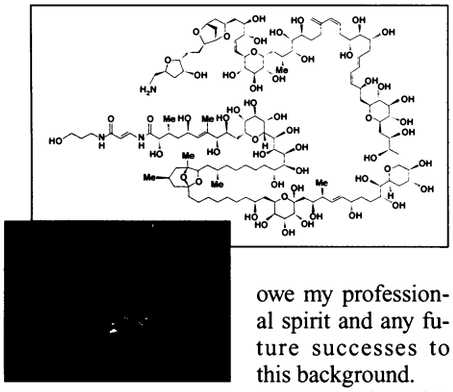
chemistry, and the study of basic chemical principles, have recently flourished. I would not trade my training in the competitive environment of total synthesis for any other. I owe my professional spirit and any future successes to this background.



The structure of polytoxin (right), a compound from *Palythoa vestitis*, a soft coral (left)

Synthesis, with all of its facets, must persevere as a mainstay of the chemical frontier. Chemistry as a whole will always enjoy a steady advance sprinkled with dramatic breakthroughs. For decades, the steady advance has been fueled in good measure by the example and excitement of total synthesis. Dramatic breakthroughs in chemistry will often be made by those schooled in total synthesis. Total "synthetikers" enjoy the advantage of being able to make any molecules we want by simply "taking known reactions and putting them in a new order" (humor intended). We can think deeply about chemistry from broad experience, and so extend our imaginations and productivity to any chemical problem we choose. What other concern can claim this continuing impact?

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Facts about Artificial Intelligence

Ray Kurzweil (Letters, *Science*'s Compass, 16 July, p. 339) responds to my review (*Science*'s Compass, 30 Apr., p. 745) of his *The Age of Spiritual Machines* (Viking, New York, 1999) as follows.

1) My review "mires the reader in obscure and misleading factual objections." Kurzweil attempts a history of computing; in history, facts matter. He challenges only one of my historical objections, concerning the UNIVAC computer. His book, in an entry labeled "1950," says, "Eckert and Mauchley develop UNIVAC, the first commercially marketed computer. It is used to compile the results of the U.S. census" (p. 269). In fact UNIVAC was under more or less continuous development from 1947; it was not the first commercially marketed computer, nor was it operational until 1951.

2) I "drag out old anti–artificial-intelligence (AI) arguments." I do not. Rather, I hold that make-believe about basic conceptual issues, such as we find in Kurzweil's book, are hindering AI.

3) I complain "about anthropomorphizing, but there is no harm...." In AI, anthropomorphizing leads to an emphasis on human qualities that are irrelevant to, and a distraction from, the real aims of AI.

4) My review "ignores [the book's] salient arguments...." I do not detect any, only fantasy, Kurzweil's own "laws" of physics, unjustified assertions, and factual errors.

His letter is no different. For example, Kurzweil insists that Wittgenstein's *Tractatus* is about the brain, supporting this with a fallacious argument. In fact, the *Tractatus* is a technical work of symbolic and philosophical logic and abstract metaphysics and has nothing to say about the brain. Moreover, when Wittgenstein later did discuss the brain, he denied precisely Kurzweil's argument, that to talk about "thinking" or "knowing" is to talk about brain activity. Kurzweil also says that "there is nothing to prevent these efforts [modest connectionist experiments] from scaling up to the entire human brain." How could he, or anyone else, possibly know this, given the vast discrepancy in scale that is involved (there are perhaps as many as 10^{14} neurons in the human brain)?

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Chimp Cultural Diversity

The special News Focus of 25 June (p. 2070) by Gretchen Vogel highlights papers in *Nature* and the *Journal of Human Evolution* reporting that chimpanzees show regional learned behavioral differences (multiculturalism), but it does not mention that phylogeographic studies would lead us to expect such differences (*1, 2*). What is often erroneously referred to as "the chimpanzee" comprises at least two well-differentiated allopatric populations that have diverged genetically for more than 1.5 million years. The same heterogeneity is now recognized in "the gorilla" and "the orangutan." There is several times more mitochondrial DNA variation in a single chimpanzee social group than in the entire human species (*2*) and more sequence variation at chimpanzee nuclear coding (MHC) and noncoding (HOXB6) regions than in humans (*3*). It is perhaps more surprising that there is any cultural variation in our own relatively homogeneous species than that there is any in our far more variable hominoid relatives. Although a few scholars still deny any role for genetics in the regulation of behaviors, and others posit the existence of nongenetic mental replicators (memes) to account for cultural transmission, we can no longer ignore the genetic diversity of the chimpanzees.

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Vogel quotes Carel van Schaik as speculating that tool-using in early hominids became more common as a result of higher "social tolerance." John Fleagle is quoted as agreeing with this speculation, noting that the reduction in canine tooth size seen in the early hominid fossil record was probably indicative of increased tolerance.

In 1993, we proposed a mechanism that would have led to increased social tolerance in basal hominids (*1*). The social change that led both to greater tolerance and to the origin of habitual bipedal posture evolved as an extension of the behavioral complex of bipedal threat displays and appeasement behaviors observed in great apes. These behaviors evolved in ape societies as means to mitigate aggression and avoid physically injurious confrontation. We speculated that these behaviors became more important in prehominid populations of the late Miocene in Africa, in part because of environmental changes. We also indicated that this behavioral change would have led to a reduction in canine size because conflict resolution would have increasingly relied on bluff and display rather than physical attacks involving biting. We have since demonstrated, using a demographic model (*2*), that a behavioral innovation leading to greater social tolerance that was effective at reducing morbidity and mortality in long-lived ape species would have been strongly favored by natural selection. This mechanism is best seen as an exaptation which, by promoting habitual bipedalism, made possible the anatomical and neurological changes associated with increased manual dexterity and tool use. One need search no farther than this to understand the origins of increased social tolerance in human ancestors.

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