Universal biology

Richard Dawkins

Artificial Life: The Quest for a New Creation. By Steven Levy. *Cape / Pantheon: 1992. Pp. 390. £16.99, $25.*

I AM enthusiastic about the embryonic field of artificial life and want to be positive about Steven Levy's book. So let me get the minor carping out of the way first.

"...scientist Harold Thimbleby, a computer scientist at Stirling University... ." The adjectival noun is ugly as well as superfluous but journalist Steven Levy, a journalist, is apparently obliged by union rules to shove it in, together with "evolutionary biologist William Hamilton", "Nobel-laureate Niko Tinbergen" and countless others.

The adjectival noun is just a trivial diagnostic of journalese. But Levy also tests positive for that more serious malady of science journalists, Dark Ages syndrome. There is a new wave of heroic young scientists (the ones the journalist has been interviewing and hanging out with). Before they burst on the scene we were mired in the Dark Ages. Left over from the Dark Ages are the Old Guard, traditional scientists with attitudes as hard as their arteries, who control the university jobs and the grant money. Our story is one of doughty deeds by the New Heroes, in the teeth of uncomprehending hostility from the Old Guard.

Occasionally, to be sure, scientific revolutions really do work like this; and in the case of artificial life its luminaries come trailing genuinely swashbuckling pasts: Doyne (pronounced Doan) Farmer and Norman Packard, who typed with their toes on ultra-miniature computers hidden in their shoes in order to break the bank at Las Vegas; Stephen Wolfram, who contemptuously forsook Eton and Oxford and created Mathematica, one of the most admired computer programs ever written; Danny Hillis, another boy-wonder, who invented the legendary Connection Machine; and the *éminence rouge* of 'Artificial Life', Christopher Langton himself, who broke all four limbs and most other bits too as an exhibition hang-glider. But the Dark Ages/Young Buccaneer formula has become a lazy cliché among science journalists, and we need to see less of it.

Levy doesn't fall into this cliché quite as heavily as some of his colleagues whose books range from anti-evolution to palaeontology to chaos theory. But he too cannot resist the temptation:

> Traditional computer scientists had no trouble ticking off reasons why this could not possibly work; they cited mathematical principles that theoretically limited the speed gain of parallel processing.

This is a set-up, of course, for a New Hero to come bounding on-stage and confound the establishment, and Hillis duly does. But it is an unsatisfying way of writing, because a mathematical principle is a mathematical principle and we are left wondering how even the Old Guard managed to get it so wrong.

> Genetic algorithms could generate robust programs and artificial adaptive phenomena by utilizing the power of evolution. Yet the lords of computer science were slow to bestow their blessings on it... .

Who are these 'lords' and do the rest of us really so obsequiously grant them the power to 'bestow blessings'?

> In the past, the prejudice against mathematical modeling in theoretical biology might have been justified.

What prejudice against mathematical modelling? What does Levy think theoretical biology mostly is, if not mathematical modelling? See any back issues of *Journal of Theoretical Biology*.

Enough of griping, let us turn this into an interesting point. There *is* a prejudice lurking in theoretical biology, but it is not against mathematical modelling. It is more pernicious than Levy realizes, and artificial life goes right to its heart. It is a prejudice against the very idea of a truly theoretical biology, against a biology that strays far from the narrow path of 'data'. I first recognized this prejudice in 1982, at the Darwin Centenary Conference in Cambridge. I presented a paper called "Universal Darwinism", in which I argued that darwinian natural selection is not just the principle that *happens* to underlie life on this planet; natural selection is a *necessary* feature of life anywhere. If organized, apparently purposeful complexity is found anywhere in the Universe, I suggested, some form of Darwinism will be the ultimately responsible force.

In the discussion my lecture was vehemently attacked, not by any Old Guardee but by a distinguished biologist and statistician. It wasn't that he disagreed with the thesis of Universal Darwinism; if he had, that would have been interesting. No, his complaint was that I had not backed up my claim with data! You might as well attack Pythagoras because he didn't sally out into the field and measure a statistical sample of right-angled triangles. In print after the conference, my paper was assailed on similar grounds as "philosophical" — a sufficiently pejorative epithet in some scientific circles. I didn't realize it then because the phrase had not been coined, but my little essay on Universal Darwinism was grounded in the same philosophy as the now aspirant field of artificial life. It is because of this philosophy that we should take the field

Plant programming — P. Prusinkiewicz simulated this *Mycelis muralis* using an L-system program, which adds self-similar new growth with each iteration of the formula. The picture is taken from the colourfully illustrated *Fractals: The Patterns of Chaos* by John Briggs (Simon and Schuster, $20 (pbk)).

seriously, even if we are not — yet — impressed by any of the attempts to synthesize life in computer or test tube.

Most of biology is, rightly, the study of the way living things actually are. Mammals have twice as many heart chambers as fish. Haemoglobin is red. The list of such facts is too large to be memorized by any individual. You can treat them as just plain true. But could there be a subset of facts that not only are true but *have* to be true (or are, *a priori*, very likely to be true)? If so, isn't there a sense in which this subset is more important than the facts that just happen to be true? My Universal Darwinism conjecture is a candidate. There are others. Nerve spikes convey information by their frequency rather than their amplitude. Is this just another fact or could it be predicted for the functional equivalents of nervous systems on other planets? Hereditary information is digital not analogue and it is transmitted, irreversibly, with exceedingly high fidelity (low mutation rate). Are these just facts about life on Earth, or must they be true of life everywhere? What about the genetic code itself. Is it a frozen accident? Could it have been different? Can we predict that lifes on other planets will have detailed similarities such as triplet codes? Sex? A separation between germ line and soma and an equivalent of Francis Crick's 'central dogma'?

It is difficult to answer questions about lifes in general, because we have a sample of only one to look at: the DNA-coded, protein-engineered, carbon-based life that has evolved over the past three to four billion years on this planet. If there are other lifes in the Universe they are probably too far away in space and time for us ever to know about them. The only practical hope we have of studying a sample of lifes greater than one is to synthesize them ourselves and let them evolve. Our present technology is such that the digital computer, perhaps especially in parallel, network form, is our best bet as an incubator for artificial life. Some simulations might be realized as robots actively moving, 'feeding' and conceivably reproducing in the real world. One might also hope to use real, wet glassware to develop alternative biochemistries and alternative genetics. All these, and their evolution, belong in the field of artificial life.

Levy's book is an adequate history of the field both before and after it was named. He fittingly begins with John von Neumann's self-reproducing machines and moves, via John Conway and cellular automata, to 1987 when Christopher Langton, realizing that there was a field waiting to be named, convened the first artificial-life conference in Los Alamos. I had the honour to be invited to this memorable gathering, and I confirm that Levy captures something of its unique, spacy, *Dr Who*-like atmosphere. He does not neglect the serious deliberations of the conference, which were soberly recorded under Langton's excellent editorship in *Artificial Life* (Addison-Wesley, 1989). Levy makes some attempt at analysing the theoretical and philosophical issues, with loads of that 'bottom-up top-down' stuff (the phrases seem instantly to strike a deep chord with everybody except me); but here I think I would rather wait for Langton's own book, due to be published in 1993, probably with the same title again.

You may read *Artificial Life* to learn about gee-whizz achievements so far, but I think you will be disappointed if you do. Give that aspect another few years to develop. A better way for a biologist to approach the field is as an aid to separating contingent facts about life from necessary, or at least highly probable, facts about lifes. It can help us to understand lifes in general, and this will illuminate Earth's life in passing. Artificial life emancipates biology from the tyranny of the particular and parochial. □

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Revealing ancient language

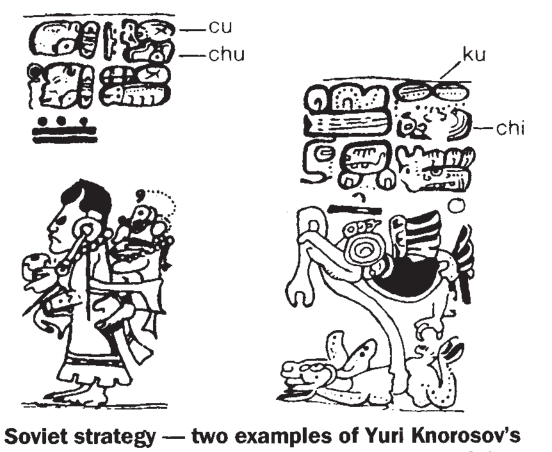
Nicholas J. Saunders

Breaking the Maya Code. By Michael D. Coe. *Thames and Hudson: 1992. Pp. 304. £14.95, $29.95.*

Few scholarly achievements are as glamorous as the deciphering of an ancient script, as Jean François Champollion's decoding of Egyptian hieroglyphics and Michael Ventris's cracking of Linear B have illustrated. These triumphs set precedents for a linguistic approach to decipherment and yet were, by turns, misapplied, ignored and eventually redefined by those seeking the grail of decipherment for the Maya hieroglyphics — pre-Columbian America's only complete script. In *Breaking the Maya Code*, Michael Coe tells this compelling story through the colourful personalities of the protagonists.

Despite the relationship between ancient scripts and modern languages established by Champollion, most Maya scholars pointedly ignored surviving Maya tongues as a possible key to decipherment. This despite the occasional prescient insight, such as Constantine Samuel Rafinesque's 1832 letter to Champollion, in which he evidently regards the inscriptions as representing the still extant Maya language. No comprehensive linguistic assault on the Maya script materialized however, and worse setbacks were to come. Coe elegantly describes the developing conflict between those who espoused a linguistic historical approach and others who saw Maya hieroglyphs as unrelated to language and used solely for calendrical and astronomical purposes. In admirable detail we are presented with an array of mathematically orientated results achieved by such meticulous scholars as Ernst Förstemann, who discovered that the Maya used a vigesimal (base 20) counting system, possessed a 'long count' of years and could account for the movements of Venus. In a similar vein was the discovery by John Teeple in 1925 that the Maya time for an average lunar month was only 33 seconds off the actual value.

The cumulative effect of such discoveries was to stifle occasional dissenting voices such as Cyrus Thomas, who regarded the Maya script as a mixture of phonetic signs and logograms (single symbols representing an entire morpheme, word or phrase). It also gave rise to a distinctive yet wholly untenable view of Maya society. By adhering to the calendrical–astronomical theory, such formidable Mayanists as Sylvanus Mor-



Soviet strategy — two examples of Yuri Knorosov's decipherments using the texts and pictures of the Maya codices. Left, signs above the encumbered Moon Goddess read *cu-ch(u)* or 'burden'. Right, signs above the Vulture God read *ku-ch(i)*, 'vulture' in colonial and modern Maya.