

That threat may have receded, but we still live under its shadow.

Sakharov wrote again to Khrushchev in 1964, this time on an issue for which he had been slanderously attacked in *Izvestiya*, and criticized at the plenum of the Central Committee of the Communist Party of the Soviet Union (CCPSU). The issue? His crucial speech that blocked the election of N. I. Nuzhdin to the Soviet Academy of Sciences. For Nuzhdin was a "faithful companion" of Trofim Lysenko, who regarded Sakharov's intervention as "a criminal matter". And it is reported that Khrushchev was so furious that he threatened to abolish the academy. (This did not occur; Khrushchev was dismissed from office in October 1964.) The pernicious sway of lysenkoism over Soviet genetics was broken by Sakharov's speech. B. M. Bolotovskii extensively quotes eyewitness accounts given to him by Tamm and Sergei Syrovatskii, as well as Sakharov's own reply to *Izvestiya* and his letter to Khrushchev. (Bolotovskii was the Communist Party organizer in the theoretical department of the academy's Lebedev Institute (FIAN), assigned by the party committee to "oppose" Sakharov during his years there.)

Khrushchev's denunciation of Stalin at the Twentieth Congress of the CPSU, and Roy Medvedev's polemic *Let History Judge*, impressed Sakharov deeply. His strong humanitarian convictions now led him to increasingly public protest and action. In 1968, his *Reflections on Progress, Peaceful Coexistence and Intellectual Freedom* was distributed through *samizdat*, and as *tamizdat* some 20 million copies were printed abroad. This cost him his job at the installation, and although he was allowed to join FIAN, he was now in official disgrace.

In the course of his human-rights campaigns, he met and married Elena Bonner, and when he was refused permission to travel to Oslo it was she who received the 1975 Nobel Peace Prize on his behalf. The abuse and vilification in the Soviet press rose to a peak. For protesting against the invasion of Afghanistan, Leonid Brezhnev exiled Sakharov to Gorky by a decree that had no status under Soviet law. During his seven years there, he suffered the appalling indignities of force-feeding when he went on hunger strike, and the spite of the KGB.

Both these books recall the disgust and anger of the scientific community, the moral support of his colleagues at FIAN and the unquenchable strength of his personal concerns, which always moved swiftly from general principles to concrete particulars. But it is to *Facets of a Life* that one should turn for passion and immediacy. It is easy to find fault with this "physicists' tribute" assembled by the theoretical department at FIAN.

It is untidy and uneven, with no evidence of editorial organization apart from alphabetical ordering by author; the English is distinctly Slavic; the subject-matter is often repetitive; there is no index, making cross-reference between the 60 contributions difficult. But for all that, I cannot recommend it too highly. Here is Sakharov as seen by those who grew up with him and worked with him; those whose lives were intertwined with his, who took risks on his behalf or who feel guilty that they did not risk enough. Not an icon of a saint, but sketches towards a portrait of the man.

The clamorous, argumentative essays jostle for attention. Many of them read like evidence at a tribunal, and most are concerned with setting the record straight. For example, there are agonizing attempts to clarify how Sakharov passed certain papers from Gorky to Moscow, one of which was a letter to Anatoly Aleksandrov, president of the academy. This letter, written *in extremis* to appeal for help before he began a hunger strike to secure permission for Elena Bonner to travel abroad (to visit her family and for medical treatment), is a heart-rending document, reproduced in the essay by Vitaly Ginzburg. But it was delivered a year late because of the scruples and hesitation of the "couriers". Not only Ginzburg, but also Boris Altshuler, Dmitry Chernavsky and

Evgeny Feinberg give their versions of what led Sakharov to write: "I have learned some details of what was going on in Moscow during my hunger strike and understood (but not reconciled myself to) the reason of [sic] disappearance of one of my documents."

Boris Altshuler's article, aptly headed with a quotation from Andrei Sinyavsky's — "I shall speak straight because life is short" — is packed with examples of Sakharov's knowhow; the achievement of strategic objectives by concentrating on concrete particulars. Altshuler had himself been fired as a physicist for his human-rights activities, and worked for many years as a caretaker. Feinberg addresses "the future historian" who will "understand Andrei Dmitrievich better than we, his contemporaries, obsessed with the intertwined and sometimes contradictory emotions and opinions." He emphasizes that Sakharov's political views evolved; it was this that perhaps gave them greater strength and maturity. Many of the authors speak of Sakharov's total integrity, the simplicity of his lifestyle, his apartness; he was regarded by some as a prophet. He surely touched their lives, and the shaping and direction of *perestroika*. And so our lives too. □

John M. Charap is in the Department of Physics, Queen Mary and Westfield College, Mile End Road, London E1 4NS, UK.

## Alien life

Frank J. Tipler

**The Cosmic Water Hole.** By Emmanuel Davoust. MIT Press: 1991. Pp. 206. \$19.95, £17.95.

NEXT year, on Columbus Day, US researchers will begin a ten-year, \$100-million programme to search for extraterrestrial intelligence. Davoust, a French astronomer, provides a very readable popular description of this and other efforts to detect radio transmissions made by extraterrestrial intelligence. But his book marks an important change from the vast numbers previously published in this genre: he admits that the search will probably fail because such intelligence probably does not exist. It is refreshing to see an astronomer join the distinguished biologist Ernst Mayr, are "... almost uniformly skeptical of the probability of extraterrestrial intelligence".

Davoust accurately expresses the force of the Fermi paradox: if extraterrestrial intelligences exist, why are they not already here? Even our primitive rockets can reach the stars in  $10^5$  years. Computer experts (such as Hans Moravec in

*Mind Children*, Harvard University Press, 1988) tell us that within 50 years we should be able to make an intelligent computer capable of self-reproduction. The combination of our primitive rockets with a payload of self-reproducing robots would be sufficient to explore and colonize the Galaxy. With such a probe, this would take only a few hundred million years to accomplish. We know that if our own evolution is typical, then most civilizations in our Galaxy must have arisen billions of years ago. Thus most experts now admit that civilizations so advanced would be here if they wished to come.

Davoust devotes an entire chapter to possible sociological mechanisms that might prevent interstellar travel. But I think he neglects the crucial point: virtually any motivation we can imagine that would lead extraterrestrials to engage in interstellar radio communication with us would also motivate them to engage in interstellar travel. The above-mentioned radio search is for civilizations wanting to contact us, for our equipment is not powerful enough to eavesdrop. Although we do not know the motivations of all advanced civilizations, we thus do know the motivation of the civilizations we search for. But robot probes would achieve the aims of these civilizations much better than radio sig-

nals. For example, probes can contact civilizations that are not listening, that is, those that do not have radio technology. Probes can be used to explore and colonize uninhabited systems.

Carl Sagan has argued that "perhaps [extraterrestrial intelligences] just don't care to strip-mine every site in the Galaxy". In his books, Sagan himself shows that all communication has costs; as he repeatedly says, the bare fact of a

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received signal from an alien civilization would change ours drastically. But the purpose of any communication is to change the knowledge of the person to whom the message is directed: to colonize a mind with memes (complexes of ideas). There is no fundamental distinction between colonization with memes and colonization with genes. But in the case of genes, it is at least possible to limit colonization to uninhabited systems. Meme colonization necessarily occurs in inhabited systems, and necessarily extinguishes other memes. It is necessarily imperialistic.

Davoust discusses at length the anthropologist Ben Finney's comparison of interstellar colonization with historical human migrations. Finney claims: "No specific migration has ever gone unchecked. Ecological barriers, the slowing or cessation of innovation, flagging motivation, or the opposition of those in the way of expansion have . . . stopped every . . . colonization movement so far." Finney infers that interstellar colonization would stop short of the entire Galaxy.

But Finney's own data indicate the opposite. The analogue of the ecological-innovation barrier is the lack of a suitable robot probe, and our own civilization is near to overcoming this. With a probe, there is no natural barrier to stop a colonizing species short of the entire Galaxy. By definition, there is no opposition of those in the way for the first intelligent species to evolve. Finney's data indicate that motivation flagged once the other three barriers made further expansion difficult. Finney's picture of the evolution of Polynesian society is exactly what John Barrow and I predicted (*The Anthropic Cosmological Principle*, Oxford University Press, 1986) would be the behaviour of a colonizing extraterrestrial intelligence: an *r*-strategy characterized by rapid expansion

in numbers would be typical of those at the frontier, whereas a *K*-strategy characterized by fluctuations in numbers around an equilibrium would be typical of those in the interior.

Those engaging in radio searches like to argue that absence of evidence is not evidence of absence. (Davoust repeats this slogan at least twice.) I totally agree, but we have evidence: extraterrestrial intelligences are not here. We just have to interpret this fact. Most astronomers cling to a belief in extraterrestrial intelligence against the evidence because of a philosophical principle: the copernican idea that our place in the cosmos must be completely typical. But we know this idea is false. The Universe is evolving: the cosmic radiation shows that there was once a time when no life existed because it was too hot. Thus, our place is atypical in time. In particular there must be a first civilization, and it happens to be ours.

Davoust does not mention Brandon Carter's argument, based on the weak anthropic principle, for the nonexistence of extraterrestrial intelligence. This is unfortunate, because some of the most interesting new developments in particle physics use Carter's argument, which is derived from the fact that the time it took to evolve intelligence on Earth is within a factor of two of the lifetime of the Sun. Carter explains this approximate equality by assuming that the average time needed to evolve intelligence on an Earth-like planet is actually much longer than the lifetime of Sunlike stars. Biological evolution will cease when the star of an Earth-like planet dies, because the dying star destroys its planet. But the longer evolution can proceed, the more likely it is that intelligence will evolve. Thus the most probable time for the appearance of intelligence would be near the end of the time that evolution has had to operate on an Earth-like planet; that is, we expect approximate equality between the Sun's lifetime and the time needed to evolve intelligence. By making Carter's argument quantitative, S. Weinberg obtained an upper bound to the cosmological constant, whereas M. Shaposhnikov (*Modern Physics Letters* 59, 2607; 1987) made a prediction of the Higgs boson mass. This prediction failed, but it is a fascinating thought that there may be a connection between the Higgs mass and the rarity of intelligent life in the Universe. Pursuing this idea would be far more scientifically productive than doomed-to-fail radio searches. The original French title of Davoust's book was *Silence au point d'eau*. Silence there will be. □

Frank J. Tipler is in the Department of Physics, Tulane University, New Orleans, Louisiana 70118, USA.

## Mosquitoes and backbiting

Len Goodwin

**The History of Yellow Fever: An Essay on the Birth of Tropical Medicine.** By François Delaporte. MIT Press: 1991. Pp. 181. \$30.25, £20.25.

RESEARCH scientists are human, and like to receive credit for their discoveries. But when recalling the development of their hypotheses, they can forget or omit to mention whose ideas really triggered them off. François Delaporte has made a detailed epistemological study of the classic discovery of the mode of transmission of yellow fever, accounts of which differ between South and North America. Cuban historians affirm that Carlos Finlay deserves most of the credit, whereas in the United States Walter Reed and his team are the true heroes. Both, of course, made vital contributions, but Delaporte, by noting what they read and wrote, reveals some facts that lead him to give credit for the seminal ideas to four Britons — Patrick Manson, Ronald Ross, Herbert E. Durham and Walter Myers.

Finlay, who had Cuban, French and Scottish blood, was an ingenious observer who had advanced several theories for the transmission of yellow fever, such as that involving increased ammonia in the atmosphere. In 1880 he had access to two important North American documents, the 'Plymouth' and the Chaillé reports, which showed that a ship needed contact with a port for an outbreak of yellow fever to occur and that some time elapsed between exposure at a port and an outbreak on board — the germ was "not like the poison of smallpox, but is produced and developed outside the body". He was also aware through the British medical press of Manson's work in China, showing that microscopic larvae of filarial worms in a patient's blood taken up by a mosquito developed in the insect to an infective stage. Finlay made the important observation that the 'Culex mosquito' (*Aedes aegypti*) could bite 12 times and lay three batches of eggs before it died; it could therefore convey infective material from one person to another, leading him to put forward his theory of mosquito transmission of yellow fever. But numerous attempts at transference from a patient to human volunteers failed because he kept the mosquitoes for only 3–5 days between bites. Finlay was regarded as a crank and it was 20 years before he was vindicated.

By 1900, yellow fever had visited 100 US cities and had killed thousands of