

Ecology of human parasites

from Robert M. May

ECOLOGICAL aspects of the relation between humans and their various parasites and pathogens is receiving an increasing amount of attention.

David Bradley (in a chapter in *Ecological Stability*, edit. by M. B. Usher and M. H. Williamson; Chapman and Hall, 1974) has recently drawn together some of this theoretical work and field observation. He distinguishes three types of mechanism whereby parasite populations may be maintained. In the first, parasite populations are determined primarily by the transmission phase. Because transmission depends on the varying environment, this makes for widely fluctuating or 'unstable' populations. This first general mechanism has received much attention in the classical parasitology literature; it invites comparison with other animal populations regulated mainly by "density independent" factors. The second type of parasite density regulation is tied to the host population level, which itself depends on that of the parasite (either through mortality, or the development of complete immunity). This density dependent regulatory mechanism makes for a degree of stability in the parasite population, but remains precariously dependent on the size and structure of a particular host community. The third and most stable mechanism involves parasite regulation by the individual hosts. The parasites in effect use the host's immune system to protect themselves against competition, and maintain infection at a steady but sublethal level: if a helminth has a usual transmission rate of 100 worms inoculated into each host, and the host has a means of preventing the worm load rising above 10, then a tenfold decrease or indefinite increase in transmission of parasites will leave the system unaffected.

This is the ultimate in regulation, and is seen to a varying degree in many parasite systems. Work by Smithers (*Br. med. Bull.*, **28**, 49-54; 1972) and others show that, in Rhesus monkeys infected with *Schistosoma mansoni*, adult worms induce antibody production, which kills or inhibits the growth of subsequent young schistosomes. Thus challenge infections are unsuccessful, while the initial infection persists, continuing its egg production. McCullough and Bradley (*Trans. R. Soc. trop. Med. Hyg.*, **67**, 475-490; 1973) and others have gathered epidemiological evidence suggesting that such a mechanism operates in some human populations infected with *Schistosoma haematobium*, the cause of urinary bilharziasis.

These ecological aspects of the way

parasites regulate their populations—by transmission, by overall host population levels, or by host individuals—clearly have implications for public health strategies. If transmission is the key link, then a relatively simple strategy of chemical warfare against the intermediate host (mosquitoes, snails, and so on) is likely to succeed. Conversely, parasites which have evolved stable levels of infection with their hosts can remain essentially unaffected by such a strategy. A clear example comes from Lagos in Nigeria, where a vigorous campaign succeeded in reducing the anopheline mosquito to less than 2% of its previous level, but where the effect on human malaria was very slight. Similarly, in a highly buffered system such as the schistosome-human host relation, a reduction in the intermediate host snail population by one or two orders of magnitude could well have little effect on the prevalence of the infection.

Vaccination against malaria provides another example where ecological theory marches with public health data. Cox (*Nature*, **252**, 268; 1974) has summarised medical evidence to the effect that (at least in monkeys) vaccines can induce not only strong protection against the homologous human malaria species, but also a degree of immunity against heterologous species. Joel Cohen (*Q. Rev. Biol.*, **48**, 467-489; 1973) observed that, to malaria species colonising a human, "each man is an island, John Donne notwithstanding": thus ecological notions as to the dynamics of island colonisation may be relevant. Such theories would predict an interaction among the species of human malaria, and Cohen surveyed a wealth of data in support of this conclusion. Such theoretical and empirical arguments for a degree of heterologous immunity have obvious practical importance: they suggest that a malaria vaccine need not be specific to each of the species, strains or antigenic variants of *Plasmodium* in order to be effective.

Chemistry should broaden the mind

from J. N. Lazonby

The Annual Chemical Congress was held at the University of York on April 7-11. The theme of the congress was 'a view towards the 21st century' and the education symposium reported here dealt in particular with problems of innovation.

"WHY talk about overproduction of chemists?" asked Lord James of

Rusholme in his lecture entitled: 'Education through Chemistry?'. "Chemistry courses have been associated too much with vocational rather than educational aspects. We must make greater claims for chemistry as an intellectual discipline and place less emphasis on industrial applications and vocational training. Undergraduate chemists must cease to think of themselves solely in terms of future chemists." Lord James saw a PhD as a highly valuable stage in the educational process and not as a final commitment to chemistry.

This viewpoint provided a sharp contrast with the previous lecture given by J. Blears (University of Liverpool), who discussed the supply of chemistry graduates in relation to the needs of industry. He pinpointed the coincidence of the expansion of university science departments with the decline in the proportion of the gross national product being spent on research and development. He suggested that the chemical industry is now sufficiently mature that the need is for economic optimisation of production, rather than for innovation. Thus, from this point of view and also in comparison with other countries, such as the USA, it would seem that we are producing enough first degree chemists and possibly over-producing PhDs for the research and development needs of industry.

R. O. C. Norman (University of York) pointed out that universities are good at keeping abreast with the development of subject matter, but there is still much to be done to enhance the educational value (as stressed by Lord James) of chemistry courses. Designers of courses must be more conscious of the qualities of mind which ought to be inculcated. Chemistry courses are good at developing numeracy, but do they develop judgement or verbal skills? Chemistry involves judgement, but students are often not allowed to practise judgement until they are doing research. In particular, he thought that the role of practical work at university ought to be examined more closely. In this respect, he welcomed the University of Sussex 'degree by thesis' as an interesting and worthwhile innovation from which much would be learnt.

Professor Norman stressed that a variety of courses must be provided, ranging from those which are suitable for the future professional chemist to those which offer a study of chemistry in a wider context. But he felt that universities ought not to over-react to student demand and introduce many new courses such as environmental sciences as such aspects may, more sensibly, be absorbed within existing science courses.