out that organisms not only adapt to their environment but construct it as well. In *The Extended Phenotype* (Freeman, 1982), Richard Dawkins argues that genes can express themselves outside the bodies of the organisms that carry them, an example being a beaver's dam. Richard Lewontin, in his contribution to *Evolution from Molecules to Men* (Cambridge University Press, 1983), also realized that the histories of organisms and the environment are a function of each other. He therefore suggested that what is actually happening in nature could be represented by a pair of coupled differential equations.

Niche Construction goes one step further by providing an exhaustive list of the possible effects of organisms on their environment, from the alteration of non-living environments to various sorts of maternal effects induced by differences in the levels of yolk, hormones and messenger RNA in the cytoplasm. In humans, cultural processes constitute an additional kind of non-genetic information that is transmitted from one generation to the next. The authors correctly argue that niche construction may result in evolutionary feedback, with the evolutionary trajectories of organisms being influenced by the changes that they induce on their environment. Feedback also occurs across generations, with individuals being influenced by the environmental modifications provoked by their ancestors.

To make their point, the authors list numerous examples. One of the most striking is the evolution of lactose tolerance. The domestication of cattle brought milk and dairy products into the diet of some human populations for enough generations to promote genes that confer greater lactose tolerance. Another example of a culturally induced genetic signature relates to the influence of agricultural niche construction on natural selection. The Kwa-speaking yam cultivators of West Africa made clearings in tropical rainforests, increasing the amount of standing water. This provided superior breeding grounds for malaria-carrying mosquitoes, which in turn increased the prevalence of malaria. At the same time, the frequency of the haemoglobin allele responsible for sickle-cell anaemia increased, as people who have one copy of this allele have some resistance to malaria. These examples demonstrate how cultural processes are not just a product of human genetic evolution but also a cause of it.

So does this mean that we need a new, extended theory of evolution as advocated by *Niche Construction*? I believe that the answer is no. First of all, the examples of niche construction given in the book can be explained by conventional evolutionary theory once all of the relevant environmental factors are taken into account. Several elegant models — including some developed by the authors themselves — have already been proposed to deal with feedback effects between organisms and their environment. At the same time, it is not possible to develop an extended theory of evolution that can encompass all of the different types of niche-construction effects. Interactions between organisms and their environment are, by their very nature, complex and result in an intricate web of interacting effects. No heuristic theory could integrate all of these effects without becoming intractable, so we need to devise specific models for each situation. Indeed, evolutionary biologists are already doing exactly this.

To summarize, *Niche Construction* does an excellent job of detailing the many ways in which organisms modify their environment and hence the selective forces acting on them. But it is unfortunate that the authors attempt to oversell the significance of niche construction. By advocating a grand, extended evolutionary theory, they distract readers from the more important message of the book, which is that the influence of organisms on their environment can have far-reaching consequences. Indeed, humans are currently working hard at building a vivid example of this. By allowing the massive-scale niche destruction that is currently under way, we are not only compromising the environment, but also affecting the prospects and evolutionary trajectories of our children and many later generations. ■

Laurent Keller is in the Department of Ecology and Evolution, Biology Building, University of Lausanne, 1015 Lausanne, Switzerland.

An enigma for all seasons

Prof: The Life of Frederick Lindemann
by Adrian Fort
Jonathan Cape: 2003. 374 pp. £18.99, Can$48.50

Stuart Young

According to Mark Twain, "Biographies are but the clothes and buttons of the man — the biography of the man himself cannot be written." Yet with so puzzling a subject as Frederick Lindemann, attempting to portray "the man himself" is difficult to resist. In the world of science he was exceptional, and in the world at war his power was as great as that of any scientist in history. But he could also be reticent and reclusive. Although former associates remember him well, to many others Lindemann remains, as was said of him recently, "the most important man you have never heard of".

Lindemann's cherished homeland was England, but his scientific education and early research took place in Germany, where he worked successfully on thermodynamic problems with Walther Nernst in Berlin. In 1911, aged just 25, Lindemann took part in

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conference discussions with all those scientists whose names were so prominent in the evolution of modern physics, including H. A. Lorentz, Max Planck, Albert Einstein, Ernest Rutherford and Marie Curie. Back in England during the First World War, he turned his experimental skill to warplanes, which he learned to fly to prove his theoretical method of recovering from an aircraft spin. And then in 1919, as professor of physics at Oxford University, he began the major task of recreating the Clarendon Laboratory's teaching and research facilities.

It is part of the puzzle that during his lifetime Lindemann aroused antipathy, if not worse, in some quarters, yet great affection and loyalty in others. His abiding and closest friendship was with Winston Churchill, who constantly relied on him before, during and after the Second World War for advice, not only on strictly technical matters, but also on a wide range of topics that his scientific mind could clarify. In the war years, Churchill required, and Lindemann supplied, concise summaries of the situation at the startling average rate of about one a day. They covered bombing strategy, shipping capacity, aircraft defence, strategic supplies, explosive efficiency, German 'flying bombs' and many other topics.

The persistence with which Lindemann's group of experts probed for the data, and his obstinacy and scorn when challenged, brought him into conflict with many at the time. After his death in 1957 there were some who vilified him as a malign hindrance to the Allied war effort, whereas others hailed him as one of the main contributors to its success. And throughout, his idiosyncrasies were thoroughly documented, as if they added significance, rather than mere colour, to the events in his life.

Until now, the foremost objective account of Lindemann's life has been *The Prof in Two Worlds* by the Earl of Birkenhead (Collins, 1961). This was prepared as the official biography soon after Lindemann's death in 1957, although in the event it was pipped at the post by *The Prof: A Personal Memoir of Lord Cherwell* by R. F. Harrod (Macmillan, 1959).

The new biography by Adrian Fort is timely. He has searched widely to uncover every available scrap of relevant information about his subject. It is clear that private papers and official documents were opened to him, shedding new and brighter light on some parts of Lindemann's influential life. But the key word is 'available', and the story told by Fort begs the question: how much more may still be hidden in secret papers? To take one example, did Lindemann have any influence in the vital wartime business of coding and decrypting?

Prof contains extracts from some of Lindemann's wartime minutes to Churchill. These provide an interesting complement to Churchill's own published account of the events, in which the directives all flowed in the opposite direction.

This is a well-rounded, very readable and reasonably illustrated life story of a remarkable man who had a profound influence on academic and political affairs. It shows how between the wars he was almost solely responsible for the rebirth of physics at Oxford University, and how the achievements there in low-temperature research were the consequence of his personal and timely protection of some prominent scientists — including Francis Simon, Kurt Mendelssohn and Nicholas Kurti — who were under threat from Nazi persecution.

With Churchill, Lindemann managed at the eleventh hour to reverse Britain's unpreparedness for air warfare, and he promoted decisive wartime advances in radio-wave air defence. Significant parts of the ensuing war strategy, such as the allocation of bomber aircraft, for which he has been heavily criticized, were a consequence of Lindemann's advice. In the 1950s he won a lone and strenuous battle to create Britain's atomic-energy enterprise. And during this period he fostered a practical demonstration of one of his interests — a laboratory at Oxford dedicated to the application of scientific methods in art history and archaeology.

Mention of Lindemann's prominent and public activities bypasses the account of his personal research achievements. Fort sketches these with care, although readers should not expect to obtain from him more than a simple, but well-referenced, summary. The large range of Lindemann's experimental and theoretical interests is, in fact, covered by more than 60 published papers.

His letters to his father reveal the softer side of Lindemann's nature and may encourage students of experimental physics. For example, there is one, written from Nernst's laboratory in Berlin, that reveals all the excitement he felt, yet contained by commendable caution, when on the brink of what he thought might be a new discovery. Other letters relate to his progress in the company of all the greatest names of the revolution in physics in the early twentieth century. And for those who may think that top-flight physics must be all-absorbing, it is worth more than a glance to see how Lindemann's student days were spent.

I enjoyed reading this book, which added considerably to my understanding of Lindemann — not only of his great impact, but now also something more of that very intriguing man himself. ■

Stuart Young is at Box 4, Noordhoek 7985, South Africa.

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