have studied the retention of mercury salts by apple fruits after seven sprays with 0·003 per cent mercury as phenyl mercuric nitrate. A fruit weighing 200 gm. had about 10 μgm. of mercury: 2 μgm. in the peel, 8 μgm. in the flesh and less than 1 μgm. in the core. T. E. Cobbold describes a compressed air nozzle for small-volume spraying, and has also assessed the field performance of the power-knapsack type of mist sprayer. Little is known about the chemical composition of the cuticle in different plants, but J. T. Martin, R. F. Batt and Margaret F. Roberts show that there are considerable variations in the overall amounts of cuticle and in the proportions of wax and cutin between plants. As the cuticle is the initial receptor of sprays, a knowledge of its constitution should be important in practice.

There are also papers on domestic food preservation, on fruit juices, and on the conversion and utilization of the Station's plantation of cricket bat willows. Research workers and advisory officers will find a most useful list of papers published by members of the Station's staff in 1957, and there is a further index of papers published in the Long Ashton annual reports during 1953–57. JOHN GRAINGER

INSECT RESISTANCE TO INSECTICIDES

THE discovery by Müller of the insecticidal properties of DDT in 1939 was followed by the introduction of a whole range of similarly powerful synthetic insecticides in the years immediately after the Second World War. These included other chlorohydrocarbons like dieldrin, the gamma isomer of benzene hexachloride, and a number of organophosphorus compounds. Their use marked a new era in the control of arthropod pests and the development of what is now an important branch of the chemical industry. The spectacular control of the malarial mosquito, for example, brought the global eradication of the disease within the realm of probability.

The development of insect resistance to some of these insecticides, however, now threatens to undermine much of the progress achieved and the hopes of some large-scale public health programmes in tropical latitudes especially. Resistance may attain such levels as to involve virtual immunity of the insect to an insecticide and the failure of effective control in the field. Yet remarkably little is known about the mechanisms of resistance and in no case has a satisfactory counter-measure been developed except to change to one of the dangerously few alternative insecticides. A major problem has been to engage the interest of suitably equipped and experienced workers and to facilitate the exchange of information and insect material between research workers and the often far-distant field entomologist or sanitarian. A good deal has recently been achieved by a small dedicated group of the World Health Organization in Geneva due in no small part to the tireless efforts of Prof. A. W. A. Brown. His recent monograph on "Insecticide Resistance in Arthropods"* is one result of a two-year term-of-office with the Organization and reflects an authority and erudition made possible only by a combination of the uniqueness of the author's position and his personal industry.

Four long chapters deal with the genetic nature and development of resistance, resistance in species which are vectors to man, what is known of the physiological and biochemical mechanisms of resistance, and resistance in species which are not vectors.

The first chapter describes the historical development of resistance in vector species, the public health implications, the genetic nature of the inheritance of resistance, and the important problem of detecting significant levels of resistance in field populations. The second chapter deals *seriatim* with case histories of the vectors such as body lice, and mosquitoes transmitting malaria and yellow fever. The third chapter deals mainly with the housefly, since much the larger part of systematic research has been conducted with this insect. The final chapter, like the second, deals with case histories of the field development of resistance in fruit flies, bed bugs and cockroaches.

The monograph will interest the geneticist as well as entomologist and biochemist. There is abundant evidence that resistance is a pre-adaptive phenomenon and under genetic control, so that the development of resistance to an insecticide is due to selective breeding from naturally resistant phenotypes. The easy culture of highly resistant strains in the laboratory has probably provided an unprecedented opportunity for studying the biochemistry and genetics of evolution.

Prof. Brown has wisely refrained from speculating about the future of the resistance problem and the possible development of countermeasures. These may indeed involve entirely new concepts in the field of insect control. On the other hand, there are grounds for believing that effective counter-measures can be developed on the basis of the continued use of insecticides: for example, the exploitation of enzymes which appear to be present in far higher concentrations in the tissues of a resistant insect than in a susceptible one, or the alternate use of insecticides negatively correlated in their respective toxicities towards susceptible and resistant strains.

Some readers may be disappointed to find relatively little reference to resistance of agricultural pests and its implications. For example, there is no mention of the serious levels of resistance to the chlorinated hydrocarbons, reported in 1957 to have developed in the cotton boll-weevil infesting the larger cotton-growing area of Louisiana. While such an omission is not surprising in a publication of the World Health Organization, it might have been usefully indicated in the title or in a sub-title of the monograph. Prof. Brown has, perhaps, drawn a little heavily on pre-publication material some of which has shown signs of being a little premature. These blemishes notwithstanding, the monograph is a timely and invaluable contribution to an appreciation of this big problem. It is recommended as salutary reading to all interested in the chemical control of arthropod pests and as an essential text to all concerned with the problem of resistance itself.

F. P. W. WINTERINGHAM

* World Health Organization. Monograph Series No. 38: Insecticide Resistance in Arthropods. By Dr. A. W. A. Brown. Pp. 240. (Geneva: World Health Organization; London: H.M. Stationery Office, 1958.) 15 Swiss francs; 25*s.*; 5 dollars.