

"Darwinism's Rules of Reasoning"

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My starting point is a book review which Theodosius Dobzhansky published in 1975, critiquing Pierre Grassé's *The Evolution of Life*.⁽¹⁾ Grassé, an eminent French zoologist, believed in something which he called "evolution." So did Dobzhansky, but when Dobzhansky used that term he meant neo-Darwinism, evolution propelled by random mutation and guided by natural selection. Grassé used the same term to refer to something very different, a poorly understood process of transformation in which one general category (like reptiles) gave rise to another (like mammals), guided by mysterious "internal factors" which seemed to compel many individual lines of descent to converge at a new form of life. Grassé denied emphatically that mutation and selection have the power to create new complex organs or body plans, explaining that the intra-species variation that results from DNA copying errors is mere fluctuation, which never leads to any important innovation. Dobzhansky's famous work with fruitflies was a case in point. According to Grassé,

The genic differences noted between separate populations of the same species that are so often presented as evidence of ongoing evolution are, above all, a case of the adjustment of a population to its habitat and of the effects of genetic drift. The fruitfly (*Drosophila melanogaster*), the favorite pet insect of the geneticists, whose geographical, biotropical, urban, and rural genotypes are now known inside out, seems not to have changed since the remotest times.⁽²⁾

Grassé insisted that the defining quality of life is the intelligence encoded in its biochemical systems, an intelligence that cannot be understood solely in terms of its material embodiment. The minerals which form a great cathedral do not differ essentially from the same materials in the rocks and quarries of the world; the difference is man's intelligence, which adapted them for a given purpose. Similarly,

Any living being possesses an enormous amount of "intelligence," very much more than is necessary to build the most magnificent of cathedrals. Today, this "intelligence" is called information, but it is still the same thing. It is not programmed as in a computer, but rather it is condensed on a molecular scale in the chromosomal DNA or in that of every other organelle in each cell. This "intelligence" is the *sine qua non* of life. Where does it come from?... This is a problem that concerns both biologists and philosophers, and, at present, science seems incapable of solving it.... If to determine the origin of information in a computer is not a false problem, why should the search for the information contained in cellular nuclei be one?⁽³⁾

Grassé argued that the Darwinists who dominate evolutionary biology have failed, due to their uncompromising commitment to materialism, to define properly the problem they were trying to solve. The real problem of evolution is to account for the origin of new genetic information, and it is not solved by providing illustrations of the acknowledged capacity of an existing genotype to vary within limits. Darwinists had imposed upon evolutionary theory the dogmatic proposition that variation and innovative evolution are the same process, and then had employed a systematic bias in the interpretation of evidence to support the dogma. Here are some representative judgments from Grassé's introductory chapter:

Through use and abuse of hidden postulates, of bold, often ill-founded extrapolations, a pseudoscience has been created.... Biochemists and biologists who adhere blindly to the Darwinist theory search for results that will be in agreement with their theories.... Assuming that the Darwinian hypothesis is correct, they interpret fossil data according to it; it is only logical that [the data] should confirm it; the premises imply the conclusions.... The deceit is sometimes unconscious, but not always, since some people, owing to their sectarianism, purposely overlook reality and refuse to acknowledge the inadequacies and the falsity of their beliefs.(4)

Dobzhansky's review summarized Grassé's central thesis succinctly:

The book of Pierre P. Grassé is a frontal attack on all kinds of "Darwinism." Its purpose is "to destroy the myth of evolution as a simple, understood, and explained phenomenon," and to show that evolution is a mystery about which little is, and perhaps can be, known.

Grassé was an evolutionist, but his dissent from Darwinism could hardly have been more radical if he had been a creationist. It is not merely that he built a detailed empirical case against the neo-Darwinian picture of evolution. At the philosophical level, he challenged the crucial doctrine of uniformitarianism, which holds that processes detectable by our present-day science were also responsible for the great transformations that occurred in the remote past.

According to Grassé, evolving species acquire a new store of genetic information through "a phenomenon whose equivalent cannot be seen in the creatures living at the present time (either because it is not there or because we are unable to see it)." (5) Grassé acknowledged that such speculation "arouses the suspicions of many biologists... [because] it conjures up visions of the ghost of vitalism or of some mystical power which guides the destiny of living things...." He defended himself from these charges by arguing that the evidence of genetics, zoology, and paleontology refutes the Darwinian theory that random mutation and natural selection were important sources of evolutionary innovation. Given the state of the empirical evidence, to acknowledge the existence of some as yet undiscovered orienting force that guided evolution was merely to face the facts. Grassé even turned the charges of mysticism against his opponents, commenting sarcastically that nothing could be more mystical than the Darwinian view that "nature acts blindly, unintelligently, but by an infinitely benevolent good fortune builds mechanisms so intricate that we have not even finished with analysis of their structure and have not the slightest insight of the physical principles and functioning of some of them." (6)

Dobzhansky disagreed with Grassé fundamentally, but he acknowledged at the outset that his French counterpart knew as much about the scientific evidence regarding animal evolution as anyone in the world. As he put it,

Now one can disagree with Grassé but not ignore him. He is the most distinguished of French zoologists, the editor of the 28 volumes of *Traite de Zoologie*, author of numerous original investigations, and ex-president of the Academie des Sciences. His knowledge of the living world is encyclopedic.

In short, Grassé had not gone wrong due to ignorance. Then where *had* he gone wrong? According to Dobzhansky, the problem was that the most distinguished of French zoologists did not understand the rules of scientific reasoning. As Dobzhansky summed up the situation:

The mutation-selection theory attempts, more or less successfully, to make the causes of evolution accessible to reason. The postulate that the evolution is "oriented" by some unknown force explains nothing. This is not to say that the synthetic...theory has explained everything. Far from this, this theory opens to view a great field which needs investigation. Nothing is easier than to point out that this or that problem is unsolved and puzzling. But to reject what is known, and to appeal to some wonderful future discovery which may explain it all, is contrary to sound scientific method. The sentence with which Grassé ends his book is disturbing: "It is possible that in this domain biology, impotent, yields the floor to metaphysics."

I began with the Dobzhansky/Grassé exchange to make the point that whether one believes or disbelieves in Darwinism does not necessarily depend upon how much one knows about the facts of biology. Belief that the various types of plants and animals were created by an extension of the kind of changes Dobzhansky's experiments brought about in fruitflies is at bottom a question of metaphysics. By metaphysics, I mean nothing more pretentious than the assumptions we all make about just which possibilities are worth considering seriously. For example, Pierre Grassé was willing to consider, and eventually to endorse, the possibility that the so-called "evolution in action" which the neo-Darwinists were observing is merely a variation within the limits of the existing genotype and not a source of genuine evolutionary innovation. To put the point in the language used by some contemporary biologists, Grassé proposed to "decouple macroevolution from microevolution." Such proposals have generally foundered on the inability to establish sufficiently credible distinctive macroevolutionary mechanisms. (For example, the widely publicized "new theory" of punctuated equilibrium turned out to be just a gloss upon Ernst Mayr's thoroughly Darwinian theory of peripatric speciation.) Grassé differed from the Darwinists in that he was willing to consider the possibility that science does not know, and may never know, how new quantities of genetic information have come into the world.

From Dobzhansky's viewpoint, to consider such a possibility would be to give up on science. As Dobzhansky saw it, we already know a lot about how plants and animal populations vary in the everyday world of ecological time. Dog breeders have given us St. Bernards and dachshunds, laboratory experiments have produced monstrous fruitflies, mainland species have differentiated after migrating to offshore islands, and the ratio of dark to light peppered moths in a population changed when the background trees were dark due to industrial air pollution. To be sure, none of these examples demonstrated the kind of innovation that Grassé had in mind. In the absence of a

better theory, however, Darwinists consider it reasonable to assume that these observable variations illustrate the working in ecological time of a grand process that over geological ages created fruitflies and peppered moths and scientific observers in the first place. By making that extrapolation Darwinists create a scientific paradigm which can be fleshed out with further research, and improved. For a critic to suggest the possible existence of some factor outside the paradigm is helpful only if he can also propose a research strategy for investigating it. To Dobzhansky, therefore, Grassé's insistence that the sources of new genetic information might be a mystery to our science was pointless and harmful to the cause of science.

There is a political and religious dimension to the issues Grassé and Dobzhansky were debating which must also be considered. To say as Grassé did that, in the domain of creation, "biology, impotent, yields the floor to metaphysics" is to imply something important about the relative cultural authority of biologists and metaphysicians. Whatever that might mean in France, in the United States the scientific establishment has been in conflict over evolution for generations with the advocates of creationism. Although the scientists have won all the legal battles, there are still a lot of creationists around who are very much unconvinced with what the Darwinists are telling them. How many there are depends upon how "creationism" is defined.

The most visible creationists are the Biblical fundamentalists who believe in a young earth and a creation in six 24-hour days, and Darwinists like to give the impression that opposition to what they call "evolution" is confined to this group. In a broader sense, however, a creationist is any person who believes that there is a *Creator* who brought about the existence of humans for a purpose. In this broad sense, the vast majority of Americans are creationists. According to a 1991 Gallup poll, 47 per cent of a national sample agreed with the following statement: "God created mankind in pretty much our present form sometime within the last 10,000 years." Another 40 per cent think that "Man has developed over millions of years from less advanced forms of life, but God guided this process, including man's creation." Only 9 per cent of the sample said that they believed in biological evolution as a purposeless process not guided by God.

The evolutionary theory endorsed by the American scientific and educational establishment is of course the creed of the 9 per cent, not the God-guided gradual creation of the 40 per cent. Persons who endorse a God-guided process of evolution may think that they have reconciled religion and science, but this is an illusion produced by vague terminology. A representative Darwinist statement of "the meaning of evolution" may be found in George Gaylord Simpson's book bearing that title. In the words of Simpson:

Although many details remain to be worked out, it is already evident that all the objective phenomena of the history of life can be explained by purely naturalistic or, in a proper sense of the sometimes abused word, materialistic factors. They are readily explicable on the basis of differential reproduction in populations (the main factor in the modern conception of natural selection) and of the mainly random interplay of the known processes of heredity. ...Man is the result of a purposeless and natural process that did not have him in mind."(7)

"Evolution" is a vague term which can be used in a variety of senses. When it means only that a certain amount of natural change occurs in nature, it has no great philosophical consequences. What Simpson was describing was something much more specific, which I prefer to call the

"blind watchmaker hypothesis," after the famous book by Richard Dawkins. According to Dawkins, "Biology is the study of complicated things that give the appearance of having been designed for a purpose."(8) Dawkins wrote his book to convince the public of something that Darwinians take for granted: The appearance of purposeful design in biology is misleading, because all living organisms, including ourselves, are the products of a natural evolutionary process employing random variation and natural selection. As Dawkins explains,

Natural selection is the blind watchmaker, blind because it does not see ahead, does not plan consequences, has no purpose in view. Yet the living results of natural selection overwhelmingly impress us with the appearance of design as if by a master watchmaker, impress us with the illusion of design and planning.(9)

We might therefore say that the watchmaker is not only blind, but unconscious.

The really important meaning of "evolution" is not that creation was a gradual process that required billions of years. It is that the process was supposedly undirected and purposeless. The prestige of the scientific establishment, and of the intellectual class in general, is heavily committed to the proposition that evolution -- in the blind watchmaker sense -- is either a fact, or a theory so well supported by evidence that only ignorant or thoroughly unreasonable people refuse to believe it. If the scientists ever had to retreat on this issue, the cultural consequences could be significant. Persons who now have a prestigious status as cultural authorities would be discredited, and the political and moral positions they have advocated might be discredited with them.

That is the fear of Michael Ruse, author of *Darwinism Defended*. Ruse proclaims proudly that Darwinism reflects "a strong ideology," and "one to be proud of." According to Ruse, most contemporary Darwinians "show a strong liberal commitment" in both their politics and their sexual morality.(10) Advocates of creation, on the other hand, want to restore a "morality based on narrow Biblical lines" with respect to marriage and sexual behavior. Ironically Darwinism, which has at so often been associated with ideologies of racial superiority, eugenics, and unrestrained competition, is currently enlisted in the fight against that trinity of political incorrectness: racism, sexism, and homophobia. Ruse concludes his book with these stirring lines "Darwinism has a great past. Let us work to see that it has an even greater future."(11)

Such statements are equivalent to the claims of creation-science advocates that to doubt the Genesis account is to open the floodgates for all kinds of immorality. I think that Michael Ruse and Henry Morris are both right to insist that cultural acceptance of Darwinism has had important consequences for politics and morality. Recognition of this factor, however, also has important implications for how we should regard Darwinism's rules of reasoning. Are those rules designed to protect a cherished doctrine from scientific criticism -- criticism that might, wittingly or unwittingly, give aid and comfort to persons who want to deprive the Darwinist establishment of its cultural authority? If physicists were to start to proclaim that belief in the Big Bang has had wonderful political and moral consequences, and we must all work to see that the Big Bang has a wonderful future, surely we would begin to wonder about their objectivity.

Darwinism's rules of reasoning not only protect the cultural authority of Darwinists. They also permit Darwinist writers to take the mutation/selection mechanism for granted even when they are describing evidence which directly contradicts it. This feat of intellectual contortionism is strikingly illustrated by Stephen Jay Gould's book, *Wonderful Life*. Gould's bestseller adds a great deal to our knowledge of the "Cambrian explosion," meaning the sudden appearance of the invertebrate animal phyla, without visible ancestors, in the 600 million-year-old rocks of the Cambrian era. Unicellular life had existed for a long time, and some multicellular groups appear in the immediately Precambrian rocks, but there is nothing that can be established as ancestral to the Cambrian animals. As Richard Dawkins described the situation, "It is as though [the Cambrian phyla] were just planted there, without any evolutionary history."(12)

In recent years the mystery has deepened, because it appears that the Cambrian animal groups were far more varied than had been imagined. The more distinct groups there were in the Cambrian, the more chains of ancestors there ought to have been in the Precambrian. Some remarkable Cambrian fossils found in a Canadian formation known as the Burgess Shale were originally classified in familiar groups. Gould explains that the discoverer of the Burgess Shale fossils, Charles Walcott, tried to "shoehorn" the odd creatures into familiar taxonomic categories because of his predisposition to avoid multiplying the difficulties of what is called the "artifact theory" of the Precambrian fossil record. As Gould explains the problem:

Two different kinds of explanations for the absence of Precambrian ancestors have been debated for more than a century: the artifact theory (they did exist, but the fossil record hasn't preserved them), and the fast-transition theory (they really didn't exist, at least as complex invertebrates easily linked to their descendants, and the evolution of modern anatomical plans occurred with a rapidity that threatens our usual ideas about the stately pace of evolutionary change).(13)

The two graphics in [Figure 1](#) illustrate both the problem the Cambrian Explosion poses for any theory of evolution, and the way a museum exhibition attempts to control the damage. The Exhibition is titled "Life Through Time: The Evidence for Evolution," and it is at the California Academy of Sciences Museum in Golden Gate Park in San Francisco. The lower diagram shows only the evidence, with the phyla appearing on parallel lines and absolutely no evidence of any common ancestors or transitional intermediates. The museum exhibit represented by the upper diagram adds the common ancestors and alters the vertical dimension representing the age of the fossils, in order to give the impression that the recalcitrant data constitute the required "evidence for evolution." At the intersection point where the common ancestors ought to be, the curators have placed magnifying glasses. Similar devices are used elsewhere in the exhibit to mark tiny animals or fossils. Unsophisticated museum visitors are likely to get the impression that the invisible common ancestors are known to science, but just a little too small for the naked eye to see. By such means even a spectacular example of absence of evidence for evolution can be transformed into evidence for evolution, and even evidence for the creative power of natural selection.

The museum exhibit illustrates the Cambrian Explosion with just a few well-known groups and thus understates the difficulty in reconciling the facts with any known theory of evolution. Reclassification of the Burgess Shale fossils has now established some 15 or 20 Cambrian species that cannot be related to any known group and therefore constitute distinct and

previously unknown phyla. There are also many other species that can fit within an existing phylum but are still remarkably distinct from anything known to exist earlier or later. The general history of animal life is thus a burst of general body plans followed by extinction. Many species exist today which are absent from the rocks of the remote past, but they fit within general taxonomic categories present from the very beginning. Darwinian theory predicts a "cone of increasing diversity," as the first living organism, or first animal species, gradually and continually diversifies to create the various levels of the taxonomic order. The animal fossil record more resembles such a cone turned upside down, with the phyla present at the start and thereafter decreasing. In short, the more we learn about the Cambrian fossils, the more difficult it becomes to see them as the product of Darwinian evolution.

Gould describes the reclassification of the Burgess fossils as the "death knell of the artifact theory," because it adds so many new groups that appear without Precambrian ancestors.

If evolution could produce ten new Cambrian phyla and then wipe them out just as quickly, then what about the surviving Cambrian groups? Why should they have had a long and honorable Precambrian pedigree? Why should they not have originated just before the Cambrian, as the fossil record, read literally, seems to indicate, and as the fast-transition theory proposes?(14)

A mysterious process that produces dozens of complex animal groups directly from single-celled predecessors, with only some words like "fast-transition" in between, may be called "evolution" - but the term is being used more in the sense of Grassé's heresy than of Dobzhansky's Darwinian orthodoxy. Each of those Cambrian animals contained a variety of immensely complicated organ systems. How can such innovations appear except by the gradual accumulation of micromutations, unless there was some supernatural intervention? It is not only that the Darwinian theory requires a very gradual line of descent from each Cambrian animal group back to its hypothetical single-celled ancestor. Because Darwinian evolution is a purposeless, chance-driven process, which would not proceed directly from a starting point to a destination, there should also be thick bushes of side branches in each line. As Darwin himself put it, if Darwinism is true the Precambrian world must have "swarmed with living creatures" many of which were ancestral to the Cambrian animals. If he really rejects the artifact theory of the Precambrian fossil record, Gould also rejects the Darwinian theory of evolution. [Careful readers will note that the non-existence of the Cambrian ancestors is vaguely qualified by the phrase "at least as complex invertebrates easily linked to their descendants." I have learned to be alert to this sort of qualification in Gould's writing, because it signals a possible line of retreat. I have reason to believe that Gould would repopulate the Precambrian world with invisible ancestors, and thus re-embrace the artifact theory, if he were accused of abandoning the mutation/selection mechanism and thus leaving the evolution of complexity unexplained.]

Readers familiar with Gould's writings know that he has at times expressed great skepticism concerning the neo-Darwinian theory that Dobzhansky proclaimed so confidently. In a paper published in *Paleobiology* in 1980, Gould wrote that, although he had been "beguiled" by the unifying power of neo-Darwinism when he studied it as a graduate student in the 1960's, the weight of the evidence has since driven him to the reluctant conclusion that neo-Darwinism "as a general proposition, is effectively dead, despite its persistence as textbook orthodoxy."(15) In place of the dead orthodoxy Gould predicted the emergence of a new macroevolutionary theory

based on the views of the geneticist Richard Goldschmidt, another heretic whose views were every bit as obnoxious to Darwinists as those of Grassé. The new theory did not arrive as predicted, however, and Gould subsequently seems to have heeded Dobzhansky's admonition: if you can't improve on the mutation/selection mechanism, don't trash it in public.

For whatever reason, Gould did not point out to his readers that the utterly un-Darwinian Cambrian fossil record provides no support whatever for claims about the role of mutation and selection in the creation of complex animal life, or for metaphysical speculations about the purposelessness of the process that created humans. Instead, he indulged freely in just such speculation himself, rightly judging that his audience of intellectuals would accept an atheistic interpretation of the evidence uncritically. In the concluding chapter he commented on a Burgess Shale fossil called *Pikaia*. Walcott classified *Pikaia* as a worm, but a more recent study concludes that the creature was a member of the phylum Chordata, which includes the subphylum Vertebrata, which includes us. That for Gould means that *Pikaia* might be our ancestor, which implies that, unlike many other Burgess Shale creatures, it left descendants. If *Pikaia* had not survived the mass extinctions that killed off so many other Cambrian fossil creatures, we would never have evolved. The existence of humans is therefore not a predictable consequence of evolution, but a never-to-be-repeated accident. Gould concluded this reflection, and the book, with the following sentence:

We are the offspring of history, and must establish our own paths in this most diverse and interesting of conceivable universes -- one indifferent to our suffering, and therefore offering us maximum freedom to thrive, or to fail, in our own chosen way.

Of course there is absolutely nothing in the Burgess Shale fossils to support Gould's speculation that the universe is indifferent to our sufferings, or to discredit the belief that we are responsible to a divine Creator who actively intervened in nature to bring about our existence. On the contrary, the genuine scientific portion of *Wonderful Life* provides ample grounds for doubting the expansive notions of metaphysical naturalists like Theodosius Dobzhansky and George Gaylord Simpson. But because of Darwinism's rules of reasoning, even evidence which is thoroughly contrary to Darwinism supports Darwinism.

Darwinian evolution will surely remain the reigning paradigm as long as Dobzhansky's metaphysical rules are enforced. To say this is merely to say that the neo-Darwinian synthesis is the most plausible naturalistic and materialistic theory for the development of complex life that persons philosophically committed to excluding the Creator from the Cosmos have been able to invent. The neo-Darwinian synthesis is a vague and flexible conglomeration that readily incorporates any seemingly non-Darwinian elements -- such as the molecular clock, or punctuated equilibrium, or even the ability of bacteria to summon needed mutations -- that appear from time to time. If Dobzhansky's team makes the rules this conglomeration of naturalistic ideas wins, because all the powerful critical points made by such informed critics as Pierre Grassé are excluded *a priori* from consideration.

To Darwinists evolution is by definition a single phenomenon. Dobzhansky's fruitfly variations constitute evolution, and evolution is also the grand creative process that produced fruitflies and human beings in the first place. Of course new genetic information originates by some

combination of random genetic changes and natural selection: how else could it originate without the participation of some force unknown to our science? Darwinism is the product of Dobzhansky's rules, and to protect the theory contemporary Darwinists insist that those rules are binding upon all who would ask questions about how complex life came into existence. Does Darwinian selection really have the creative effect that Darwinists claim for it? The question doesn't arise. The power of natural selection to create was settled long ago -- not by evidence, but by the cultural power of those who made the rules. Anyone who questions those rules -- even if he is President of the French Academy and the most knowledgeable zoologist in the world -- is dismissed out of hand. He doesn't understand how science works.

I have the honor of speaking today to an audience of anthropologists in an age which is often characterized as "post- modern." Surely this audience above all others ought to understand how a priesthood can maintain its cultural authority by enforcing rules of discourse that prevent consideration of alternatives that the priests disfavor. I assume that this audience also has some acquaintance with the literature of the philosophy of science. If so, you are not likely to be fooled by persons who proclaim that there is a unitary activity called "science," which has fixed boundaries and is governed by a set of rules that no one may question. Philosophers know better. Here, for example, is the concluding paragraph of Larry Laudan's famous article, "The Demise of the Demarcation Problem:"

Through certain vagaries of history, ...we have managed to conflate two quite distinct questions: What makes a belief well founded (or heuristically fertile)? And what makes a belief scientific? The first set of questions is philosophically interesting and possibly even tractable; the second question is both uninteresting and, judging by its checkered past, intractable. If we would stand up and be counted on the side of reason, we ought to drop terms like "pseudo-science" and "unscientific" from our vocabulary; they are just hollow phrases which do only emotive work for us.... Insofar as our concern is to protect ourselves and our fellows from the cardinal sin of believing what we wish were so rather than what there is substantial evidence for (and surely that is what most forms of "quackery" come down to), then our focus should be squarely on the empirical and conceptual credentials for claims about the world. The "scientific" status of those claims is irrelevant.(16)

Surely Laudan is on the right track. For example, whether mutation and selection can create complex organs like wings and eyes is a question to be resolved by evidence. To insist that belief in the creative power of natural selection is "scientific," and doubt on the subject is inherently "religious," or even an instance of the thought crime known as "creationism," is simply to try to prejudice the inquiry with a tendentious use of labels. Perhaps those who attribute creation to a Creator are committing what Laudan called "the cardinal sin of believing what they wish were so rather than what there is substantial evidence for." On the other hand, perhaps this is still more true of Darwinists, who are so eager to believe on slight evidence that natural selection can do all the work of creation.

The points in dispute can only be settled by an unbiased examination of the evidence. Those who have confidence in their evidence and their logic do not appeal to prejudice, nor do they insist upon imposing rules of discourse that allow only one position to receive serious consideration, nor do they use vague and shifting terminology to distract attention from genuine points of

difficulty. Still less do they heap abuse and ridicule upon persons who want to raise questions about the evidence and the philosophical assumptions that underly a theory. When an educational establishment has to resort to tactics like that, you can be sure that some people are getting desperate.

Notes

1. Pierre P. Grassé, *L'Evolution du Vivant* (1973), published in English translation as *The Evolution of Living Organisms* (1977) (hereafter Grassé). The review of the original French edition by Dobzhansky, titled "Darwinian or 'Oriented' Evolution?" appeared in *Evolution*, vol. 29, pp. 376-378 (June 1975).
2. Grassé, p. 130.
3. Grassé, p. 2.
4. Grassé, pp. 7-8.
5. Grassé, p. 208. See also p. 71: "We are certain that it [evolution] does not operate today as it did in the remote past. Something has changed.... The structural plans no longer undergo complete reorganization; novelties are no longer plentiful. Evolution, after its last enormous effort to form the mammalian orders and man, seems to be out of breath and drowsing off."
6. Grassé, p. 168.
7. George Gaylord Simpson, *The Meaning of Evolution*, pp. 344-45 (rev. ed. 1967).
8. Richard Dawkins, *The Blind Watchmaker* (Longman, England 1986, p. 1. (Hereafter Dawkins)
9. Dawkins, p. 21.
10. Michael Ruse, *Darwinism Defended* (Addison Wesley, 1982), p. 280.
11. Ruse, supra, p. 328-329.
12. Dawkins, p. 229.
13. Stephen Jay Gould, *Wonderful Life* (1989), pp. 271-273.
14. Ibid.
15. Stephen Jay Gould, "Is a New and General Theory of Evolution Emerging?", *Paleobiology*, vol. 6, pp. 119-130 (1980), reprinted in the collection *Evolution Now: A Century After Darwin*, (Maynard Smith ed. 1982).
16. Larry Laudan, "The Demise of the Demarcation Problem," reprinted in the collection *But Is It Science?* (Ruse ed. 1988).