

## Outrageous Events: Don't Count Them Out

tems—more species, richer webs of interrelationship—were thereby better able to resist disturbance. I showed that there was no such arbitrarily general rule. Quite the contrary: randomly constructed complex ecosystems are more likely to lose species after disturbance than are simple ones. But, I emphasized, “the balance of evidence would seem to suggest that, in the real world, increased complexity is usually associated with greater stability. There is no paradox here.... The real world is no general system. Nature represents a small and special part of parameter space [shaped ultimately by evolutionary forces acting on individuals]” (1, p. 75).

In short, the 1973 book expresses exactly Taylor's sensible argument that real ecosystems “develop” by adding, and losing, species over time, not by randomly sampling ecological possibilities.

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### References and Notes

1. R. M. May, *Stability and Complexity in Model Ecosystems* (Princeton Univ. Press, Princeton, NJ, 1973). To be reprinted, with an extensive new introduction, in the series *Landmarks in Biology* (Princeton Univ. Press), in press.

In his insightful News Focus article, “CERN's gamble shows perils, rewards of playing the odds” (29 Sept., p. 2260); Charles Seife discusses a paradox of “three-sigma” and “five-sigma” findings in the experiments of physicists and astronomers. Findings that are statistically significant to three standard deviations (that is, three sigma) theoretically occur less than one chance in 1000 if a hypothesis of no effect is true. Yet, Seife quotes particle physicist John Bahcall, “Half of all three-sigma results are wrong.” Seife comments, “To a statistician, such vagaries may seem absurd.” Actually, to statisticians the phenomenon is common. The problem usually is that the probability model under which the significance level is calculated is wrong. An example is the phenomenon Mosteller and Wallace referred to as the “outrageous event” (1, 2).

An outrageous event is one that is unexpected and is not included in the probability model that yields a multi-sigma answer—like the “systematics” Seife mentions that tripped up astronomer Peter Van de Kamp and others (in the case of Van de Kamp, changes in a telescope lens assem-

bly were the source of evidence for a wobbly star and hence an extrasolar planet). When Muhammed Ali was boxing, Mosteller liked to give the example of himself, Fred Mosteller, contending with Ali for the world heavyweight title. Although Ali would be heavily favored in the odds, he could trip over his shoelaces rushing from his corner and be out cold, with Fred the winner on a technicality! The serious point is that a small probability of a finding cannot in practical terms ever be smaller than the probability of the “outrageous events” that could produce the finding.

Another example pertinent to the paradox is this: The more data one searches through to find a “finding,” the more opportunity there is to reach three sigmas (3).

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### References and Notes

1. F. Mosteller and D. Wallace, *Applied Bayesian and Classical Inference: The Case of the Federalist Papers* (Springer-Verlag, Berlin, ed. 2, 1984), p. 90.
2. S. Fienberg et al., Eds., *A Statistical Model: Frederick Mosteller's Contributions to Statistics, Science, and Public Policy* (Springer-Verlag, Berlin, 1990), p. 257.
3. See articles and citations on “Multiple Comparisons” in S. Kotz, N. Johnson, C. Read, Eds., *Encyclopedia of the Statistical Sciences* (Wiley, New York, 1988).

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