

Book Reviews

Ecological and Evolutionary Aspects of Insecticide Resistance. By JOHN A. MCKENZIE. R. G. Landes Co. (Academic Press). 1996. 885 pages. Hard cover. ISBN 0 12 484825 7.

Entomologists were first employed by the US government to help solve several problems: grasshopper plagues in the Mid-West, the cotton boll weevil in the South, and to evaluate chemical mixtures proposed to cure insect and other pest problems. Now, the United States Department of Agriculture (USDA) has grown into an enormous branch of the Federal Government which employs more people than there are farmers in the USA. Meanwhile, the 'little guys' manufacturing quack insect cures have become a billion-dollar global industry producing highly sophisticated, relatively safe, low dose herbicides, insecticides, and fungicides. With the political climate against 'big government', the once independent universities and government agriculture departments are increasingly being asked to obtain funding from the very chemical industry that they were set up, all those years before, to evaluate and control.

John McKenzie's new book treats one of the major problems we are facing in agriculture and human health: insecticide resistance. The chemical industry doesn't like resistance, of course, as it may reduce their income. However, the industry depends on volume sales of chemicals. Given a short patent life, companies must sell as many pounds of chemical as possible to obtain yearly profits for shareholders and executives' bonuses. They hope that they will have new chemicals available if the old ones become useless because of resistance. Farmers' interests are somewhat different. If there is a cheap means of insect control, farmers would like it to last a long time, provided resistance management doesn't affect current farm profits. World and national health organizations have yet another interest; they would like to maximize long-term health for poor citizens at minimum cost; if possible, they would like to eradicate vector-borne disease. The statistics of vector-borne disease are staggering. Malaria, for example, kills 1–3 million people per year, more than any other transmissible disease, and 300–500 million people in the world are infected. In the 1960s, it was hoped to eradicate the disease worldwide, but the plan has been shelved in large part because of mosquito resistance to insecticides and trypanosome resistance to chemotherapy. An unknown, but probably large fraction of the mosquito resistance is due to insecticide use on crops such as rice and cotton. Health organizations therefore have a very long-term interest in maintaining susceptibility to the cheapest possible insecticides. The conflicts between these three sets of interests (chemical industry, agriculture, and health workers), together with the biology of the insects and insecticide biochemistry, interact to produce current pest control practice and the resultant spectrum of insecticide resistance evolution.

John McKenzie is one of a handful of acknowledged leaders in the understanding of insecticide resistance and its management, and he has written an easily-understood, clearly explained account. His own work in Australia on the sheep blowfly has become a classic in evolutionary biology as well as in applied science. He is particularly well-known for work (often published in journals such as *Nature*) elucidating the deleterious side-effects that genes for insecticide resistance have, and how the insect overcomes these side-effects by selection at modifier loci. His new book covers all aspects of insecticide resistance evolution, from the genetic basis, field factors that influence resistance evolution, pleiotropic side effects of resistance genes, biochemical basis of resistance gene action, and applied aspects of resistance management. The approach is from the point of view of a geneticist and evolutionary biologist, and it will therefore appeal to readers of Genetical Research.

However, the book is written for a relatively inexpert audience, as is suggested by the book being part of a series called 'Environmental Intelligence Unit'. One might expect in a book of this nature that the statistical analysis of insecticide dosage–response curves, and their relevance to resistance evolution and quantitative genetics, would be explained. Graphs using log–dose and probit mortality transformations are presented, and the term 'LD_{50}' (median lethal dose, where 50% of the population dies) is used frequently, but the reasons for these peculiar forms of analysis are not discussed; in fact, the term 'probit' does not even appear in the somewhat exiguous index. Quantitative genetic studies are mentioned, and heritability is discussed, but again, there is no detailed explanation.

Many theoretical works on the evolution of resistance have been published, but McKenzie does not go into details about modelling evolution, nor does he discuss why such models may be inadequate. Most of the modelling efforts have been single-locus simulations done by non-mathematicians, and they are extremely crude. McKenzie does mention that genetic drift might be more important than hitherto realized. Mutation/selection balance probably determines the frequency of resistant genotypes in the population and, because resistance is usually selected against in the absence of insecticides, the resistant alleles may often be at numbers below which drift (and mutation itself, another stochastic factor) becomes important. There is quite a lot of recent activity in this area by theoretical population geneticists such as Lande, Gillespie, Kondrashev, Turelli, Barton and others; but, to date, these theoreticians have not stooped to try to recommend policies which might overcome the real problem of insecticide resistance evolution.

The skimpiness of the treatment of theory may reflect McKenzie's own preference for experimental, field work and resistance management practice. All the theory in the world won't get farmers and chemical companies to change their practices unless there is a clear political effort to change the dynamic between these two players and the independent, government sector. Whatever your political preference, it does seem that the original role of organizations like the USDA was a sensible use of taxpayers' money, to work for the long-term common good of farmers and consumers. If you ask your government-paid agricultural researchers to work for the chemical industry, or when you scrap the government research effort altogether, you will end up without an independent body to make recommendations. When I worked in the Mississippi State University Department of Entomology, my colleagues knew that double the amount of insecticide was being used on cotton than needed to control pests. The evidence came from experience with farmers and from experimental plots. One of the major pests of cotton, the tobacco budworm *Heliothis virescens*, was not known to feed on cotton until organic insecticides in the form of DDT appeared on the scene. Very likely, this species was controlled by its natural enemies until that time, and the enemies are less resistant to insecticides than the pest itself. But the political pressure in Mississippi and virtually everywhere else is now for applied entomologists to obtain funding from the very companies whose profits such research would reduce. An obvious conflict of interest. And yet the simplest conclusion from evolutionary biology is that, to slow resistance, we must reduce the selection pressure. All we need to do is to find a way to use less insecticides.

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The Genetical Analysis of Quantitative Traits. By M. J. KEARSEY and H. S. POONI. Chapman & Hall. 1996. 381 pages. Price £27.50. ISBN 0 412 60980 0.

Introduction to Quantitative Genetics. By D. S. FALCONER and T. F. C. MACKAY. Fourth Edition. Longman. 1996. 464 pages. Price £24.99. ISBN 0582 24302 5.

The study of quantitative genetics has been complicated by the existence of two rival research traditions, with their British centres in Birmingham and Edinburgh. Both schools study the statistical properties of continuous, quantitative characters determined by the interaction between multiple environmental and genetic factors, but they differ in their terms of reference. The interests of the Birmingham school are centred around the quantitative genetics of plants and its applications to plant breeding, and they study changes in the mean and variance in successive generations following a cross between two pure, inbred lines. This simplifies the analysis because there are only two alleles at each segregating locus and because the genotype frequencies in any generation can be specified from basic Mendelian principles. The Edinburgh school has concentrated on animal quantitative genetics and its applications to animal breeding and evolution. There may be an arbitrary number of alleles at any locus with arbitrary gene frequencies, the only possible simplification being that of random mating. Thus the two schools start from different assumptions and it is not surprising that there is little connection between their results. What connection there is has been obscured by their use of different terminology.

The textbook of the Birmingham school has been *Biometrical Genetics* (K. Mather, 1949; K. Mather and J. L. Jinks, 1982), which has been out of print for some years. Following the death of both authors of this classic text, Kearsey and Pooni, who have each made important contributions to the subject, have written a successor to it. Their book differs from that of Mather and Jinks in two main ways. First, they have generously abandoned the Birmingham in favour of the Edinburgh notation, so that notational differences need no longer be a barrier between the two schools. However, the reader should not be lulled into a false sense of similarity; the two schools start from different populational assumptions and their results are conceptually different even when they use the same symbols. Secondly, Kearsey and Pooni's book is written at a more popular level than that of Mather and Jinks. They have minimized the maths and statistics in order to appeal to a biological audience, and in places they go too far in sacrificing accuracy for simplicity; for example, on p. 42 they present a simple but erroneous method for testing homogeneity of variances. Nevertheless, this is a valuable introduction to the methods of the Birmingham school.

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