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TECHNICAL DISCUSSIONS

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RESISTANCE OF INSECTS TO INSECTICIDES¹

The significance of the development of insect resistance to insecticides as a public-health problem was established at a WHO symposium on the control of insect vectors of disease held in Rome in 1953, when it was reported that this condition had been recognized in 32 countries and that published records indicated that approximately 35 species of insects were involved.

A number of these insects have considerable importance from a public-health viewpoint. Certain species of anophelines were reported to have shown varying degrees of acquired resistance to DDT and several species of culicines had followed the same pattern, for example, body lice in Korea could no longer be controlled by DDT; fleas were claimed to have developed resistance in some areas of the Eastern Mediterranean Region and in the Americas; and house-fly control with chemicals was no longer possible in almost all areas where these materials had been used for any appreciable length of time.

The Eighth World Health Assembly drew attention to the potential dangers of resistance to insecticides in the anopheline vector species and requested governments to intensify plans of nation-wide malaria control so that malaria eradication might be achieved and the regular insecticidal spraying campaigns safely terminated before serious resistance developed. (resolution WHA8.30).² The situation regarding the resistance of insects to insecticides in general, particularly as it affects the anophelines, has deteriorated steadily since that time.

A. sacharovi in Greece has been proved to have developed marked resistance to all the chlorinated hydrocarbon insecticides and the use of the organic phosphorus chemicals as an alternative has not been entirely successful. In the Lebanon the same species has shown a lesser degree of resistance. A. sundaicus in Indonesia appears to have acquired a mild physiological resistance and A. stephensi in Saudi Arabia is suspected of following the same pattern. A. albimanus in Panama has been demonstrated to have developed behaviouristic changes as a result of a number of year's

¹Some of the basic information in this paper has been taken from an unpublished document EB17/6 Add.1.

²Off.Rec.Wld Hlth Org. 63, 31

exposure to insecticides. Fairly recently, a report has been received to the effect that a strain of A. quadrimaculatus with a marked degree of resistance to dieldrin, BHC and chlordane has been isolated in Mississippi, USA.

In addition, it has recently been demonstrated that a strain of A. aegypti from Trinidad has shown itself to be extremely resistant to DDT. The median lethal dose for the Trinidad strain is 2.0 p.p.m. of DDT as compared with 0.004 p.p.m. for a normal susceptible laboratory colony.

House flies are now almost universally resistant to the halogenated insecticides and a report has been received from Denmark that strains resistant to the organic phosphorus insecticides have now been isolated. Resistance in cockroaches and bed bugs is now well established in many countries and in others the control of fleas by insecticides is no longer feasible. Among the latter is an allegation of resistance in the Oriental rat flea, X. cheopis.

It will be seen, therefore, that as important as the problem is in the field of malaria, the situation in respect to a number of other diseases - including some of epidemic importance - is equally grave.

There is now sufficient evidence available to assume that the pattern observed in the house fly in the development of resistance to insecticides will be followed by other insects of medical importance and that after repeated exposure to the chlorinated hydrocarbon insecticides the development of comparable resistance may be expected. Should the degree of resistance in vectors of disease such as malaria, yellow fever, plague and typhus reach the point where control by the available insecticides is no longer possible, disastrous results from a health viewpoint will inevitably occur in many parts of the world.

In 1953, the Symposium in Rome suggested¹ that WHO might stimulate work on the use of new insecticides in different parts of the world. However, the number of new insecticides that have become available since that time have been too few and too limited in efficiency to have had a significant effect on the trend of events. Even if this were not the case, it would be unwise to base existing or future programmes on the assumption or hope that satisfactory new insecticides will be produced to replace those now becoming ineffective. As it is, the majority of the materials now being used as alternatives present a higher toxic hazard to man than has been experienced with DDT or BHC.

¹World Health Organization

Symposium on the control of insect vectors of disease, Rome.
Chron. Wld Hlth Org. 8, 129-135, 1953.

A statement in the symposium report¹ reads as follows:

"We are insufficiently informed as to what causes death when insects are exposed to insecticides and as to the biochemical and physiological bases of resistance."

This situation remained unchanged.

A survey of the research on resistance being performed in the leading laboratories throughout the world is at present being carried out by WHO. A preliminary report concerning the work of 27 of these centres in the European, East Mediterranean and South-East Asia Regions indicates that the amount of money and effort being devoted to work which might contribute to the solution of the problem of resistance is appallingly small.² The majority of their activities are concerned essentially with (1) efforts to develop resistant strains of vectors in the laboratory, and (2) surveys to determine the status of resistant vectors in certain countries. These are necessary parts of large-scale programmes of insect-borne disease control in which insecticides are being used, but they will provide little or no information on the mechanism of resistance or the means of combating it.

In a survey conducted in the Western Pacific Region in February and March 1956, it was learned that although the amount of work on insect resistance is not considerable, the potentialities for additional work exist in many laboratories. In some of these laboratories, work on insect resistance has been restricted because of a lack of certain essential equipment. It was also revealed that the results of some important research have not been made available to other workers because these have been reported in a language other than English or French. It is evident that research on insect resistance at present is unco-ordinated and important phases of the work are not receiving due attention. The geographical limitations of vector species alone would preclude investigations by any one laboratory on all insects that might be involved.

The same situation seems to exist in the majority of countries in all parts of the world. This lack of effective research on resistance throughout the world cannot help but have serious consequences on many current national programmes of insect-borne disease control, and if these consequences are to be avoided a determined effort must be made to strengthen and expand activities in this field.

¹World Health Organization

Symposium on the control of insect vectors of disease, Rome.

Chron. Wld Hlth Org. 8, 129-135, 1953

²Unpublished document EBL7/6 Add.1.

So far there has not been any report of malaria vectors having developed resistance to insecticides in the Western Pacific Region, but this does not mean that this possibility is remote; there is every reason to be alert and to detect the development of resistance as early as possible.

In considering the global problem of insect resistance, WHO's main objectives are as follows:

1. To develop an international collaborative programme of research on as wide a basis as possible on problems associated with resistance and the control of resistant insects, with particular emphasis on neglected areas of research.
2. To stimulate and encourage more research within the framework of this collaborative programme; this phase to include assistance by WHO through the provision of grants, equipment and technical personnel.
3. To recommend measures which might be adopted by national governments to control resistant insects or to prevent resistance occurring in those areas where the vectors are still susceptible to the chlorinated hydrocarbon and organophosphate insecticides.

The following draft resolution is submitted for the consideration of the Committee:

The Regional Committee,

Having considered the report on resistance of insects to insecticides,¹

Realizing that the development of resistance of insects to insecticides represents a public-health problem of the greatest importance,

Believing that research work in this field has to be co-ordinated at an international level,

Noting that a programme of co-ordination and stimulation of research is being undertaken on this problem and that steps are being taken to provide Member States with advice on measures to be taken to control vectors which have developed resistance to insecticides,²

¹Unpublished document WP/RC7/7

²Unpublished document EB17/6 Add.1.

1. RECOMMENDS that an inter-regional symposium be held in 1958 to which workers performing research on insect resistance and allied fields would be invited with a view to exchanging views and promoting co-ordination of the work, and
2. REQUESTS the Regional Director to collect and disseminate information on research on insect resistance.