does it properly.

G: Obviously, part of what is an issue in a discussion of evolution and religion is just what you touched on, and that is how much of this information, biological knowledge,

impacts on some of the philosophical underpinnings of religion? And if we are to interpret, if we are to carry biological knowledge to its limit, well then there's almost complete overlap with so many tenets of religion. To me, it's very interesting about scientists who are not interested really in carrying these implications.

B: Yes, let's put it this way–I always love a quote which I won't give accurately. I'll paraphrase it from Isaiah Berlin who was interviewed by a journalist [who asked] was he a philosopher? And he answered, "No." He decided quite early that he wanted to be a historian and not a philosopher, and you know the quote. He said that philosophy never gets you anywhere. I guess I feel very much along the same lines. In other words, that I'm not saying that the problems raised by the philosophy of science aren't important and interesting, and that I'm glad that somebody's doing it. It's just not me. I just don't want to do it. I would prefer to stick with biology or history or something of that sort.

G: Right, and in the sense of biology for you, is it specifically because you are problem solving? Is that what differentiates it from well, you say, not getting anywhere?

B: Well, yes, I think that's true probably, and I guess it's a matter of taste. What is it that you are really interested in doing, solving, thinking about, discussing, and those things are always for me within the borders of what you would call empirical science. Or maybe you can get a better expression than that.

G: No, I think that's as good as any. Shifting gears, but sort of staying on the same highway here: is it a quest to understand reality that drives your work? Or do you not like that word?

B: No, I think it is. In other words, I find myself very much sort of old-fashioned about the idea that there are basic biological truths, some of them which are hidden, and one has to kind of think of clever ways of revealing them. And so I think–in other words, I'm in no sense a revisionist, a reconstructionist, or anything of that sort.

G: I do find that interesting. The idea of underlying truths that need to be revealed because that's kind of where philosophy, at least for me, goes astray. There's really no experimental procedure or anything other than consensus to get at philosophical truths.

B: When I was a student, I got very interested in J. H. Wodger, and I don't know if you are familiar with him, but he was a philosopher who wanted symbolic logic to make sense out of biology. And I found it quite fascinating actually. And so, part of my senior thesis, with the help of a friend, was trying to analyze development from a Wodgerian point of view using symbolic logic. And what happened was that as I went on into graduate work and thought about it. I decided that it was fun, but it didn't tell

me anything about development that was particularly interesting.

G: And was that the time that you switched to doing experimental development?

B: No, no. My senior thesis was primarily experimental, and I continued the experiments right on through, except for a small hiatus in the air force during the Second World War. But even there I worked in the aeromedical lab and did physiological experiments. But not as interesting as developmental ones.

G: And then did you go to Harvard after that?

B: Yes, you see I actually got all three degrees at Harvard, and so I did one year of graduate work when I went into the air force and to the aeromedical lab in Dayton, Ohio, and then came back for about a little over a year and finished my thesis.

G: And just for the record, who was that under?

B: It was under William H. Weston. And I don't know if you have looked at my *Lives of a Biologist*.

G: No.

B: Well, I did write sort of an autobiography and history of biology in the 20th century, and so I describe all those things which I just mentioned.

G: I'm sorry–oversight on my part. That's definitely interesting and relevant. I'll have to get a copy of it. It's hard when someone like yourself has written so many books to do the research for an interview.

B: The thing is, in that [book], I talk about that senior thesis. And so I may also mention Isaiah Berlin. I'm not sure about the latter, but I mention it somewhere.

G: You might also mention this in your book, but I'm curious to know: was there a single moment or a single book or professor that really helped you or helped catalyze your world-view when it comes to evolution and religion? Your rejection of religion and your desire to study biology, did they go hand in hand?

B: Well, I can answer that because I haven't actually written that up, and the way it went was this way. When I was about 13, I got interested in biology, and my father gave me–because he was worried that I was just paying attention to birds–he thought that was no way to make a living. So he gave me what was then a recent book called *the Science of Life* by H. G. Wells, Julian Huxley, and G. P. Wells. And that is what

decided me. I mean right from that early age, I had my core set. I wanted to be a biologist. And I was in school in Switzerland at the time at a boarding school, and I got tremendously involved with something called the Oxford Movement. Does that mean anything to you? It's long since past. Sometimes it's called Buckminites. And it's a kind of, it's a form of Christianity which has a Quaker-like quality to it where you sit around and people spontaneously talk and so forth. You have these group meetings. And so I got tremendously fired up about religion for about two years, I'd say. But then the reason that I decided one day that I really didn't want any religion at all at that age–well I was maybe 14 by this time–and the reason, my argument was, I'm embarrassed to even say this, my argument was that birds–sparrows outside my window seem to be having a perfectly fine existence and are managing tremendously well, and all the other things in nature. But for some reason, again, birds were on my mind, and I thought they can do that without god, and so that's what made me decide that religion was not for me, but I really felt as though from that moment on, I really did not believe in god.

G: Yeah, that's not embarrassing at all. I think that's a very rational way of looking at the world. And it's also good evidence as to how a teenager or young person forms their world-view.

B: And from that moment on I never turned back. I think it had something to do to with reading a novel. I'm not sure when, but I got tremendously in favor of Aldus Huxley and H. G. Wells' books, which clearly had characters who were atheists. But I think that really came afterwards. In other words, I find myself saying, "Hey, I'm not alone in this."

G: That helped solidify your position. Part of what I'm not going to be able to establish in my dissertation, but what I hope to write about after my dissertation, is this idea that a lot of these belief systems are either rejected or supported based on our view of naturalism. And it sounds like to me if it wasn't for your observations of birds and of nature in general, you might not have ever stumbled upon that idea.

B: Well, I think maybe you're right. Of course, it's hard to be certain that many years ago. But I have a feeling that's essentially correct.

G: What does it mean to you this word naturalism? Do people call you or do you call yourself a naturalist?

B: Well, yes I do to some extent. Yes. But I think of it in the broadest sense of someone who is interested in nature, and living nature especially. So I think of myself as someone–even my work on slime molds–I like to think of it that I don't just look at it from the point of view of development or molecular biology at all, but rather than

how they fit in the whole web of nature, as it were.

G: So it's more a life history of slime molds instead of just an experiment.

B: Yes.

G: The idea of naturalist. Now when you hear the two words naturalist or naturalism, do you think of them as separate ideas?

B: Well, it's interesting because naturalist means someone like myself, but naturalism–I always have the suspicion that this has all sorts of meanings that I don't know about because it's just the "ism" that makes me suspicious. And so, I not only feel that I don't know anything about it, but I really don't feel as though I want to pursue it.

G: It's one of those philosophical things that might lead us astray.

B: Right.

G: No, I don't blame you. It can get confusing. To what degree do you believe that mathematical modeling of development is a depiction of reality? We were talking about reality before. You mentioned the mathematical use of equations to describe development. Or then in the conclusion you call it fantasy land. But I'm wondering is that reality or is that, as you mentioned, a guide for us to explore experimental pathways?

B: I guess I find mathematics in developmental biology very interesting from two points of view. One is that it can often suggest where you should look. In other words it says this is the simplest way you could explain this, and then you set that to one side in your experiments–you could try to see whether or not this is what really happens. In that sense, it isn't reality, but it's a good way of nudging your imagination. And the other things is–and that's the kind of modeling I'm the most interested in really–the other kind of developmental modeling is to try and get a model which gets more and more complicated to fit all of the detailed facts of a developmental process, and I find that less interesting. Furthermore, my feeling about it is that it sort of clutters things up, and you might as well keep on looking for empirical information rather than getting a more and more complicated set of equations which will describe all the little blips that actually occur during development. So I think that I'm definitely in favor of the first kind and definitely not interested in the second, though I'm always willing to be surprised.

G: I can't speak for developmental or molecular genetics or anything I'm not expert

on, but certainly I studied a lot of ecology, and behavioral ecology at that, and it seems some of my contemporary students, my friends, loved the mathematical modeling that went on because they thought that that was nature itself. So it's really interesting this idea that mathematical models could be used just as a guide.

B: Yes.

G: And yet, aren't there some biologists who make their living only doing the mathematical?

B: There are indeed, and it's really gotten to be quite a severe problem I think. And I'll tell you how I feel about all of this. I had–when you read *Lives of a Biologist*–I had a dear friend for some time, and that's Robert MacArthur, and he of course you know, is really the pioneer in using math to simplify complex ecological problems. He would say to me, "Now my model gives helpful insight into what might be going on but," he said, "I don't think there's any permanence to it because when we know more about what's going on, it may be stimulated by my model, we'll have to change the model and look at it in a fresh way." So again, he thought of it as a way to guide what you're looking at.

G: I think that must have had an effect on me not because I had any direct connection with the man, but one of his students, Martin Cody, was an important teacher for me at UCLA.

B: Oh yes, I know Martin Cody.

G: And he taught a course that was very important to me that was a field biology quarter where we would spend the entire quarter semester in the field. We went to Central Mexico. He basically let you loose for the first week. We were there for 5 weeks. And you were just supposed to come up with a project, and I chose something I knew nothing about, which was *Atta* ants. And I ended up doing quite a good project on leaf cutters. But that interaction with him is what first got me thinking about these issues of modeling. It's very uplifting to hear you say that about MacArthur because it's true that I never looked at a model as something that was concrete. But to that degree then, I'm also in this current project, very interested in the idea of faith and belief among scientists. What does that say about our faith or belief in these models? I should probably try to refine it. If we agree that the models guide the direction of our empirical research, does that entail belief?

B: I would say, without really thinking about it, that the belief part goes in thinking that the empirical things are solid. Facts are facts. You just look at it in the most simple minded way, and the only faith in the modeling from MacArthur's point of

view and certainly from mine too is it's just a tool. And it's sometimes a very useful tool because I was with Robert during this time, and his work was suddenly getting widespread attention, and I remember meeting ecologists who were just furious with him. And the reason that they were furious was that they said that the glory of ecology was how complicated everything was. And the idea that you could make it simpler by using mathematics was just ridiculous. And of course, that's exactly what not only did MacArthur do, but he really started a whole movement. And even Hutchinson should get a tremendous amount of credit for it as well. And so, it is really always fascinating to me that for a long time traditional ecologists thought it was wrong to do what MacArthur was doing.

G: I think you touched on something that maybe can simplify the idea of naturalism. The way I look at it, even though it is an "ism," is that when you mentioned this faith in facts, to me that is the simplest possible way to describe what naturalism is. It is a belief system that is founded on verifiability. And that's why it is distinguished from theism or deism or these other belief systems that are founded on belief that is not verifiable or testable. So anyway, that's just the way I make sense of it.

A couple more questions if you don't mind. As far as your own personal world-view is concerned, how much of that do you think was created by evolution? One related question to that is: do you think morality is a topic that is decoupled entirely from evolutionary biology?

B: Well, I just sort of think of it as an interesting appendage. And I have that feeling because of some of the interesting things that have been done with primates and questions of whether or not their behavior is ethical. And other animals as well. There are some fascinating chimpanzee experiments where you show that chimpanzees are capable of selfish and unethical behavior by hiding the bananas, and so forth, from the other chimpanzees. And so, I always feel that's very interesting, and it's interesting to know to what extent that is socially induced or created or whether or not there is some sort of genetic basis or both. So those questions are interesting, but I don't feel that they are central. So that's why I refer to it as an appendage.

G: In your own personal evolutionary world-view, is your ethical position reinforced by your views on evolution.

B: No. It's totally separate. In other words, if someone talks about ethical problems related to animals, and maybe with human parallels, I find it interesting, but it has nothing to do with my basic thoughts about evolution or for that matter . . . well, maybe animal behavior, yes. But again, not evolution. Mind you, I'm not saying I'm doing the right thing. But that's the way it is.

G: I appreciate it as an opinion. How important is it that evolutionary biologists agree

on the implications of evolutionary theory?

B: Now, when you say implications . . .

G: Let's say social or . . .

B: That's the word. I guess that . . . let me put it this way. Basically, the old business of social Darwinism and the idea that in modern times, the idea that human behavior can be explained in terms of natural selection and so forth. And they call it something psychology . . .

G: Evolutionary.

B: Evolutionary psychology. I find myself somewhat standoffish about it because I feel as though that often, and certainly in the beginning of social Darwinism, that the analogy was so overdrawn that it was probably untrue most of the time. I can see the temptation of trying to extend evolutionary ideas to human behavior because certainly, we do successfully apply it to behavior in animals, but I think that my problem with it is that it gets off into conjecture. It's a little bit like my feeling with cosmology. I'm sure it's very interesting, but it's always one guess succeeds another. And I really would like to have it more solid than it is. You know, I always feel this way about Freud. I always thought Freud had the most wonderful ideas, and he opened up all sorts of things just with his ideas. Nowadays, we don't think very many of them are true anymore. But still, he managed to make people look at things in a different way. But I sort of feel that evolutionary psychology today is not doing that. It's just sort of . . . well how should I put it? It's just sort of nibbling at ideas, but not coming up with any terrific new ideas.

G: So in its current state, it's not fruitful as it's claiming to be?

B: Yeah, I would definitely say that.

G: But evolutionary psychology is also attempting to address an issue of enormous complexity, and that is culture, consciousness, all these hugely complex systems. So, could it be seen as a blueprint in the sense that mathematical modeling of development is also a guide to future work?

B: Well, I'm more pessimistic. In other words, I just feel as though it's a lot of guess work, and I don't really know how you can pin it down except by making more guesswork.

G: Is this–aside from those disciplines you mentioned–your view also of the last

chapter of sociobiology? When the leap is made to apply these things to humans, apply these principles or applications that we have so successfully used on animals. Because you mention evolutionary psychology which was an outgrowth of sociobiology.

B: Yeah, that's right, it comes directly really from Ed Wilson's initial ideas.

G: So I guess I'm wondering if that was fruitless or if you were as pessimistic about that as you were about evolutionary psychology?

B: I think all of it, including evolutionary psychology, is interesting, but I'm not convinced that it is a step towards anything. Now let me go back to Freud again. Most of Freud's ideas are not considered "it" today; nevertheless, he stimulated people to think about it. He had tremendously imaginative ideas. I think Ed Wilson initially was a little bit in the same category although I think Conrad Lorenz and Tinbergen were much more so. I think they were the ones who really had some novel ideas about animal behavior that were tremendously stimulating and, actually, in their case, have stood the test of time pretty well. But when I look at evolutionary psychology by itself I don't see what comes next.

G: Do you think it's because of Tinbergen and Conrad Lorenz' work that these theories have stood the test of time?

B: I think so. I really do. I hadn't though about it that way. But I think it's absolutely on.

G: Finally, I'd like to conclude with a question that I've asked everyone. It's not meant to be off the cuff. What is the use for evolutionary biology knowledge? What are we to use this knowledge for as a society?

B: Well, I would say–it is terrible. I'm talking now, I'm shooting form the hip. I would say it has absolutely no use at all. But I'll tell you what, and that is I can remember with some of the fellow scientists at the aeromedical lab at Dayton, Ohio during the Second World War sitting around the table one day at lunch, and one of the guys said–we were talking about Louis Pasteur–and he said, "There's not any important scientific discovery or idea that doesn't have a use." And I said, "Well, I can think of one. And that's natural selection." It operates without being able to sell a product or anything else. And I'm sure you could make all sorts of arguments that say, well, resistence to antibiotics and so forth and so on. But I think basically the idea of natural selection, of Darwinism. What it's done, it seems to me, is influence a very important field of knowledge in a very important way, but I don't think of it as being of any use. But that's probably because I haven't thought about it at all.

G: That's possible. The only reason I bring it up is because [of] one of the branches of philosophy that's called axiology, and, you know, it's one of those areas of questions that philosophers ask "what do we use this knowledge for?" You are probably well aware of this, but the three basic areas of this that I've studied in my elementary way are ontology or metaphysics, meaning the questions of what exists. Then there is epistemology, which is how do we know it exists? And there's axiology, which is what do we do with it now that we know it? And that's very interesting to me in terms of evolutionary biology because most evolutionary biologists agree on the first two. But it's that third one–what do we do with this knowledge?–that I find the most diversity of opinion.

B: I guess, in thinking now, a few seconds later, I would say that maybe the use has to be to understand how the world evolved, in other words, understand the mechanisms of evolution and that has implications for our knowledge, but it doesn't have any use other than it has simply altered our way of thinking about things.

G: Right, and the idea of using it for social programs is thoroughly offensive to many particularly like yourself, those who were in the war and saw some of the fallout from early ideas of eugenics and what not.

B: Yes.

G: I just wanted to know if you think there is anything about your research that you've done that might be considered offensive by people, or controversial, especially as it might affect a religious person.

B: I think not on religion. I know that when I wrote that book on the evolution of culture in animals, that anthropologists were furious. Some were tremendously supportive, but the furious ones, their claim was that the word culture was their word, and that it only applies to man, and sort of "get out of my territory." So that was kind of a silly argument. And the reason that I think that–I always think: what could be offensive about my working with slime molds? I do terrible things to them, and I realized that I can torture slime molds and not feel guilty about it, nor does anybody else feel guilty about it. I cut them up and do all sorts of things like that. And so, maybe I've spent my life trying to do something that won't offend any particular group.

And as far as religion, I just don't think I have [done anything offensive]. I can remember–this is a silly anecdote. Years ago, I had [given] strict instructions [to] my oldest son, who was 12, that when Jehovah's witnesses came, be polite to them but don't buy the *Watchtower*. It cost a dime. And so, one came when I wasn't there, and Jonathan was there. I came home and there was a *Watchtower* sitting there. And I said, "Jonathan, I told you not to do that." And he said, "Well, the man said there was

something about you in it." So I thought it was worth a dime. And it said that evolutionist Bonner agrees that there are unsolved problems in the evolution of invertebrates, and I forget the exact phrase, but they made it sound as if I were rejecting evolution within a book review in which I said that the author had difficulty in knowing exactly what the relationship among different groups of invertebrates were long before DNA genealogies.

G: So it was offensive to biologists that you ended up in the *Watchtower*?

B: All my life, that's the only brush you might say that I've ever had with any religious group and so, I don't feel as though anything I've done or said has [been offensive], except in this case of misinterpretation.

Professor E. B. Lewis
Interviewed by Greg Graffin
May 16, 2003
CalTech, Pasadena, CA

G: Greg Graffin
L: E. B. Lewis

G: First, I'm wondering what does it mean to you when you call yourself a naturalist? If someone were to say Professor Lewis is a naturalist, what does them?

L: Well, under Sturtevant and Morgan--these people knew every plant and animal, and I don't. I know some things, but I don't know the plant kingdom at all, and I know some insects, but I don't know much about vertebrates. I don't consider myself a naturalist at all. But from an early age, I was interested in animals, and in Wilkes-Barre we had vacant lots full of little green leaf snakes, all kinds of things that hadn't been disturbed yet by urban life.

G: Right. Similar to what we still have in Ithaca, actually.

L: Probably. Yes. It was Wilkes-Barre. Do you know Wilkes-Barre?

G: Great. So how does this word "naturalist" relate in your mind to "atheist"?

L: Well, I guess they were linked at one time, but at one time the naturalists all believed in god, I guess, like Darwin and people like that, and only gradually I would expect that they have drifted away, but there are probably plenty of people in these cults that are into, like the Green Party and various things, who try to merge mysticism and science–to put them together and all this foolishness. There was a survey of our national academy a few years ago. I couldn't put my finger on it, but they did ask all the people, "Do you believe in god?"

G: Yes, that was Ed Larson, but that one was only focused on belief in god. That's really all. I'm trying to get to a more meaningful distinction.

L: The tape discusses Steve Weinberg.

G: Yeah, I read the book.

L: Well, he wants to be clear that if god is a personal god then that's something we don't need, essentially, [that] is what he's saying. And of course, they turn around and denounce him.

G: I think that's true. Do you find working in the field that you work in, you're much more focused on the material properties of life?

L: We're trained to solve problems full-time because you don't have time for that kind of stuff.

G: Would you say that your focus is to solve those problems based on a material understanding of life?

L: Well, it's a revolution now. We're doing DNA sequencing to answer questions that we could never have even thought we could answer before and then still doing a lot of the lab work–which *Drosophila* has been held very powerful in its genetics–we can solve almost any problem with that organism now. And people, well, what people are doing–it's a pretty accurate field, but we're really worried about funding and so on. The funding always gets cut back for all these special projects in this administration which we've got now. I think in the history of this country, this administration could completely destroy the country. And they [the administration] will be so badly in trouble that they will not be re-elected. So I like to worry about that.

G: Do you think the work that you do entails belief in any way?

L: No, even the thought of discussing this makes me sick because in fact, at lunch, I rail against it [belief] so much that it's become a joke. You've read about how St. Luke's hospital went bankrupt? So Cal Tech may take it over. [My friends joke that] they're going to call it the Ed Lewis Wing, but it's just a joke. But it's the flavor of what they [my friends] think about me. In fact, I may over do it. Because there are always some engineers or physicists who are more likely to [be believers] . . . DNA, they don't grasp the importance of DNA. They don't know anything about genetics, so they're sure that there's something else. Some of their people are like that, even some of the people on our faculty.

G: Gaps. The gaps in our knowledge is where god resides, of course.

L: Is that the term god-of-the-gaps?

G: Yeah, you see it in the New York Review of Books.

L: They get reviewers who primarily push this idea. See, I don't read that. I just don't like that. I don't have time to read anyway.

G: Yeah, that's the reason. But the god-of-the-gaps notion is something that allows them to continue back-peddling as science fills in more details. So this is completely a

matter of opinion but that's what I'm interested in. In order to form your world-view, your view of the world, do you use evolutionary biology knowledge as well as knowledge from other sources? In other words, how do you construct your world-view when you talk to a young person, for instance, or a grandchild or something, and you want to tell them about your world-view? What knowledge do you pull from, what do you use?

L: Well, I think I don't do much of that. I try to avoid advising people on what they should do, what their career should be. The goal is to tend to leave my two boys alone, and one of them is a lawyer and one of them is a biology technician. But I leave them alone pretty much. I think it's probably somewhat narrow, but I do try to have a background in physics and chemistry, and statistics is what I do and biology–all the sciences and then I try to keep up with the faculty members here who are right on top of everything and we have lunch everyday and everyday we talk. So it's all an ivory tower. I live in an ivory tower, and I'm going to stay in an ivory tower as long as I can. And so I don't really think about a grand philosophy, because I have a sort of contempt for attempting such a thing. Do you know what I mean?

. . . you get all this controversy. It's bad enough to keep up with the current backgrounds in science where you have to read a lot of papers and talk to people. Imagine if in the field that you're in, there's so much more stuff to sift through, and that's why I don't read much. I don't have time. I mean time is so short, I'm 85 years old. So I don't have time to think about things and the kids are gone. It's too late!

G: But certainly you have a theory in your head or an idea in your head about what's right and wrong?

L: You're brought up in a Presbyterian church, but right away you learn that it's all nonsense what they're telling you. And you take the oath before you're mature enough to know what you're doing. And then I used to laugh about the cannibalism that was involved in Christianity. And this stuff. Crazy stuff. But what is so dangerous now is the–what do they call it? Intelligent design. That's really dangerous.

G: The new creationism.

L: So these people are always threatening our whole school system. So the immediate problem is very serious, and I turned down a request to talk [at] some of these things because it's too hard for me to take time to organize a talk, and I don't do it even in science. But there are good spokesmen. You need good spokesmen to get out there. Spokeswomen, maybe, at any rate.

G: But they have to come really from your field.

L: They should come from science, from biology even. But, boy, you're up against it if

you try. You know, 90% of the people are religious in this county. You probably know that. 50% don't believe in evolution. And one of the basic problems is that congressmen have no education in science. That is a very serious problem.

G: That's why I take my role very seriously as being able to hopefully translate science into a more popular and more readable form.

L: Do you write much? Do you do a lot of writing?

G: Yeah, I do a lot of writing. And I'm a musician also.

L: What do you play?

G: I'm a singer and songwriter.

L: I play the flute.

G: Back on morality and ethics. Do you think that morality and ethics is completely decoupled from evolutionary biology and knowledge?

L: Not quite. I know somebody who thinks that in order to . . . I don't know quite how to phrase it. But the idea is that the reason we are religious is that it was selected for. I've never heard it stated before, but the idea would be that for some reason, people who had belief in mystical things somehow survived better maybe cause they killed off anybody who didn't. That's what's happening today, you might say. You don't believe in that stuff. You're outlawed, isolated. So in a way, isn't that part of an answer?

G: Do you believe that?

L: I think it's possible. I think it's selection. Another example is sickle cell anemia. This horrible disease was selected to give an advantage. So a slight advantage has led to this, and now we are faced with it in our brain. And our brain wants to believe this stuff. And Hollywood exploits it. They also make fun of science. That's a very serious matter, too. The essence of science cannot be conveyed simply because you are always in doubt, and the people don't want to be in doubt. They've got to have an answer, and they'll go get the answer no matter what.

G: Well, you've just referred to the people who are mystical, and they believe maybe because their brain is–just selection has favored that kind of neurophysiological pattern–how can you and I be different from them? In other words, what I believe is that my sort of mysticism, my belief, is just a belief in science. How do you feel about that?

L: I think that's a philosophical statement that is a belief in a different sense.

G: Well, I would say it's a belief in a natural law that I can't see, but I still believe it's there because it's verifiable.

L: I think, the verifying means you have to experiment. And that's something that people don't want to do either. They don't want experiments. They want the answer, and they won't expect the result of an experiment because then they'll think of some other way out of the thing, and it'll go on and on. I hate to say it, but early training [is critical]. Instead of getting kids into religious schools early, they should be getting this, but then a lot of people will never be scientists. That's another strange thing. Because during the '60s, there was a movement to get more people into science because that's where the jobs were. And we had more students who came who were just disasters because they weren't motivated to find the answers. They were motivated to get a job in a field that was coming. It was a mistake.

G: I know what you're saying. I was a TA at UCLA in geology, and the students all wanted to be oil geologists. They weren't really interested in the science part of it. That's an interesting point.

L: Not everyone is cut out to [be scientists].

G: So you think it might actually be a subgroup of humans who are able to do science.

L: I think we're overcoming something, just the way you'd try to overcome some urges that you have. You're overcoming this urge. I think it's there. [You think], "Maybe I shouldn't take this flight because maybe it'll crash." But you suppress it. I think that's maybe the answer.

G: That's a good point. Just to let you know, the way I suppress it is by probability. I live my life by probability.

L: Risk analysis.

G: And that came from my training in science.

L: Well, risk analysis isn't understood usually by anyone outside of people who have studied it. Statistics, even.

G: So you think statistics could aid in helping form a world-view?

L: Certainly, probability and the essence of science is that everything has varying degrees of probability. And that requires an above-average intelligence. People with

below average intelligence will never grasp that. Because they can't . . . I don't know what it is. They don't really think maybe deeply about anything. They want somebody else to do it for them, maybe. Of course we're social animals. That's another big thing. All things that go with social.

G: That's why I'm really interested in evolutionary biology as a symbol. What does evolutionary biology knowledge symbolize to people in the world?

L: Yeah, it's too bad it gets dressed up in fancy jargon and terminology. It does. You have to somehow break through to get to the people who can't be reached and are turned off as soon as you say that. So you have to be very clever to change the mind set of people. I don't know how to do it. Of course, nowadays, it's gotten worse and worse and worse instead of getting better. There was a time when we were getting–well, we're a long way away from the prudery that existed. It was based on prudism. We're a long way [away], but we're probably going back.

L: Anyway, that's a sad thing, and it's very disgusting and disturbing and counter productive.

G: 74% of the respondents to the questionnaire said that religion can be viewed as a social adaptation. Now why couldn't we view evolutionary biology also as a social adaptation that better explains the things that religion was trying to explain?

L: Well, how do you communicate it to the student? You mean have courses that do that?

G: The story that is–the great evolutionary epic that has been written is a story that is just as profound and as traditional religious stories.

L: Well, magazines like *National Geographic* have wonderful articles that should do this, but it doesn't reach as many people as it should, and that's an amazing thing–the expense that goes into those articles. It could be only 1% of the population buying it instead of 50%. I'll bet you don't have 50% of the people looking at that. They can't afford it, and the same for any of these attempts. The *Natural History* magazine wouldn't rival that. It's quite good.

G: But in terms of evolutionary biology as a body of knowledge being suitable to answer the questions.

L: Yeah, it is. I certainly agree. The only problem is it's not reaching, it's not communicating.

G: Now, in the middle part of this century there were people trying to communicate it.

George Gaylord Simpson wrote *The Meaning of Evolution*. And even though it was far-fetched, Teilhard de Chardin, *The Phenomenon of Man*, was trying to communicate it.

L: That was pure mysticism. See those people had influence, too. You must realize, too, that we didn't have DNA, and as long as you didn't have DNA, you could entertain mystical ideas about the genes and so on. There was a guy Goldschmidt who wrote absolute nonsense about genes that don't exist. He said that if I plucked a "C" note on the violin, it doesn't mean there is a "C" body. It was a very clever statement. And there are still people who cite this idiot.

Genetics used to be a very abstract field, so people who weren't good at abstraction couldn't believe that anything you found out had any meaning. Now with DNA, nothing is abstract quite the same way anymore, so there's a concrete basis for everything we know about living things.

G: You of course won the Nobel Prize, which is the greatest accomplishment of any scientist. What do you think your contribution would have meant 150 years ago? You found a particulate way of explaining how the plan of the body is organized. 150 years ago that would have been something that only god comes up with. A plan of the body.

L: There was a guy who was trying to understand why legs turned into antennae. That was Bates in 1890. I've written an essay on that called *Homeosis*, and that is where our work led. But the important thing about what I did was I wasn't interested in development. I was interested in how you get new genes from old genes. That was the motivation entirely. And the stuff I found out probably never would have been found out even maybe now because the sort of genes involved were figured out because they could take DNA from this creature and find it was in us [humans], for the same genes make the fundamental body plan for all animals that have a head, thorax and neck. And so because they're in human beings, is why I got [the Nobel Prize], because [we showed] - somebody else also showed this and they didn't share the prize but they should have - that these genes were in human beings and other animals. And people marvel at the diversity of animal life. That's absolute crap. There is no diversity. Everybody is alike and they're using these genes.

G: So the meaning that comes from that, the fallout so to speak, is very profound and the meaning of it is in direct contradiction to what we've been taught by theology.

L: The thing that people won't ask is: who made god? Or they won't ask: how did these things happen? You know Jesus would not be a male. There was no way without god's Y chromosome. It's so ridiculous, and yet, you cannot get that across.

G: But you think that what you were able to demonstrate then is directly contradictory to what we were taught?

L: Well, the only point is that science asks a question and all kinds of things fall out in the answers . . . it's the old basic science attitude which you can't often convince granting agencies to accept, but many of the granting agencies are aware of the importance of supporting this kind of stuff. So I had get support by saying that I was working on mutations, and the Atomic Energy Commission would support that. So I was making mutations. I did a lot of work on radiation cancer induction. It was a sideline [project]. I have a colleague next door working on this book, he is going to publish selected papers, and we're deeply into this, and I have a whole section on radiation papers.

G: So do you think it would be harder if you were to study DNA specifically to disprove some of the tenants in the Bible?

L: It wouldn't do you any good, anyway. It reminds me of Templeton when he was interviewed by the BBC, and he funded a man at Georgetown University–did you know about that? [He postulated that] the people who go to church frequently live longer. And he's expecting science to prove this.

G: How do feel about that?

L: Well, it's clear that you don't hire someone who is completely incompetent to do it, who wouldn't know how to do epidemiology, wouldn't realize that he's selected certain types of people who can afford to put on a coat and tie and go to church and who are going to live longer. They're healthier. You wouldn't get a group of coal miners. Just because they went to church, you wouldn't find that they lived as long.

G: As a wrap up then, do you think that because your work has such profound possible meaning, do you feel responsible in a sense to not stretch your conclusions too far?

L: Well, I don't think people are interested in the conclusions. I am still interested in and worried about the radiation results in the sense that they won't start nuclear testing and everything else. And that it is a genetic problem and a serious one. It's not genetic mutations and germ line. It's somatic cancer. And we don't have any cure for cancer. It's estimated that 1% of our cancers are caused by natural background radiation. That came out of the estimates that I did. So all the epidemiologists agree on the risks, now, but they're not accepted by anybody else. Medical people won't admit it to people who get breast cancer exams with mammograms–those are definitely producing breast cancer with a low frequency. But they're not detecting it with a very high frequency either. The mammogram does detect cases. Ultrasound is better, but it's too expensive. Doctors have x-ray machines. They've got to pay for them, right? They did say they lowered the dose. It was very high when they started. Very soft x-rays. At any rate, that's a scandalous situation.

G: What about ethical aspects?

L: Well, I think it's just that this is a very serious ethical question that I devoted half my life to, and that takes half your life and you can't go beyond it, and you've got to focus on something very serious, and [it] is something that [has] some intriguing aspects because you know that there are people with terrible conflicts of interest. They own stock in the reactor company or they are practicing medicine and have to use radiation and they have to assure the patient that there is no danger at all when there is. People now get panicked, people don't know how to judge risk, so they mention radiation, and they're scared to death. So it gets back to the statistics that we talked about. I think maybe your main emphasis has to be on what you said, probability and statistics and how to reform the whole world because you're talking about reforming the whole world. And you have to narrow down and focus on some little branch of it where you can make a contribution because if you get too broad and too vague then you have to watch out. You get all these fringe groups joining you, and before you know it you're really in a mess. So that's [my view]. I'm very narrow in my focus, and it pays off. I've been focused on that all my life.

Professor Henry Harpending
Interviewed by Greg Graffin
May 9, 2003
University of Utah, Salt Lake City, Utah

G: Greg Graffin
H: Henry Harpending

G: Assuming that you have a certain world-view, that you see the world in a certain way, I'm wondering: do you use the story of evolution to inform that world-view or do you use other stories that you've heard in your life?

H: I think as far as my world-view goes, I guess I think that my knowledge of evolution often contradicts it. I think that I have ethical feelings that have no basis that I could see in my knowledge of biology.

G: Do you have any idea where those ethical notions came from?

H: Well, my parents and my community growing up. There was a strong sense of what a decent person acts like. And I find myself constrained by that, but we all do. A big issue in economics is why you'll leave a tip in an airport in Rome, and you've never been there, and you'll never be there again. You'll leave a tip for a stranger that you've never seen before, and you'll never see again, and you'll still leave a tip. Economists can't tell you why that's true. But people do it. I've felt foolish doing it, but I can't walk out of a restaurant in France without leaving a tip.

G: You said that sometimes your evolutionary biology knowledge contradicts some of these things in the sense that it doesn't make sense because the implications of evolutionary biology are contrary to some ethical considerations.

H: Yes.

G: Does that imply that evolutionary biology knowledge requires an interpretation in order to bridge ethics, or do you think that there is an inherent ethical component to evolutionary biology knowledge?

H: Well, there may be. I think we don't understand it yet. I mean I'm sure there's a good reason why I leave a tip in a restaurant or a train station in England, but I don't understand what it is. But it may be that my knowledge of human evolution isn't advanced enough for me to really grasp that. This is a big problem in economics.

OK, so you're my waiter in a restaurant in England at the train station and I leave you a $3 tip. That cost me $3, and I don't get any benefit from it. I'll never see

you again. There's no way that makes sense.

G: In that context it doesn't make sense. But as a symbol of the way you live your life, it makes a lot of sense. Because you are probably not alone. You might be with your family. You might be with your close relatives. In a sense, as the symbol of that behavior, you're teaching them ethics.

H: I'll give you that. I'm displaying something to them. I'm showing them what a good guy I am. I don't have any coherent theory of my own behavior, and I don't think they do either.

G: Are you trying to uncover a picture of reality in your research, or are you trying to build on the story that's already there? I'm curious though, what drives your hunger for research?

H: It's like playing a game of chess against nature. If you're trying to figure out things and see patterns. And playing with theory, and seeing if it works. I can't imagine anything that's more fun. They pay me a salary to do it. I enjoy it.

G: On a deeper level, do you feel that it has any connection to understanding, making sense of what's out there?

H: Oh, of course.

G: Do you think that you are contributing to our understanding of what really exists out there? Or is that secondary?

H: Oh, no. I feel that I'm figuring out the way the world is working. Sure. If I want to understand HIV, I think the answer is to understand the evolution of the mechanisms of viral replication.

G: You've just brought up HIV, for instance. Do you think understanding the minutia of the virus is a way to eradicate it or combat it?

H: Eventually, sure. Eventually. But I also have to admit, I find it personally interesting to understand its history and play with models of it. I don't study HIV because I want to cure it. I study it because it's fascinating in the same way that some people find baseball statistics fascinating. It's just fun to learn about.

G: Then do you think when you go on to the next stage when you're teaching people about it, what is your purpose in that? What is the role?

H: Sharing the fun. Sharing the pleasure.

G: As a role model?

H: Yeah, I guess. My view about teaching, as I tell my students, if you're not having fun, then there's something wrong, that this is really interesting. It's your world, as a human you ought to understand it. I think I would have, say, a horrible time teaching in a medical school.

G: Where it's almost like a vocation?

H: Yeah. I would have an awful time with it.

G: Do you find that sometimes what you're teaching as fun really gives some students a hard time because they're so torn between understanding the tenets of evolution and the contradictions that are inherent from their ethical teachings from their institution of religion?

H: Yeah, occasionally. Not so much here. Many more in Pennsylvania when I worked at Penn State.

G: Some people are deeply offended, have such a hard time because they just can't get these contradictions out of their head.

H: I see that. What I tell them is that I've learned a lot ever since I was in high school about electrons. I've never seen an electron. In one sense, I believe in them–they make a computer work, and it's their responsibility to learn about the material, and whether they believe it or not, I don't care.

G: As far as getting through the class?

H: Just as my physics teacher didn't really care whether or not I believed in electrons. I just had to know the equations and the physical laws. I put up that parallel. Maybe it's a cop out.

G: Why is it? Why in your teaching avoid that question of belief in electrons?

H: Because it doesn't contribute to . . . . It doesn't go anywhere. It's all some guy's personal struggles. There's no new knowledge that comes out of it.

G: What if someone didn't believe that the genes and the mutation rates that you study exist?

H: Well, we go over the evidence. We go over DNA sequences. We go over other kinds of functional genomics.

G: And those all depend upon you pointing to an actual thing that exists–that is, a sequence of nucleotides that has to basically correspond to a real entity.

H: But that nucleotide sequence comes from laboratory chemistry, and you may choose not to believe the chemistry. But all of science is this way. Scientists will tell you what the speed of light is. How do you know? I don't know. I can't remember how you know. I may used to have known.

G: I see what you're saying. There comes a point when it doesn't necessarily reinforce what you're trying to demonstrate. What's interesting to me is where that point is. With DNA you have to believe that these base pairs exist–those are real things. And I know that there is a point when it comes down to the atomic or the elemental level, where most biologists are quick to turn it over to the chemists. "Let them tell you what exists because that's beyond my realm."

H: X-ray diffraction is down the hall, yes.

G: To what degree is ethics and morality connected to evolutionary biology information or knowledge?

H: I guess I personally–talking about beliefs–think that ethics and morality are a good thing, and that, somehow, we've come up with what I think are good systems in spite of evolution. And I'm not sure, I mean one group of people would say, "No, these have evolved. We just don't know the mechanisms yet." Ed Wilson would say that. And my view point is maybe, but I don't see it.

G: You're not sure that they're connected to cultural evolution. So you think it might be a much more functionalist approach?

H: Maybe, there have been a few people smart enough to say, "Look we got to get past the pure Darwinian." I don't know. Things like that have happened. When the Roman Catholic church and marriage made really profound changes in society because it broke up familial nepotism, nepotistic networks. In medieval times. But marriage patterns really did change as a result of that especially in southern Europe. So some people would say the reason that you can be loyal to Cornell or America is that you don't have the strong family dragging you back. And the reason that we're not going to see a liberal democracy in Iraq is because . . .

G: Their loyalties are already to . . .

H: Clans. And the way you get that is because of marriage. And I find that plausible. I don't think I know enough to say that that is absolutely true. And that was a rather self conscious act of the church if I remember my history.

G: And a socio-biologist might say that they just happened to come up with that doctrine, and it stuck because it was selectively advantageous in the particular cultural climate.

H: But to who's advantage? To the churchman's advantage because they may have increased their own resources.

G: True. I'm suspecting from a selfish-gene perspective that it was an advantage to the gene. Because cousins marrying cousins can lead to more harmful mutations, so purely from a selfish-gene perspective, the genes benefitted from this cultural decision that was made.

H: Oh, that's not clear. Let's say that you marry your cousin and then you're feeding your children. If you married your cousin, you're feeding more copies of your DNA than if you married a stranger.

G: But won't mortality rates be higher?

H: They don't compensate for it. No. If you marry your cousin then you're feeding something–when you're feeding your kids, instead of feeding half your genome, you're feeding something like 63% of it. And so the mortality would have to go up by that amount. 20%. But it doesn't. It goes up 3% or something. So I think from the view point of pure gene nepotism, cousin marriages would be a good deal. It's also been 20 years since I worked this out.

G: I see what you're saying. It makes sense.

H: So if the church, who were powerful males and controlled a lot of resources, put out this law even though not everyone obeyed it, then I think in the end it made for a much more decent society. That's why they did it, I think. They were just trying to amass power for the church and take it away from family. So I think that's the sense in which I suspect a lot of morality and ethics is [derived], in spite of low level evolution.

G: Is evolutionary biology like a religion? Even though you're not a religious person, do you have any practices that might be seen as religious?

H: Well, I have something like religion in the sense that I really appreciate the culture, history, the ritual. Every time I go to Cambridge, I always go to service at King's

College, just because they've been doing this for a thousand years, and I really get a kick out of it. But your question is . . .

G: There's a reverence for tradition there, but you also find this when you go to a football game, you do the wave because that's another reverence for tradition. Is there a deeper, spiritual connection?

H: But that's the point of my remark, you see, because I can get the spiritual kick out of going to service at King's College chapel. And I don't think I get any spiritual kick out of my buddies talking about evolutionary biology. That's not a very good answer to your question.

G: No, that's very good because that means that there's something in your work that's not touching your emotional response.

H: That's right. I guess I think that . . . I'll tell you what I'm trying to reconcile. A few years ago, one of these sort of right wing radio preachers, I can't remember which one, started railing against secular humanism. And I thought, "What on earth is that?" But then I came to see that there was a kind of humanism among many of my colleagues that looked a lot like religion to me. Stephen J. Gould or Dick Lewontin, and I thought wow, he was one of these hillbilly preachers, but he's got an insight there. And I'm trying to [understand] what the difference is between that insight and the question you asked me about whether evolutionary biology was like a religion. I don't have a good answer. But I don't think I feel evangelical about evolutionary biology. And I think someone like Dick Lewontin is evangelical about his view.

G: But what if we could decouple the evangelical completely? If you think about an aboriginal tribe from some area, they have religion, but what we call their religion is nothing like the huge institutionalized religion we call Christianity.

H: I've lived for years with Kalahari bushmen, you know. And they have a religion only in the loosest sense.

G: That's what I'm getting at. It's part of human psychological development, so what I'm interested in is whatever you call the religion of the Kalahari, why couldn't we have that kind of religion in modern industrial society acknowledging that it's just a part of how humans are developed psychologically?

H: I don't know. I think a lot of people in this building have about as much religion as Kalahari bushmen. As far I can see, there's two things: after people die they hang around a while playing tricks on you. So if it's late at night and you stumble over a root and fall, it's because your grandpa pushed you over, and he's laughing at you.

And they [the bushmen] also have a notion that you can go into a trance and extract toxins from ill or upset people. But they don't have any other beliefs or a system of beliefs.

G: Would you call yourself a naturalist?

H: I think naturalism fails at very interesting points. I don't think naturalism informs me at all about why I leave a tip in a restaurant in the middle of England when I'll never be there again in my life. But I have these beliefs or behaviors that I don't understand in terms of naturalism, and I'm happy to admit that, but other than that I think it's the only way I understand the world.

G: Yeah, that's what I'm wondering. When it comes to us sitting here in this room in this moment, do you invoke any processes other than natural ones? I think that's what I'm getting at.

H: No.

G: That is one of the criteria that separates a naturalist from a theist. If it was guided by certain other forces. So is "atheist" a word that you use or is it implied by the word "naturalist"? I think on the questionnaire you checked "naturalist." But "atheist" was a choice.

H: Oh, I don't know because there may be people who identify themselves as theists who in all every other way conform to what I call or you call " naturalist." So I don't have an opinion. I don't know what Thomas Jefferson thought.

G: But generally you don't use "atheist." You feel better using "naturalist."

H: Yes, I think the last time I heard anyone use the word "atheist" that was when I was in college. I associate atheist with Battler and Murry O'Hare, and with the kind of belligerent, in your face stuff, and I don't do that.

G: I see what you're saying. It has come to mean more of a provocative word.

H: "I want to argue with you about this."

G: Why couldn't we view evolutionary biology as a social adaptation that better explains the things of religion?

H: I don't think it explains them better yet–like why I leave a tip and things like that. I mean, there are people trying real hard like Alexander and Ed Wilson, trying to

understand the evolution of ethics. I don't think they got very far. I can't make sense of what they say.

I suppose science is really different with its insistence on evidence. And science is really sterile as a belief system. It doesn't have any of the kind of smooth edges and grandeur that traditional religions have.

G: It's not as epic, you mean, in its story?

H: It's equations. Is the bridge going to stand up or is it going to fall down? I mean this is science. I was at a meeting at the Smithsonian and a geologist remarked that earth was a wonderful planet but kind of spoiled by this carbon based slime all over the surface of it. And I thought, "This is an astronomer talking now."

G: Well, he is certainly stretching the equation on that. So do you think it's possible maybe from a neuroscientist that we will understand social adaptations better?

H: Oh, I think the economists are high after this sort of game theorists, people like Rob Boyd and Herbert Guinders, the guy at UMass, that are looking at complex experimental games, and I think they may be honing in on the reason that humans, all humans, start out being more altruistic than they ought to be. In other words, if I meet you, I give you the benefit of the doubt initially. Now, if you let me down, I may not forgive you for a long time. But I start out being a good guy. And humans violate all the laws of economics whenever you have them play games. I think they're on the way to understanding something important about the kind of issues you're talking about.

They all do things like . . . we'll have a game where you've got $50. I've got $50 and I offer it to you, but there's somebody on the other side of the country on a computer terminal. You offer some of it to this other person, like you say I'll give you $10. This other person can either agree to take the $10, or this other person can turn it down, in which case he gets nothing, and you get nothing. And the economic optimum is for you to give this other person 50 cents and for this other person to take it. This is what people do. They end up, 30, 20, with somebody you've never seen, never know who they were. Understanding how this kind of thing evolved, I think, is going to be the key to understanding a lot of what decency is.

G: What's the evidence that humans are carrying neanderthal genes?

H: I got into human evolution and molecular genetics in human evolution–it kind of came screaming just by accident because I was in a department with Mark Stoneking, who had done mitochondrial DNA work, and we published a paper in about '93 that I think was the best and clearest evidence that there was no image, at the time. I never believed there was, and I was happy with that evidence. But then over time, it has become apparent that the very clear pattern we see in human mitochondrial DNA of

this small origin in this mushrooming population of 50,000 years ago. It's not there in the nuclear DNA. The pattern is entirely different. And there's paper after paper that said, "Gee, we don't see what is in the mitochondria." So I've more or less changed my mind. I think that there's nothing wrong with our interpretation of the history of mitochondria, but it's entirely possible for one gene to have one history and the rest of the genome to have another.

If you held me down and made me give you an answer, my bet is that modern humans had a big advantage, that it had to do with the pelvis, the head shape, and child birth, that archaic females were probably disadvantaged because the only way I can see to explain all the data is that archaic females didn't contribute to modern humanity, but the rest of the archaic genome may be in us. There are lots of genes where all the diversity is outside Africa. The deep roots seem to be outside Africa. The melanocortin 1 receptor is a gene that influences hair and skin color. If you have two copies of the ginger version for example you're freckled and red-haired, kind of Irish. All the diversity is in Europe. All the old haplotypes are in Europe. Africa is completely monomorphic. That looks like something we might have picked up on the way out. There are some others in this pattern, but I wouldn't bet more than $5 on either scenario. It's completely up in the air. Ten years ago we knew the truth because we saw the pattern in mitochondrial DNA. Today, I don't know what's going on.

G: So again, the mitochondrial DNA indicated the bottleneck because there were so few mutations.

H: Because the shape of the gene tree was very much star-shaped. And the way you get that is you have a small population that gets big, and human mitochondrial DNA's history is just like that. Human nuclear DNA never shows that. And so I think either the mitochondrial data are an accident, sampling artifact, or female and male genomes had different experiences with the admixture process.

G: And what did you call the melanocortin gene?

H: The melanocortin 1 receptor . . .

G: Is not sex linked?

H: No, no. That's not an autosome. Beta-globins that are another system, that show all diversity in Asia, not in Africa. There are a number of them like that.

G: Is any resolution going to come of this with the human genome filling in?

H: We published a paper a couple of months ago based on a million loci. No signature of expansion, no history and all of that. But some kind of signature of a population

collapse. I think there's some kind of mathematical model out there that's going to explain all of this that we haven't stumbled on yet. Sometimes, I go to sleep trying to do it in my head.

G: That's a good way to fall asleep, right?

H: It is.

G: That's not counting sheep. That's counting genes.

Professor Tim Clutton-Brock
Interviewed by Greg Graffin
June 11, 2003
Cambridge, UK

G: Greg Graffin
C: Tim Clutton-Brock

G: What does it mean to you when you refer to yourself as a naturalist?

C: I think what I mean is that I'm interested in whole animals. I'm particularly into whole animals in their particular environments, so the questions that I've spent my life working on concern the interactions between animals and their immediate environment, including each other. The social environment is also important, and then the evolutionary consequences of that for adaptation, for changes in gene frequency, for the time for adaptation, and for functional strategies.

G: So the word naturalist distinguishes something?

C: Right, it distinguishes me from a lab-based scientist. Mind you, I wouldn't want the naturalist bit to be stressed too much because I would reckon that I work within a framework of evolutionary biology, and I do predictive science, so I'm not just picking up facts. I'm not just someone with binoculars collecting what facts I can pick up and then trying to make a *post hoc* or *ad hoc* sense of them. I am someone working within a framework of evolutionary theory. Ultimately, a mathematical theory back at the base to actually make predictions about what animals do. So the sorts of information that I collect in the field are closely integrated with that conceptual theoretical framework.

G: So naturalism, if we could jump to a new word . . .

C: In this country, we call it natural history. That's the old term.

G: In America, it's called that too, but if you are a student interested in natural history, you have no hope of finding an academic curriculum that suits your needs. My undergraduate degree was in anthropology. My masters was in geology. And my PhD is in zoology, believe it or not.

C: And the same for me. It's for those reasons that I wouldn't be happy to be called a naturalist. I'm a scientist and a naturalist.

G: I can see that. The point about you saying that you don't want to be thought of as a person who just goes out and collects facts is because you are collecting facts for a larger purpose?

C: Yes, and within a conceptual framework. And I'm setting up ideas on the basis of a fundamental theory and testing it.

G: Right, so along those lines, does that entail belief in any way? In what sense is this connected to belief?

C: Well, the thing that I have to dichotomize [is] there are things that one believes on the basis of evidence and that may be absolutely firm, water-tight, experimental evidence or it may be less water-tight evidence. So I believe in that framework, that natural selection is very important. I believe that the origin of life probably developed in a deep sea, probably oozes at some particular state in time. Now, I don't understand that. I believe the evidence.

G: You believe the evidence.

C: So that's one extreme. Things where I'm absolutely sure, 100% of the evidence, through to things that the evidence suggests, that fits into my overall framework. In that sense, I do believe.

I believe in another sense altogether, which really concerns how I think humans ought to deal with the circumstances they find themselves in because I don't think they should leave that to natural selection. I think if we left that to natural selection, the world would be a really rather nasty place. Perhaps, not as nasty as some people believe because natural selection favors cooperation as well as the opposite. But there are lots of ways in which individuals need to limit how they treat other people in order to achieve a happy time for themselves and a happy society to live in.

G: So is there a point where you actually decouple your knowledge from evolutionary biology from your ethical positions?

C: I decouple in two ways. I think I would generally go along with the sort of humanist principles–basically, because I believe that that's probably the most satisfactory way ahead. Secondly, I would rationalize that humans like ritual, and so I would quite happily involve myself in ritual that might be religious without any very firm belief in it, but for reasons largely of enjoyment.

G: I think bird watching is largely ritual.

C: Some of it is ritual, certainly. But I'm going beyond that. I mean I go to occasional

services in King's Chapel not because I believe the structure of religious belief that's being offered, but because I do believe that ritual is enjoyable, and that it helps people to think in community based terms, in humanist terms.

G: But to me there is nothing in evolutionary biology that would preclude someone from going to social rituals, so in that sense I don't see a real conflict.

C: That's true. I'm just playing around with what you mean by belief.

G: You said you believe in humanist principles–humanism, I think, is as poorly defined as is naturalism. I'm curious as to why naturalism is harder for you to advance.

C: Come back and tell me what naturalism is.

G: It is a belief, and a belief system that people who are naturalists use to create their world-view. What separates it from other belief systems is that it's relatively new in human history, and it's based on verifiability. It's based on empiricism.

C: Empiricism. I think where I differ from that–if you just go down the line with empiricism, one might then have a belief structure about how humans should operate which was actually in line with how animals operate. And that would be a very nasty one, and it would be based very simply on power.

I mean animals very seldom hesitate. If they can do so cheaply, they're quite happy to kill each other. We do occasionally, but not too much. If that were as acceptable to humans as it is to animals, I think it would be a very nasty place to live in. So my belief structure there is linked to humanism. If I were going to put in into one phrase, it would be: do as you would be done by. Do you call that belief or not? I believe that is about the happiest way you can go. I believe that it is important that we have some sort of guiding principle like that.

G: Do you find that among the most social of the mammals, at least, that statement holds to what you just said that, "they are happy to kill each other"?

C: Yes, they are happy to kill each other. It varies between species and it varies among circumstance.

G: I'm not going to comment on social species. I am going to say, as a student of human behavior, we are perfectly happy to cheat one another even if we pretend that we love one another. The killing is an extreme position, but maybe you're right.

C: I think we kindly use limited power. We vary in power in many systems, but we tend to have systems which limit the extent to which my power is allowed to affect

your survival and well-being. That's what law is about ultimately.

G: Yes, it's supposed to be. What is the use for evolutionary biology knowledge? In other words, how do we apply this?

C: I think there are two answers to that. There is one that virtually nothing makes sense except in the light of evolution. I forget who [said this].

G: Dobzhansky.

C: So, you look out the window, and you need it to interpret that. I think also there are many areas–and we are starting to progressively appreciate them–where understanding how evolution works guides people to understanding how diseases are going to change, how populations are going to change, how gene frequencies and heritable disorders are going to change in populations. So there are really quite a lot of areas where evolutionary biology generates specific understandings which are important.

G: So these are mostly vocational? Or is that wrong?

C: Well, it depends on what you mean. First, it enables [us] to interpret [our] environment. Secondly, it has practical applications in dealing with the environment. And if you don't understand how evolution operates, you don't understand how to control malaria. You don't understand how to deal with retroviral drugs to AIDS. You don't understand the problems you're gong to have in limiting population numbers, and you probably don't understand how to deal with agricultural problems, how to deal with fisheries. [There are] many, many areas where understanding evolutionary change is vitally important to actually predicting what's going to happen in biological populations.

G: You as a master of socio-biology–if I may . . .

C: To Americans, yes.

G: Over here in Great Britain, it's behavioral ecology. I've read Krebs and Davies. Actually, I was taught on Krebs and Davies. We're talking about the evolution of social behavior.

C: Yes, societies.

G: Now how important is it for evolutionary biologists to agree on those social implications of their science? Because people can read into it really almost what they want, can't they? I'm not suggesting it's open to interpretation, but the conclusions

mean something. How important is it that it means the same thing within evolutionary biology?

C: Well, hopefully there is a right view and a wrong view of the evolution of society. How important is that? Ultimately, that affects the structure of how we understand animal societies, how we understand the context of human society. So how important is it? It's very important. It's so important that people as going to disagree about bits of it for a long time.

I'm not bothered about that. That is how science works. If you don't have disagreement, you tend not to have progress. But one hopes that it is progressing towards a better understanding. I said just now that I think one of the main points of evolutionary biology is that it helps you to understand the world about you. And what we're really now saying is that it helps you to understand the people about you and the society about you. I'd say that it helps you to understand where you are.

G: Is there any part of your research that you might think is particularly offensive to the general public or especially as it might affect a religious person?

C: Well, bits of it are offensive. It is common in mammals that males harass females and sometimes force them to mate with them. If one describes that in detail to students, it's not always a popular move. There are people who find that sort of appreciation offensive. I sort of got involved peripherally because the gay lobbies came to argue that homosexuality is common in animal populations. My belief is that homosexual behavior may be, but sort of dedicated homosexuals, individuals who are attracted to the same sex throughout their lives, are actually very, very rare in wild animals. I'm interested in why there's a difference between humans and most animals.

Now, that's a perception that certain people find offensive. It's not meant to be offensive. It's not meant to be homophobic. It's an empirical observation. And it's an empirical observation that only someone could make who had known hundreds of individuals in the wild as individuals throughout their lives. There are rather few people who are in the position to have a view of that. I'm one, so I'm happy to offer that view even if it's not necessarily a popular view.

On the other side that I'm very interested in, and that certain people disagree with–I believe that there is extensive cooperation in many animals who are entirely unrelated to each other because they benefit from the synergy. So I believe that synergy generates many forms of cooperation from many levels from the cell to the whole animal. And there is a continuing conflict between synergy–benefits of getting together–and competition and cheating. And sometimes synergy wins and sometimes competition and cheating wins. And both those elements are present throughout.

G: Can you define synergy?

C: Yes, where we are better operating together than we would be operating alone. So if we are competing with all the other people in rooms around here, it may be better for us to sink our differences and compete with them as a pair, than for us to compete with each other. And that crops up at all biological levels. So it crops up at probably the level of proteins, certainly at the level of genes, certainly at the level of chromosomal functional units, certainly at the level of multicellular bodies, possibly at the level of ecosystems.

John Maynard Smith talks about synergy. There's a continual battle between synergy and competition, even if it's better for us to put aside our differences and compete with the people out there, it may still be to my benefit to cheat you a bit, but not too much, or vice versa.

G: And is it all under the umbrella of increasing fitness?

C: Well, you have to realize with humans, it's operating through learning, so not only is there selection operating on all of us, but I'm actually learning in the course of my lifestyle what maximizes my individual enjoyment and well-being. Is it competition or is it cheating? I learn the benefits and costs of both of those.

G: Hopefully, your interpretation of it is something that the public can live with.

C: Hopefully, yes. I'm just in the middle of writing a book about mammal societies which brings this all together and hopefully I will attach it to something about human societies.

WORKS CITED

Barlow, Connie ed. (1994) *Evolution Extended, Biological Debates on the Meaning of Life*. MIT Press, Cambridge

Best, Myron (1982) *Igneous and Metamorphic Petrology*. W. H. Freeman and Company, New York.

Bibby, Cyril ed. (1967) *The Essence of T. H. Huxley, Selections from his Writings Edited with Several Brief Interpretive Essays by Cyril Bibby*. Macmillan, London.

Bonner, J. T. (2000) *First Signals, The Evolution of Multicellular Development*. Princeton University Press, Princeton.

Bowler, Peter J. (1984) *Evolution the History of an Idea*. University of California Press, Berkeley and Los Angeles.

Bronowski, J. (1978) *Magic, Science, and Civilization*. Columbia University Press, New York.

Burnham, Terry and Phelan, Jay (2000) *Mean Genes, From Sex to Money to Food Taming Our Primal Instincts*. Penguin, New York.

Burtt, E. A. (1925) *The Metaphysical Foundations of Modern Physical Science, A Historical and Critical Essay*. Harcort, Brace, and Co., New York.

Comte, Auguste (1856) *The Positive Philosophy of Auguste Comte Freely Translated and Condensed by Harriet Martineau*. Calvin Blanchard, New York.

Crews, Frederick C. (2001) Saving us from Darwin. Part I. *The New York Review of Books*, Oct. 4., NYREV, New York.

Crick, Francis (1994) *The Astonishing Hypothesis*. Scribner, New York.

Dawkins, Richard (1999) *The Extended Phenotype, The Long Reach of the Gene, 2nd ed.*, Oxford University Press, Oxford.

------ (1996) *The Blind Watchmaker, Why the Evidence of Evolution Reveals a Universe Without Design*. Norton, New York.

Darwin, Charles (1958) *The Autobiography of Charles Darwin*. Barlow, Nora, ed. Norton, New York.

deDuve, Christian (2002) *Life Evolving, Molecules, Mind, and Meaning*, Oxford University Press, Oxford.

Dobzhansky, Theodosius (1967) *The Biology of Ultimate Concern*. New American Library, New York.

Draper, John William (1874) *History of the Conflict Between Religion and Science*. Appleton, London.

Edelman, Gerald M. and Tononi, G. (2000) *A Universe of Consciousness: How Matter Becomes Imagination*. Basic Books, New York.

Freeman, Scott and Herron, Jon C. (2001) *Evolutionary Analysis, 2nd ed.* Prentice Hall, Upper Saddle River, NJ.

Gasman, Daniel (1998) *Haeckel's Monism and the Birth of Fascist Ideology*. Peter Lang, New York.

Goodenough, Ursula (1998) *The Sacred Depths of Nature*. Oxford University Press, Oxford.

Gould, S. J. (1999) *Rocks of Ages, Science and Religion in the Fullness of Life*. Ballantine, New York.

------ (1988) On replacing the idea of progress with an operational notion of directionality. In *Evolutionary Progress*. Nitecki, Matthew H. ed. University of Chicago Press, Chicago. pp. 319-338.

------ (1980) *Hen's Teeth and Horses Toes, Further Reflections in Natural History*. Norton, New York.

Gould, S. J. and Lewontin R. C. (1979) The spandrels of San Marco and the Panglossian paradigm: a critique of the adaptationist programme. *Proc. R. Soc. Of London. B*. 205, pp. 581-598.

Greene, John C. (1959) *The Death of Adam, Evolution and Its Impact on Western Thought*. Iowa State University Press, Ames, IA.

Haeckel, Ernst (1894) *Monism, the confession of faith of a man of science*. Adam & Charles Black, London.

------ (1920) *Last Words on Evolution, A Popular Retrospect and Summary*. Peter Eckler, New York.

Hinton, Perry R. (1995) *Statistics Explained, A Guide for Social Science Students*. Routledge, Sussex.

Huxley, Julian (1957) *Religion Without Revelation*. Parrish, London.

------ (1953) *Evolution in Action*. Chatto & Windus, London.

Huxley, Thomas H. (1896) *Science and Christian Tradition*. Appleton, New York.

------ (1896b.) *Science and Morals and Other Essays*. Appleton, New York.

Johnson, Phillip E. (1995) *Reason in the Balance*. Inter Varsity Press, Downer's Grove, IL.

Kim, Jaegwon (1995) Emergent properties. *In The Oxford Companion to Philosophy*. Honderich, Ted., ed. Oxford University Press, Oxford.

Krebs, J. R. and Davies, N. B. (1981) *An Introduction to Behavioural Ecology*. Sinauer Associates, Inc., Sunderland, MA.

Kuhn, Thomas S. (1962) *The Structure of Scientific Revolutions*. University of Chicago Press, Chicago.

Larson, E. J. (1997) *Summer for the Gods, the Scopes Trial and Americas Continuing Debate Over Science and Religion*. Basic Books, New York.

Larson, E. J. and Witham, L.(1999) Scientists and religion in America, *Scientific American*, pp 88-93.

------ (1998) Leading scientists still reject God. *Nature*. 394. p. 313.

------ (1997) Scientists are still keeping the faith. *Nature*. 386. pp. 435-436.

Leuba, J. H. (1916) *The Belief in God and Immortality: A Psychological, Anthropological and Statistical Study*. Sherman, French and Co., Boston.

------ (1934) Religious beliefs of American scientists, *Harpers Magazine*, pp. 291-300.

Lumsden, Charles J. and Wilson, E. O. (1983) *Promethean Fire, Reflections on the Origin of Mind*. Harvard University Press, Cambridge.

Margulis, Lynn and Sagan, Dorion (2002) *Aquiring Genomes, A Theory of the Origins of Species*. Basic Books, New York.

Maynard Smith, John (1988) Evolutionary progress and the levels of selection. In *Evolutionary Progress*. Nitecki, M. ed. University of Chicago Press, Chicago pp. 219-230.

Mayr, Ernst (1982) *The Growth of Biological Thought, Diversity, Evolution, and Inheritance*. Belknap, Cambridge.

Mayr, Ernst and Provine, William B. eds. (1980) *The Evolutionary Synthesis*. Harvard University Press, Cambridge.

Midgley, Mary (1985) *Evolution as a Religion*. Routledge, London.

Nitecki, Matthew ed. (1988) *Evolutionary Progress*. University of Chicago Press, Chicago

Paley, William (1846) *Natural Theology, A New Edition*. Longman, London.

Pink, Thomas (1995) Gnosticism. In *The Oxford Companion to Philosophy*. Honderich, Ted, ed. Oxford University Press, Oxford.

Provine, William B. (1988) Progress in evolution and meaning in life. In *Evolutionary Progress*. Nitecki, Matthew H. ed. University of Chicago Press, Chicago. pp. 49-74.

------ (1985) Adaptation and mechanism of evolution after Darwin: a study in persistent controversies, in *The Darwinian Heritage*. Kohn, David ed. Princeton University Press, Princeton. pp. 825-826.

Raup, David M. (1988) Testing the fossil record for evolutionary progress. In *Evolutionary Progress*. Nitecki, Matthew H. ed. University of Chicago Press, Chicago. pp. 293-317.

Ruse, Michael (2003) Is evolution a secular religion? *Science*. 299. p. 1523.

------ (2002) Darwinism and atheism, a marriage made in heaven? In *Science and the Spiritual Quest*. Richardson, W. M., Russell, R. J., Clayton, P., and Wegter-McNelly, K. eds. Routledge, London and New York.

------ (2001) *Can a Darwinian be a Christian, the Relationship Between Science and Religion*. Cambridge University Press, Cambridge.

------ (1996) *Monad to Man, The Concept of Progress in Evolutionary Biology*. Harvard University Press, Cambridge.

------ (1995) Comte, Isidore Auguste Marie Francois Xavier (1798-1857). In *The Oxford Companion to Philosophy*, Oxford University Press, Oxford.

Russell, Bertrand (1945) *The History of Western Philosophy*. Simon and Schuster, New York.

Segerstrale, Ullica (2000) *Defenders of the Truth, The Battle For Science in the Sociobiology Debate and Beyond*. Oxford University Press, Oxford.

Simpson, George G. (1949) *The Meaning of Evolution*. Yale University Press, New Haven.

Sinnot, Edmund W. (1955) *The Biology of the Spirit*. Viking, New York.

Smith, Homer W. (1952) *Man and His Gods*. Little Brown, New York.

Strauss, Anselm L. (1987) *Qualitative Analysis for Social Scientists*. Cambridge University Press, Cambridge.

Strickberger, Monroe (2000) *Evolution, 3rd ed.* Jones and Bartlett, London.

Wallace, Bruce (2003) What is Life. Unpublished MS. Submitted to the Quarterly Review of Biology.

Williams, George C. (1997) *The Pony Fish's Glow and Other Clues to Plan and Purpose in Nature*. Basic Books, New York.

Wilson, D. S. (2002) *Darwin's Cathedral, Evolution, Religion, and the Nature of Society*. University of Chicago Press, Chicago.

Wilson, E. O. (1992) *The Diversity of Life*. Harvard University Press, Cambridge.

----- (1998) *Consilience*. Knopf/Random House, New York.

----- (1984) *Biophilia*. Harvard University Press, Cambridge.

------ (1978) *On Human Nature*. Harvard University Press, Cambridge.

------ (1975) *Sociobiology, The New Synthesis*. Belknap, Cambridge.