Letters

Evolution and the Fossil Record

As the evolution-creation debate heats up, the amount of misinformation passed back and forth increases. An important example of general interest is contained in the letter by Robert Root-Bernstein (26 June, p. 1446). In discussing the power of evolutionary theory, Root-Bernstein says: "In the absence of evolutionary theories, any chronological ordering of the fossil record would seem to be a possibility, and no means would exist to choose one order over another." This statement expresses the common misconception that paleontologists arrange fossils in a theoretically reasonable order and then use this order to construct a chronology. In fact, no evolutionary theory at all is required to use fossils for geochronology. The best evidence is that the geological time scale in its modern form was fully developed by about 1840—before Darwin's *Origin of Species*. The time scale based on fossils was built by geologists who were creationists. Since 1840, many details have been filled in, but the basic sequence has remained unchanged.

So, the geological time scale and the basic facts of biological change over time are totally independent of evolutionary theory. It follows that the documentation of evolution does not depend on Darwinian theory or any other theory. Darwinian theory is just one of several biological mechanisms proposed to explain the evolution we observe to have happened.

This is part of a more general problem. A large number of well-trained scientists outside of evolutionary biology and paleontology have unfortunately gotten the idea that the fossil record is far more Darwinian than it is. This probably comes from the oversimplification inevitable in secondary sources: low-level textbooks, semipopular articles, and so on. Also, there is probably some wishful thinking involved. In the years after Darwin, his advocates hoped to find predictable progressions. In general, these have not been found—yet the optimism has died hard, and some pure fantasy has crept into textbooks. This is illustrated by other statements in the Root-Bernstein letter, such as: "Evolution postdicts certain immutable trends of progressive change that can be falsified." This is simply not the case! In the fossil record, we are faced with many sequences of change: modifications over time from A to B to C to D can be documented and a plausible Darwinian interpretation can often be made after seeing the sequence. But the predictive (or postdictive) power of theory in these cases is almost nil. The problem faced by the evolutionary paleontologist is not unlike that of the stock market analyst. Both the stock market record and the fossil record are complex Markovian time series wherein causal interpretations after the fact are often possible but the predictive value of theory is weak to nonexistent. In fact, the technical market analyst probably has a better record than the paleontologist. This does not disqualify evolutionary theory; it simply illustrates the difficulty of applying any statistical theory to actual cases.

One of the ironies of the evolution-creation debate is that the creationists have accepted the mistaken notion that the fossil record shows a detailed and orderly progression and they have gone to great lengths to accommodate this "fact" in their Flood geology.

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Achievements in Social Science

Sociologist Allan Mazur (Letters, 22 May, p. 875) unduly minimizes the contribution of his own (and my own) discipline. Even if it were true that "we [social scientists] do not have any theories that allow us to predict events with more accuracy than intelligent laymen," this argument loses much of its force when one considers that "intelligent laymen" *become* "intelligent" in dealing with social matters largely by absorbing concepts and findings in social science. And comparing "random samples of sociologists, physicists, and journalists" to see which group comes up with the best solutions to social problems appears quite irrelevant. One evaluates physics not by what randomly selected physicists can do but by what Newton and Einstein did. The social sciences should similarly be evaluated in terms of their best rather than their average performances, even if Newtons and Einsteins have not (yet) emerged among us.

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A publication of the National Science Foundation (NSF) (*1*) reports briefly on 14 "unanticipated benefits from basic research." Of the 14, three resulted from research in the social sciences, an excellent proportion given the distribution of funding over all the sciences. A later publication (*2*) catalogs a number of specific benefits resulting from one of the three projects the NSF reports on.

Mazur asks, "What . . . has been contributed by professional social scientists?" and answers "little" and "hard to find." Yet almost any member of the large U.S. adult deaf population would reply that study of the language and culture of the American deaf community (begun with NSF funding in 1960) by a growing number of linguists, psychologists, sociologists, and anthropologists has led directly to more and better jobs for deaf persons, to improved educational programs, to worldwide recognition of sign language art forms in dance and drama, and to a 180-degree reversal in public attitude toward deaf people's signing.

In the social sciences, as elsewhere, low expectations lead to lower contributions. . . .

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References

1. *Unanticipated Benefits from Basic Research.* (National Science Foundation. Washington, D.C., February 1979).
2. W. C. Stokoe, in *Language in Public Life*, J. E. Alatis and G. R. Tucker, Eds. (Georgetown Univ. Press, Washington, D.C., 1979).

Mazur complains that social scientists do not perform much better as social analysts than do intelligent laymen. He is right but has no cause for complaint. The results of social science investigation are usually written in a language most people can understand and diffuse rapidly to the intelligent and literate public. Unhappily, the mistakes also propagate rapidly.

The conflicts we see in the policy arena are conflicts between contemporary social science theories, or those that have diffused relatively recently. Many more people are capable of disagreeing about social policy precisely because these interpretations of society have reached them. The first great wave of this popularization came with the literacy of Protestantism; Cotton Mather just dies a little slower than the hard, massy atom. Not so long ago those folks claimed the world was flat. Patience.

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Creationism, the Random Hypothesis, and Experiments

The concept that the biotic world evolved from a random (*1*) beginning by random processes has been expressed both directly and indirectly [for example, (*2*)]. The possibility of evolution from a random origin has been challenged, for example, by Wigner (*3*) and by Eden (*4*) on the basis of mathematical analyses. Wigner has stated that the possibility of emergence of multiplicative organisms from a "random symmetric matrix" is arguably nil. Eden states, "Any principal criticism of current thoughts on evolutionary theory is directed to the strong use of the notion of 'randomness' in selection. The process of speciation by a mechanism of random variation in offspring is usually too imprecisely defined to be tested. When it is precisely defined it is highly implausible."

Neither Wigner nor Eden offers an alternative explanation for the variation found in the living world. Gish (*5*), however, attributes variation to a Deity, and the Institute for Creation Research (*6*) asserts that the "creation model" "fits all the observed facts"; those "facts" include originally random mutations.

Random processes are thus featured both by evolutionists concerned with theory and by creationists; each, however, uses this assumption in his own way.

The scientific question posed by randomness has been answered both in theory and in a physical model for the first cells on Earth; the answer is a natural one. It is based on experiments and observations (*7*) which indicate that both the matrix and the processes were *non*-random. This answer is rooted in stereochemical forces rather than in assumed randomness (*8*). These forces are related to the shapes and electrical fields which are unique for the molecules of each kind of compound. Accordingly, molecules of various amino acids reproducibly ordered themselves when warmed to form prebiotic proteins. Thus, an assumption challenged experimentally within science should not be used to support a supernaturalistic thesis.

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References and Notes

1. The definition of the term random used here is essentially that of Eden (*4*); it posits that every conceptually possible elementary variant is equally probable.
2. S. Wright, in *Mathematical Challenges to the Neo-Darwinian Interpretation of Evolution*, P. S. Moorhead and M. M. Kaplan, Eds. (Wistar Institute, Philadelphia, 1967), p. 117; G. Montalenti, in *Studies in the Philosophy of Biology*, F. J. Ayala and Th. Dobzhansky, Eds. (Univ. of California Press, Berkeley, 1974), p. 15; F. H. C. Crick, S. Brenner, A. Klug, G. Pieczenik, *Origins Life* **7**, 389 (1976); M. Eigen and P. Schuster, *Naturwissenschaften* **65**, 341 (1978).
3. E. Wigner, in *The Logic of Personal Knowledge* (Routledge & Kegan Paul, London, 1961), p. 231.
4. M. Eden, in *Mathematical Challenges to the Neo-Darwinian Interpretation of Evolution*, P. S. Moorhead and M. M. Kaplan, Eds. (Wistar Institute, Philadelphia, 1967), p. 5.
5. D. Gish, *Am. Biol. Teacher* **35**, 132 (1973).
6. H. Morris, Ed., *Scientific Creationism* (Creation-Life, San Diego, Calif., public school edition, 1974).
7. S. W. Fox, in *The Nature of Life*, W. H. Heidcamp, Ed. (University Park Press, Baltimore, 1978), p. 23; *Naturwissenschaften* **67**, 576 (1980); *Int. J. Quantum Chem.*, in press.
8. S. W. Fox, *Am. Biol. Teacher* **43**, 127 (1981).
9. The new understanding is derived from observations resulting from experiments that have attempted to retrace the earliest steps in organic evolution. Experimental program supported by National Aeronautics and Space Administration grant NGR-10-007-008 and by the National Foundation for Cancer Research.

Strategic Stripes?

Constance Holden (News and Comment, 17 Apr., p. 305), discusses critical minerals and their stockpiling. What is not discussed is the wasteful use of these minerals.

The best example of this wasteful use can be seen in the case of chromium. Approximately half of the traffic striping paint used in the United States is yellow. The yellow pigment used is lead chromate, which is about 16 percent chromium and 64 percent lead. It is estimated (*1*) that 22 million pounds of lead chromate are used annually in yellow striping paint.

The National Highway Traffic Safety Administration has mandated this use of lead chromate despite the fact that yellow lines have a lower visibility, especially at night, than white lines, and more important, despite the fact that lead chromate is highly toxic. In use, traffic line paints chalk, erode, and are abraded by tires, releasing particles of toxic lead chromate to the atmosphere and to the dust and soil.

Thus, the federal government is mandating the poisoning of our population while losing a scarce resource and increasing the cost of traffic line paint.

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1. *National Paint and Coatings Data Base Program* (SRI International, Menlo Park, Calif., 1980).

Authorship Questions

Price (Letters, 29 May, p. 986) argues that "The payoff in brownie points of publications or citations must be divided among all the authors listed on the byline, and in the absence of evidence to the contrary it must be divided equally among them." Bridgwater, Bornstein, and Walkenbach (*1*) report the results of a survey of academic psychologists which indicates substantial agreement regarding credit for authorship. The first or senior author should be the person who designed the project. The second author should be the person who wrote the report. Most other activities relating to the research (such as data collection, data tabulation, data analysis, searching the literature, designing or building equipment, and even providing the idea without being actively involved in the project) should be acknowledged by footnotes rather than by inclusion in the byline. If these seemingly generally accepted guidelines were followed, there would be both a reduction in the average number of authors per paper and an increase in the ease of apportioning credit (or blame).

Of course, all of the other questions relating to the apportionment of brownie points for publications would remain. Should a letter to the editor be considered as the equivalent of an article, a book, a book review, or all of the above? If letters to the editor are to be counted, should a long letter be credited with more points than a short one, or should a short letter be worth more points since it indicates precision and clarity of thought and also is more likely to be published? If long letters are worth more, I'll be happy to rewrite and resubmit this one.

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1. C. A. Bridgwater, P. H. Bornstein, J. Walkenbach, *Am. Psychol.* **36**, 524 (1981).