Evolution Flies

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Source: *Science*, New Series, Vol. 286, No. 5439 (Oct. 15, 1999), pp. 413-414
Published by: American Association for the Advancement of Science
Stable URL: https://www.jstor.org/stable/2899295
Accessed: 17-07-2021 14:00 UTC

introduced such departmental committees, and only as of this year. I hope that more universities will follow.

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Response

Gudrun Ihrke states that a serious issue was "reduced to personal mudslinging" because the article described the specifics of two conflicts. The fact is that these two cases powerfully illustrate a larger problem: The lack of effective procedures to resolve serious differences between postdocs and advisors can and does damage people's careers. As the article and an accompanying article, "Getting to the front of the bus" (p. 1514) make clear, information about these kinds of situations has spurred postdocs to organize and push for better institutional protection. Johns Hopkins is indeed one of the first universities to require annual written evaluations of postdocs by departmental committees, as the accompanying article clearly states. But while postdoc activists called these committees an important step, they emphasized that effective grievance procedures are still necessary to resolve serious conflicts and hold both postdocs and advisors accountable.

Dan Ferber

Problems with the Polygraph

In David Malakoff's 3 September News of the Week article (p. 1467), the statement about polygraphs from the Department of Energy (DOE), that there are "no scientific studies" that cast doubt on their value "as an investigative tool," is incorrect. Allen Brett, John Beary, and I analyzed the polygraph's ability to generate a positive finding from those telling lies and a negative finding from those telling the truth (*1*). We used data from field studies of suspected criminals to determine the predictive power of the polygraph. Our analysis was weighted toward the most favorable evaluation of the polygraph because all of the studies had been performed by experienced operators in real-world investigations where truth or falsehood was subsequently determined by confession of the guilty party. We found that the polygraph detected those lying at little better than the rate predicted by chance alone. If an interrogator flipped a coin, with heads for liars and tails for truth-tellers, then the results would be about the same as with a polygraph.

If the polygraph were merely useless, it would not be so bad. Unfortunately, it is harmful because it generates a large number of false-positive test results that may incriminate people who are telling the truth. Suppose 1000 people were screened, and 50 of them were liars. The polygraph would generate positive results in 38 out of 50 liars and in 351 out of 950 truth-tellers, that is, more than nine false positives for every true positive. The polygraph gives the wrong answer 9 times out of 10, and who would want to use a fire alarm or a cancer test that was wrong 90% of the time?

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Although the editorial by Stephen Jay Gould (*Science*'s Compass, 25 June, p. 2087) was perhaps peculiar, David W. Hogg's statement (Letters, *Science*'s Compass, 30 July, p. 663) that the hypothesis of evolution has not been "validated" seems extreme. When Wallace and Darwin independently concluded (from the pattern of morphological types of plants and animals between islands and continents) that new species evolved from previously existing species and that many current species shared common ancestor species, they were suggesting an alternative to their previous view that each species was created independently. They knew nothing about molecular biology, but these two hypotheses make very different predictions about molecular biology. Creation theory predicts that molecular components and processes in one species will be unlike those in another species, whereas evolution predicts that they will be similar and that differences will occur in particular patterns representing evolutionary change. In this regard, evolution is a superior hypothesis because it makes more specific predictions and is thus more easily refuted.

The last 100 years have provided an enormous amount of information that fits an evolutionary pattern—from basic facts such as that all organisms contain proteins and nucleic acids, to the deluge of sequence data that derive practical value from the fact that the data fit an evolutionary pattern. In addition, the mechanisms by which genetic variation is produced and transmitted are now well known. From what has been learned about the internal mechanisms of organisms, computer models demonstrate that evolution is inevitable. And finally, evolu-

tionary change is directly observed in both laboratory and field situations. The hypothesis of evolution is "validated" by all three of Hogg's criteria.

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According to Hogg, a physicist, the empirical support for evolution is limited to a few experiments on fruit flies and is altogether lacking in predictive tests and falsifiable hypotheses. This raises the question, what is the nature of science? Put briefly, scientific theories are postulated to explain scientific facts (observations so thoroughly confirmed that they are considered "true"). Evolution is no different in this regard from, say, the theory of relativity. Gravity is a scientific fact that relativity seeks to explain. That organisms share a common evolutionary history is as much an established fact as any other in science, and the theory of evolution seeks to elucidate the mechanism or mechanisms by which this has occurred. (This includes, but is not limited to, Darwin's concept of natural selection.) Thus, Hogg's complaint that evolution has not been "validated" is unfounded. But can evolution (the theory, not the fact) make testable predictions? The results of countless laboratory and field experiments strongly suggest that it does. Moreover, these tests are similar in principle to those in physics (has anyone actually traveled at the speed of light to test relativity?). It is also easy to imagine potential falsifiers of evolutionary theory—the discovery of genetic mechanisms not compatible with natural selection, for example. Not only has evolution been overwhelmingly "validated" as a fact, but evolutionary theory has been greatly supported in its specifics. The past 150 years of biology cannot be ignored. Until evolution (both as fact and as theory) is better understood, trends such as those illustrated by the educational developments in Kansas are likely to continue.

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Hogg, of the Institute for Advanced Study, presents some intriguing points about the weaknesses of evolutionary theory not mentioned in Gould's editorial. Hogg notes a lack of rigorous tests of the theory by presentation of "verifiable, falsifiable prediction about some as-yet-unobserved aspect of the natural world." Researchers have presented such tests, but unfortunately they tend to be published in obscure journals not easily accessible by scholars of "advanced" institutes. These include *Science*, *Nature*, *Evolution*, *The American Naturalist*, and *Proceedings of the National Academy of Sciences*. And Hogg dismisses laboratory studies of the evolution of fruit flies, presumably because such work reveals little about the natural world. Although laboratory fruit flies are real organisms, in real populations, in real environments, experiencing real genetic changes that define evolution, Hogg's dismissal of laboratory science may be a major cost-saving idea. The huge and expensive contraptions favored by physicists, such as the $8 billion Next Linear Collider, could be discarded in favor of real-life research in which theoretical physicists are sent directly into the sun to study nuclear events.

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