

was unable to see it at the time. As he says, "most of one's time is spent in confusion, much in error, and a little with truth". This honest book is Chitty's sacrificial lamb.

The volume is dedicated to the late Helen Chitty, and is a valuable reminder of her significant contribution to the study of population cycles. Among other duties, she organized much of Elton's data by doing what Dennis Chitty calls "mail order zoology", including the Canadian Arctic Wildlife Enquiry and the Snowshoe Rabbit Enquiry, two important sources of information on spatio-temporal ecological variation.

There are, unfortunately, too many ugly, out-of-date 'facts' in the book that are not really synthesized into an integrated whole. The book could have done with further critical scrutiny and the use of an editor's red pen. Another problem is that it was written for three very different kinds of readers: those seeking what Chitty refers to as the ecological Holy Grail ("to understand the 10-year cycles in numbers of animals such as lemmings, voles, snowshoe hares, game birds and

defoliating insects"); scientists, whatever their speciality, who may be interested in the principles of scientific inference; and "anyone interested in mysteries, whether scientific or otherwise". Chitty is certainly aware of the difficulty of combining these three kinds of books into one: "in trying to kill two birds with one shot I here run the risk of merely wounding both". Perhaps he should have focused on just one type of reader: the scientist with an interest in the history of ecology and the development and discussion of his hypothesis.

The Chitty hypothesis may not be as beautiful as many long believed, and Chitty still does believe, but he has produced a very beautiful book. It is well written and full of interesting historical information. To give it colour there are quotations and references from a variety of sources, including the Bible and philosophy texts; indeed, seeing who he quotes is a fascinating exercise in itself. □

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Full circle

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Turbulence: The Legacy of A. N. Kolmogorov. By Uriel Frisch. *Cambridge University Press: 1995. Pp. 296. £45, \$80 (hbk); £15.95, \$29.95 (pbk).*

THE phenomenon of turbulence holds a peculiar fascination both for physicists, who, like Einstein, still see it as the most challenging unsolved problem of classical physics, and for mathematicians, who see it as presenting the ultimate problem in the theory of dynamical systems. But for the meteorologist, oceanographer or engineer, turbulence holds a rather different kind of fascination as usually the unavoidable and intractable phenomenon at the heart of a given physical situation. It must be modelled through judicious approximations, based at best on physical insight or at worst on the need to come up with numbers, or through predictions, which may be no better than 'best guesses' in the absence of a satisfactory underlying theory for turbulent flow. In practical engineering, any small improvement in the modelling of turbulence could have important economic consequences, and this lends an edge to the urgency and competitiveness of research on turbulence. Nevertheless, progress at a fundamental level has been slow over the past 40 years, a reflection of the intense difficulty of the subject.

Uriel Frisch takes as his focus the theory of turbulence put forward by A. N. Kolmogorov in a famous series of three short papers that appeared in 1941 in *Comptes Rendu de l'Académie des Sciences de l'U.R.S.S.* These papers, published in Russian, were translated into English for the Aeronautical Research Council, and were 'discovered' by Batchelor shortly after the Second World War. He reviewed them, together with the almost parallel theories of Onsager, von Weizsacker and Heisenberg, at the Sixth International Congress of Theoretical and Applied Mechanics, held in Paris in 1946 (see *Nature* **158**, 883).

Kolmogorov's theory is based on two general hypotheses concerning the statistics of the relative velocities at a set of points in a turbulent flow. The net effect of these hypotheses is to identify a single dimensional parameter, namely the mean rate of dissipation of energy per unit volume, denoted ε by Kolmogorov (a notation that was subsequently adopted universally), as the key parameter that, together with the kinematic viscosity of the fluid ν , determines all the statistical properties of the small-scale ingredients of the turbulent flow. This theory flourished during the 1950s and early 1960s, when observational evidence from studies of turbulence in the atmosphere and ocean was found to agree substantially with the theory, at least as far

An arctic loon or diver, *Gavia arctica*, surveys a northern lake. The picture is one of more than 120 that appear in *Loons* by Aubrey Lang and Wayne Lynch. In the accompanying text the authors examine the scientific facts behind the many myths that have long surrounded these birds. Firefly, \$19.95 (pbk).

