We do not wish to detract from the empiricism of the molecular biology and genetics of the *fru* study, but we suggest that extensions of such work on insects to human beings or any other organisms should be made in a proper evolutionary hypothesis-testing framework.

***Rob DeSalle***
*Molecular Laboratories,*
*American Museum of Natural History,*
*79th Street at Central Park West,*
*New York, NY 10024, USA*
***Ranhy Bang***
*Graduate Training Program in*
*Anthropod Systematics,*
*Department of Entomology, Cornell University,*
*Ithaca, NY 14853, USA, and*
*Department of Entomology,*
*American Museum of Natural History*
**Michael Yudell**
*Molecular Laboratories,*
*American Museum of Natural History*
**Rudolf Meier**
*Department of Entomology,*
*American Museum of Natural History*

### References

1. L. C. Ryner *et al.*, *Cell* **87**, 1079 (1996).
2. C. Nielsen, N. Scharff, D. Eibye-Jacobsen, *Biol. J. Linnean Soc.* **57**, 385 (1996).
3. P. Abramson and S. D. Pinkerton, *Science* **273**, 1155 (1996).

## Moore's Law

The Research News article "Can chip devices keep shrinking?" by Robert F. Service (13 Dec., p. 1834) represents Moore's Law as a doubling in the number of transistors on computer chips every 18 months. In the graphic by VLSI Research Inc., with a caption heralding the validity of Moore's Law "for more than three decades," two exponential growth curves are drawn for DRAM memory and Intel microprocessor, respectively. As depicted, the doubling times for the two curves are slightly more than 2 years for processors and just under 2 years for memory.

In 1965, when Intel Corporation's founder Gordon Moore first commented on the growth of the microelectronics industry (*1*), he noted a doubling of the number of elements on a produced chip once every 12 months. For a decade, that meant a factor of approximately 1000. Today when Moore's Law is quoted, the time constant used is 18 months. Actually, it was 18 months starting in the mid-1970s, that is, approximately 10 years after the original observation. For a decade, then, the factor was approximately 100.

The 18-month time constant was no longer valid by the end of the 1980s. For example, the number of Intel-80x processors grew from about 29,000 to approximately 1,200,000 from 1980 to 1990—substantially less than a factor of 100. In the 1990s, the time constant has been closer to 2 years. That gives a decade growth factor of approximately 32.

As we approach the physical limits of the technology curve we have been riding so effectively, let alone the economic limits that are also at work, the rate of growth of transistors on chips will further decrease. The Semiconductor Industry Association Road Map (*2*) shows a growth of only about a factor of 10 for microprocessors in the decade between 1997 and 2007. That implies a Moore's Law time constant for doubling of about 3 years.

***Alfred E. Brenner***
*Deputy Director,*
*Institute for Defense Analyses,*
*1801 North Beauregard Street,*
*Alexandria, VA 22311–1772, USA*
*E-mail: abrenner@ida.org*

### References

1. R. N. Noyce, *Sci. Am.* **237**, 63 (September 1997); *Information Technology and R&D: Critical Trends and Issues* (OTA-CIT-268, Office of Technology Assessment, U.S. Congress, Washington, DC, February 1985), p. 324.
2. *National Technology Roadmap for Semiconductors* (Semiconductor Industry Association, San Jose, CA, 1994), p. 11.