there is still a serious theoretical difficulty in propagating magnetic disturbances through a liquid conductor, and in order to make progress Alldredge has been forced into treating the core as a solid, thus substituting the theory of electromagnetic propagation for the much more difficult hydromagnetic theory. But the physics of the two situations are very different: a liquid, for example, allows propagation of a variety of waves which are impossible in a solid, and these waves will allow magnetic variations to propagate, when in a solid they would be screened due to electrical conduction. In fact the core possesses a whole spectrum of free hydromagnetic oscillations[5].

Although hydromagnetic theory is difficult, it is possible to describe the induction process in the core by Maxwell's laws. On the time scale over which we have observations, say 10–20 years, the electrical conductivity of the core is so high that resistance effects can be ignored. This assertion can, and has been, tested against observation. One might hope, therefore, to infer the motion of the fluid at the top of the core from magnetic observations, but this is not possible[6] unless we can confidently make further assumptions about the forces driving the flow. However, recent work has shown how to find some general features of the core flow even though a detailed map of the motions may be beyond our grasp. For example, upwelling of liquid from deep inside the core can be measured at points where the magnetic field at the core attains a maximum of minimum vertical component. Surprisingly, the upwelling is very small at these locations[7], suggesting that the liquid is not convecting strongly, at least near its upper surface.

This and other recent proposals[8] suffer from the poor quality of available data. Field changes are monitored at only a few Southern Hemisphere sites. The field must be projected down onto the core surface before it can be interpreted — a procedure well understood in principle but inherently unstable when the observations are inaccurate or sparse. Two recent models of the secular change for 1965 agree quite well at the surface of the Earth but differ by factors of up to two or three at the core. The differences are due in part to the methods that are used in computing the models from the observations, and not all to inadequate data, so that while we wait for another MAGSAT there is still hope for improvements in models of past years by new analytical methods. □

1. Alldredge, L.R. *J. geophys. Res.* **86**, 7957 (1981).
2. Barraclough, D.R. *Nature* **294**, 14 (1981).
3. Halley, E. *Phil. Trans. R. Soc.* **17**, 470-478 (1692).
4. Hide, R. & Malin, S.R.C. *Proc. R. Soc.* **A374**, 15 (1981).
5. Hide, R. *Phil. Trans. R. Soc.* **A259**, 615 (1966).
6. Backus, G.E. *Phil. Trans. R. Soc.* **A263**, 239 (1968).
7. Whaler, K.A. *Nature* **287**, 528 (1980).
8. Barton, E.R. *Phys. Earth planet. Int.* **20**, 111 (1979).

Animal disease and conservation

from Geoffrey R. Smith

WHEN the material interests of man and the well-being of wild animals are considered side by side, real conflicts of interest emerge. Advances in human medicine lead to the growth of population, an increased demand for land and a corresponding loss in wildlife habitat. Environmental pollution is a well recognized side effect of industrial development. Less well understood by many is the threat to wild animals from infectious disease. Fatal or incapacitating infections may be introduced by domestic animals, and there can also be times when the destruction of wildlife becomes necessary to protect man and domestic animals from disease. These matters were considered at a recent symposium* held at the Zoological Society, under the general chairmanship of Sir Andrew Huxley, PRS.

From 1889 to 1898 rinderpest swept from North-east Africa to the west coast and Cape of Good Hope in a 'virgin-ground' panzootic that produced catastrophic losses in cattle and many wild ungulate species (W. Plowright, ARC Institute for Research on Animal Diseases). The disease was eliminated from southern Africa, but a focus of mild permanent infection later became established in the Serengeti region. Rinderpest disappeared from both cattle and game in that region in about 1964, after cattle had been treated with attenuated tissue-culture vaccine for several years. Between 1961 and 1971 the number of buffaloes and wildebeest in the Serengeti more than doubled, probably largely because the young no longer died from rinderpest. There are now 1–15 million highly susceptible wild ungulates in the Serengeti. Once again they are under threat of invasion by rinderpest from the north-east. Plans need to be made now to meet this threat.

Although antigenically very similar, rabies virus strains from vampire bats in South America and foxes in western Europe have characteristic features detectable by monoclonal antibodies. Bats and foxes are sometimes killed as a means of controlling rabies. When fox population density falls below 0.3 per km^2 the disease disappears. An alternative strategy, still experimental but possibly of great significance, is the use of attenuated virus, concealed in chicken-head baits, to immunize foxes. The oral-vaccine virus multiplies in the tonsil and so far shows no sign of reversion to virulence (F. Steck, Vet.-Bakteriologisches Institut, University of Bern).

The role of animal infections in the origin and spread of human influenza pandemics is still the subject of much speculation (M. Kaplan, Pugwash Conferences on Science and World Affairs, Geneva). Inter-species infections can and do occur on occasion, apparently when mutations and recombinations take place. The segmental mode of replication of influenza virus favours recombinative encounters between human and animal strains. Wild birds, in which infection is mainly intestinal and symptomless, constitute an ineradicable reservoir of the everchanging virus — a reservoir that is a permanent potential threat to man and other animals. Recent observations on whales, seals and terns show that influenza in wildlife is not always subclinical, and that high mortality can occur.

Botulism kills millions of waterfowl annually on lakes and marshes throughout the world, and no radical control methods are known (G.R. Smith, Institute of Zoology, The Zoological Society of London). Mud from certain localities, such as the Camargue, inhibits the growth of *Clostridium botulinum*. Our knowledge of the inhibitory mechanisms is incomplete, and a deeper understanding might give some hope for control. As an adjunct to wetland management, surveys for the causative organism are advocated to distinguish between areas of high and low risk.

The evidence that bovine tuberculosis infection is transmitted from badgers to cattle is irrefutable, and the impossibility of separating the two species physically or protecting them adequately by vaccination has necessitated the policy of gassing badgers in the south-west of England (Sir William M. Henderson). While research on the problem continues, the present control policy cannot be abandoned without causing suffering for us all — human beings, cattle and, not least, badgers.

It is impossible to generalize about the part played by disease in the control of numbers of wild animals in comparison with that due to water and food supply. But what the symposium made absolutely clear is that the whole field of animal disease is now of major importance. The subject overlaps at almost every point with that of disease in man and in domesticated animals and offers a great intellectual challenge to the research worker. □

*The proceedings of the symposium on 'Animal disease in relation to animal conservation', held at the Zoological Society of London on 26 and 27 November 1981, will be published for the Society by Academic Press in the series *'Symposia of The Zoological Society of London'*.

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