ARTICLES

LELAND OSSIAN HOWARD (1857–1950) AND MALARIA CONTROL: THEN AND NOW

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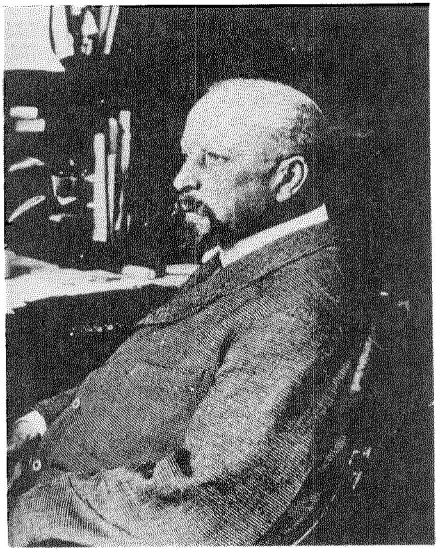
"As when a swarme of gnats at eventide
Out of the fennes of Allan doe arrive,
Their murmuring small trumpets sownded
wide
Whiles in the air their clustring army flies
That as a cloud doth seem to dim the skies,
No man nor beast may rest or take repast
For their sharp wounds and noyous injuries
Till the fierce northern wind with blustring
blast
Doth blow them quite away and in the Ocean
cast."
Edmund Spenser, Fairie Queene, 1589

"Well, in our country" said Alice, still panting a little, "you'd generally get to somewhere else—if you ran very fast for a long time as we've been doing." "A slow sort of country," said the Queen, "Now, here, you see, it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that."
Lewis Carroll: *Alice in Wonderland*

In the history of entomological sciences the name of Leland Ossian Howard occupies a special place. Much of this place is dusty, covered with cobwebs, and rarely visited by those hurrying towards the next millenium. It is fitting and proper that the recent commemoration of the centenary of the discovery of the malaria parasite by Laveran should be followed this year by remembering the life and work of one of the great American pioneers of economic and medical entomology.

Leland Ossian Howard was born in Rockford, Illinois in 1857 (the same year as Ronald Ross). After receiving his B.Sc. and then M.Sc. at Cornell, and his Ph.D. at the Georgetown University, Howard obtained the post of Assistant Entomologist with the Bureau of Animal Industry, U.S. Dept. of Agriculture. He held this post from 1878 to 1894 and then became the Chief of the Bureau for the following 33 years, and Principal Entomologist for the next 4 years, retiring in 1931.



Dr. L. O. Howard
From collections of the Wellcome Museum of Natural Sciences, London, U.K.

He was Honorary Curator of the Department of Insects U.S. National

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Museum, Consultant Entomologist U.S. Public Health Service, President of numerous International Congresses and Societies, Fellow of the American Academy of Arts and Sciences and recipient of many awards, including the French Legion of Honour. Of his major works three are of lasting importance: "*Monograph on Mosquitoes of North America*" (1912–1917), "*History of Applied Entomology*" (1930)[2] and the prophetic "*Insect Menace*" (1931). He died in 1950 at the ripe age of 93.

This dry but factual account of the life and work of one of the most versatile, knowledgeable, farsighted and also most colorful representatives of American science, of the period linking the past and the present centuries tells little about the impact that Howard had on the growth and understanding of applied entomology.

His historical outline of the rise of this discipline does not go into the dark and confused recesses of Indian myths of Atharvaveda, strained interpretations of the Biblical plagues of "flies," or the spread of insect-borne diseases in the aftermath of the Crusades.

Howard prefers to describe with some relish the events of the early 18th century and indicates the less than respectable position of amateur collectors of insects at that time. "The botanist (he writes) . . . may dedicate his hours to mosses and lichens, without reproach; but in the minds of most men, the learned as well as the vulgar, the idea of the trifling nature of a pursuit [of insects] is so strongly associated with that of the diminutive size of its objects, that the term entomologist is synonymous with everything futile and childish . . . Now when so many other roads to fame and distinction are open . . . there are evidently no great attractions to lead [a man] to a science which . . . promises to signalize him only as an object of pity and contempt" (Howard 1930).

Another interesting point made by Howard refers to the somewhat strained relationship between systematic entomologists, whose metaphorical ancestry can be traced to eccentric collectors of the past centuries, and the applied (or economic) entomologists, who were considered as unscientific dabblers of the farmer's class. With the admirable scientific fieldwork which was done by the latter group and with their practical successes, their status was soon established. In fact there was some evidence of bitterness on the part of the "museum people" at the larger salaries of the "field men." All this is the thing of the past, although some rumbles of the old feuds can occasionally be heard even today.

I am not qualified to speak about Howard's tremendous contribution to economic entomology related to agriculture in its broadest sense, and would like to stress his place in medical aspects of this science. The chronological origin of medical entomology is subject to some dispute. There are those who maintain that it dates from 1877 when Patrick Manson discovered that a mosquito is a vector of Bancroftian filariasis (Service 1978). Others, who extend the term entomology to cover the mites (Arachnida) believe that this discipline goes back at least to 1687, when two Italians, Cestoni and Bonomo demonstrated the presence of *Acarus scabiei* in the skin of a man suffering from severe itch.

Whatever may be the outcome of such scholastic controversy there is no doubt that in the immortal words of L. W. Hackett, early entomology was a virgin field pregnant with consequences. The taxonomy and systematics of mosquitoes developed slowly. Linnaeus created the genus *Culex* in 1758; the *Anopheles* had to wait until 1818 when Johann Meigen, the organist of Stollberg and a remarkable amateur entomologist gave them their generic distinction. But the pace of new

[2] Howard's "*History of Applied Entomology,*" while not a conventional study in the modern sense of collected and interpreted documentation is a lively, anecdotal, almost gossipy, personal narrative, with an annex comprising photographs of nearly 250 personalities directly involved in the advance of entomological science.

discoveries was gathering momentum. *An. punctipennis* and *An. quadrimaculatus* from the eastern parts of the USA were described by Thomas Say in 1823 and 1824. At the end of the 19th century about 20 species of *Anopheles* had been described out of some 400 that we know today.

The pioneering studies of Boisduval, Coquillett, Fabricius, Forskal, Ficalbi, Giles, Kirby and Spence, Latreille, Thomas Say, Taschenberg, Theobald, Reaumur, Robineau-Devoidy, Walsh, Westwood, Wiedemann and many others were known only within small circles of devotees. No wonder that the parasitologists of that time had little knowledge of entomology; Ross could hardly distinguish between his "grey," "brindled" or "dapple winged" gnats (Ross 1910).

There is no doubt that Ronald Ross's discovery in 1897–98, soon confirmed by the Italian workers, was the starting point of the scientific approach to malaria control. It was in June 1899 that Ross delivered in Liverpool his inaugural lecture under the title: "*The possibility of extirpating malaria from certain localities by a new method*" (Bruce-Chwatt 1977). This was also the year when Nuttall's important monograph on the role of mosquitoes as carriers of disease of man and animals provided an additional basis for action (Nuttall 1899).

Although kerosene was occasionally used for destroying mosquito larvae in the middle of the 19th century in France, in New Orleans and in the Milledgeville penitentiary in Georgia, USA, it was Howard who in 1892 carried out a series of careful experiments on the spreading power and film persistence of "illuminating oil" in a pond (Howard 1893). This was 5 years before Ronald Ross's discovery and can be regarded as the beginning of modern methods of mosquito control. (Boyce, 1909)[3]

Recognizing the role in transmission of malaria of *An. quadrimaculatus* in the southern USA, Howard prepared in 1900 and 1901 a series of short articles and a monograph under the title: "*Mosquitoes: How they live? How they carry disease? How they are classified? How they may be destroyed?*"

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[3] The splendid effort in controlling in 1903 an outbreak of yellow fever in the city of San Antonio is worth mentioning. A number of cases with some deaths caused much concern and affected the local industry and commerce.

Howard (1930) describes the events as follows:

"In the effort to allay the panic, the existence of yellow fever was denied, not only by persons having business interests in the city, but by many medical men as well. Very many not only denied the existence of the fever in the city, but denied the relation between the mosquitoes and the fever. Perhaps the majority of the adults seemed too old to learn; and to the enlightened physicians it appeared that it was impossible to begin education at the wrong end of life.

"The chairman of the sanitary committee of the school board of San Antonio, Dr. J. S. Langford had the happy idea that sanitary problems of this city could be improved by the involvement of children.

"He suggested to the board to educate all of the school children in prophylaxis and make sanitarians out of them all. The school board heartily approved of the proposition, and the campaign was at once begun. The best medical literature on the subject was procured and furnished to the teachers, and a circular letter was sent outlining a proposed course and offering a cash prize for the best model subject. An aquarium, with eggs and wriggler, was kept in every schoolroom, where the pupils could watch them develop; and large magnifying glasses were provided that they might study to better advantage. The children were encouraged to make drawings on the blackboard of mosquitoes in all stages of development; lessons were given and compositions were written on the subject. Competitive examinations were held, and groups of boys and girls were sent out with the teachers on searching expeditions to find the breeding places. Rivalry sprang up between the 10,000 public school children of the city in the matter of finding and reporting to the health office the greatest number of breeding places found and destroyed. Record was kept on the blackboards in the schools for information as to the progress of the com-

Ronald Ross's first attempts at mosquito control in West Africa and in Egypt, however encouraging, were only moderately successful (Ross 1911). Undoubtedly, the greatest early 20th century demonstration of the value of mosquito control measures was given in Havana, and in the Panama Canal Zone by William Crawford Gorgas. Not only did Gorgas stamp out yellow fever from those two areas by anti-*Aedes* measures but as a result of his sanitary work the malaria rate in Havana was reduced tenfold between 1899 and 1901; it fell even more spectacularly a few years later. The success in the Panama Canal Zone was more difficult to achieve but also more lasting. It certainly deserved the praise of Malcolm Watson as "the greatest sanitary achievement the world has seen." (Le Prince and Orenstein 1916, Scott 1949, Russell 1953).

Other remarkable advances and cruel defeats were still to come and the heroic saga of man's attempt to eliminate from the world one of the most ancient and widespread human diseases can be conveniently divided into 4 major chapters covering the past 80 years.

The first one from 1899 to 1920 ("The Dawn of New Science") comprised the use of larvicidal methods such as petroleum oil or Paris green; the latter measure, advocated by Barber in 1921, was widely employed. New methods of drainage and naturalistic control or "species sanitation" based on the study of behavior of *Anopheles* vectors of malaria were an outstanding success under Malcolm Watson in Malaysia and elsewhere. Biological control by various predators became also very popular and the star of the show was the little top-minnow from the Florida Everglades given the scientific name of *Gambusia* (Hackett 1937). First mentioned by Howard (1901), the use of *Gambusia affinis* or other top-minnows for control of mosquito larvae in small ponds has been widely applied in California and Florida before it spread to various parts of USA and thence to Cyprus, Spain, Italy and all over the world.

Other natural enemies of mosquitoes including their predaceous genera of *Psorophora* and *Megarhinus,* as well as dragonflies, frogs, salamanders, etc. were not a success. Not even bats whose breeding and roosting was advocated by a Dr. Campbell, here in San Antonio (Campbell 1925).

It soon became obvious that the success of naturalistic methods depended on the careful study of every situation and on the sound knowledge of bionomics of most of the local *Anopheles* species (Gillies 1977).

The next chapter from 1922 to 1945 may have as a title "The Great Hope." It was then that the immensity of the malaria problem in tropical countries was realized by everyone and particularly by the Health Organization of the League of Nations. The great pandemic of malaria in post-revolutionary Russia, the invasion of Brazil and Upper Egypt by *Anopheles gambiae,* the malaria epidemic in Ceylon and the impact of the disease on troops fighting in tropical areas formed the background to the global picture. There were some brighter events such as the clarification of the puzzling differences of the transmission potential of the *An. maculipennis* complex in Europe. But the major advance of this period was the development of synthetic antimalarials by the Germans, followed by the Americans, the British and the French. There is little doubt that without these new drugs available to the Allied Forces the outcome of the war in the South Pacific would have been different. The mass administration of antimalarial drugs was considered as

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petition and great enthusiasm was stirred up.

"The result of this work, was a decided diminution of mosquitoes in San Antonio. While there had previously been from 50 to 60 deaths a year from malarial trouble, the mortality was reduced 75 per cent the first year after this work was begun, and in the second year it was entirely eliminated from the mortality records of San Antonio."

the best means for widespread control of the disease.

The period from 1946 to 1970 is the third chapter rather optimistically given the title "Man's Conquest of Malaria?" It was dominated by the technique directed against adult mosquitoes and arising from the discovery of nearly miraculous insecticidal properties of DDT, soon followed by other residual insecticides, such as HCH, dieldrin, and later malathion and propoxur. The advent of these compounds presented the world with a new strategy of malaria control by attacking the *Anopheles* vector during its epidemiologically most important stage, after its bloodfeed on man or on animals in the relevant dwelling or shelter (Russell 1955).

Soon after the Second World War, the newly born WHO recognized that malaria not only killed more people than any other disease, but also interfered with the socio-economic advance of tropical areas. The intensive control methods carried out in some western countries produced excellent results but could not be easily applied in developing countries. It soon became obvious that properly applied residual spraying could not only decrease malaria to very low levels but might also interrupt transmission of the infection by reducing below a certain threshold the density of the *Anopheles* population and especially its mean longevity. This was demonstrated in 1950 by the success of the Sardinian project, supported by the Rockefeller Foundation (Logan 1953). The concept of countrywide malaria eradication was born in 1955 when several examples of the first successful campaigns (Italy, Cyprus, Greece, Guyana, Venezuela and USA) produced most impressive results. It appeared that the method of total coverage by indoor spraying with DDT was the fastest, most reliable and economical method for the interruption of transmission (the attack phase) especially in rural areas. In the next phase of the eradication programme (the consolidation phase), the remaining foci could be detected by epidemiological surveillance and eliminated by the distribution of antimalarial drugs (Pampana 1966).

This simplified description of the principles of malaria eradication gives no idea of its operational complexity. Few other public health endeavors need such careful planning, efficient administration, adequate financing, good evaluation and a steady support by the community.

In 1957 a global programme of malaria eradication was launched by the WHO, but only pilot projects were attempted in Africa. Over the next decade an immense effort was deployed by some 60 countries and the initial successes in southern Europe, USSR, in the Middle East, in India, Sri Lanka, Southeast Asia, Mexico, the Caribbean Islands were spectacular. By 1968 the population living in previously endemic areas and virtually freed from malaria rose from 316 million to nearly 1000 million. Malaria eradication has been attained in 36 countries out of 140 where the endemic disease was present.

As pointed out by Brown (1980) in 1961 some 190,000 spraymen applied a total of 64,000 tons of DDT, 4,000 tons of dieldrin and 500 tons of HCH to about 100 million houses throughout the world. It has been estimated that the malaria eradication activities were saving during the 1960s over one million of human lives every year.

The future looked promising but for a small cloud of DDT resistance of *Anopheles* vectors that appeared quite early but became a serious menace towards the end of the 1960s.

And now we are in the midst of the fourth chapter that may well be called "The Shattered Dream." It covers the past decade though it started in 1967–68 when we recognized the nature of technical problems such as the unexpected exophily of some species of *Anopheles*, extension of resistance of major vectors of malaria first to DDT, then to other chlorinated hydrocarbons, and eventually to some organophosphates and carbamates. At the same time the news of malaria parasites (especially *P. falciparum*) not responding to some of our best antimalarials in Colombia, in Brazil, in South-East Asia undermined much of our confidence.

Although the global malaria eradication programme freed some 500 million people from the threat of endemic malaria in Europe, North Africa and large portions of Asia and the Americas, the situation showed no progress in tropical Africa and has now greatly deteriorated especially in southern and southeastern Asia.

The resurgence of malaria in the Indian and Indochinese subcontinents has reached dramatic proportions with an estimated number of well over 30 millions of reported cases in 1974–78. A number of factors related to human ecology interfered with antimalaria activities. Inaccessibility of some localities, the custom of replastering houses for religious feasts or family events, reluctance of some communities to have their houses sprayed, movements of nomadic populations were of growing importance. Urban malaria became a new phenomenon especially in India and Pakistan. Among other obstacles those of administrative and operational nature were prominent. They ranged from shortages of trained manpower, to inadequate Government support, premature integration of malaria eradication activities into general health services and various logistic difficulties of procurement of insecticides, drugs and transport.

The present resurgence of malaria indicates how far we are from the conquest of this disease. It also emphasizes the role of malaria as one of the many factors at the core of the great issue of socioeconomic development of tropical countries. There is no denying that, in spite of the great achievements of the eradication programme, a large reservoir of endemic malaria remains over most of the tropics.

One of the consequences of this is the increasing concern with malaria as one of the tropical diseases now frequently brought into Europe, the USA, and other parts of the temperate world. The constantly rising speed and volume of intercontinental air-travel has created new conditions for massive importation of human carriers of communicable disease into countries where these infections were unknown or from which they had gradually disappeared with the advance of public health.

Another problem that we may soon be facing is the extension of distribution of *Anopheles* vectors of malaria from the zones of their normal distribution to other areas, through the new and greatly increased means of travel not only by air but also by land (Bruce-Chwatt 1970). The opening this year of the all-weather tarred road across the Sahara links for the first time tropical Africa with the North of that continent.

The practical implications of insecticide resistance of mosquitoes generally and malaria vectors in particular are very serious and have been stressed by Brown (1976, 1980). Suffice it to point out that 46 species of *Anopheles* have become resistant to cyclodienes, 37 to DDT and 13 to organophosphates or carbamates (Gratz 1976, WHO/MAP/VBC/80.1.2.)

Whether any residual insecticide aimed at the adult *A. gambiae* species complex will be of much use in the savanna areas of tropical Africa is now uncertain. A recent WHO report on the Garki project in Northern Nigeria is perhaps unduly pessimistic but its conclusions gave rise to much concern (Molineaux and Gramiccia 1980).

In view of the paradoxical fact that nearly all the known synthetic insecticides seem to have, like some motor-cars a "built-in obsolescence," due to mother-Nature fighting back by a rapid evolutionary process, the chemical industry, stimulated by the WHO attempted to produce a number of new insecticidal compounds. This splendid effort resulted in some 2000 candidate insecticides (malathion, propoxur, fenitrothion, landrin and temephos) of which only 6 passed through a tight screening programme for toxicity to humans and other characteristics. The introduction of synthetic pyrethroids (permethrin, decamethrin and others) is a triumph of modern organic chemistry, although it seems that their glory may be shortlived. Unfortunately and especially since 1973, the use of all insecticidal compounds alternative to DDT increased the operational cost of malaria control by a factor between 5 and 20. Even the cost of DDT spraying went up from about 150,000 USA dollars per million of population, to nearly 300,000 USA dollars in 1977 (Noguer 1978). No wonder that many developing countries cannot afford these heavy charges and depend increasingly on international or bilateral aid. Moreover, the speed with which mosquitoes and some other insects develop resistance to new compounds has discouraged many chemical companies from expanding their research into new insecticides. The widespread disquiet of ecologists about the possible pesticide hazards and the demands for extensive toxicological and environmental screening of candidate pesticides has also had an adverse effect on the process of discovery and subsequent testing. The often voiced concern about the toxicity of some widely used pesticides is at times imaginary or exaggerated. However, there are cases when it is well founded as for instance in Pakistan in 1976, when a consignment of malathion caused, in spraying personnel, some 2800 cases of poisoning due to the presence of a product of chemical degradation in tropical storage (Baker et al. 1978).

Since the highest degrees of resistance to one or more insecticidal compounds occur usually in areas where agricultural pesticides are widely and excessively used the WHO has repeatedly stressed the need for greater control of these activities. However, the success of this appeal has been minimal in areas of economic importance where the financial gain or higher yields of crops are the primary objective (Busvine 1978). It has become increasingly obvious that the best way of countering the development of resistance depends on our ability to limit the degree of a specific selection pressure.

In these conditions much attention has been given to 3 possible alternative methods of mosquito control: biological, genetic and environmental (naturalistic *pro parte*).

In the first group of biological agents there is a whole range of methods from viruses, through bacteria, protozoa, fungi, waterplants, to bats and fish. Although the introduction of various predators of larvae was often claimed as beneficial, few of them were of real importance. *Gambusia* and other fish of the family Cyprinodontidae achieved a wide acclaim during the 1st quarter of this century (Howard 1912) and are having now some revival of notoriety. But few quantitative surveys of their real value have been carried out in endemic areas and they seem to be of marginal importance in mosquito control. The recent field tests of *Bacillus thuringiensis* or *B. sphaericus* and of the crystalline proteins that they produce, have created much interest but once again it is doubtful if these products are superior to the existing larvicides.

Genetic control of mosquitoes seemed to be promising a few years ago because of 2 possibilities: introduction of a non-vector strain or releasing into a local insect population competitive sterile males of *Anopheles*, which by hybridizing with the local strain will cause sterility of female mosquitoes or distort the sex ratio. Practical difficulties of these 2 methods when applied to mosquitoes with their high reproductive potential are so great that the hopes for their early application have now almost disappeared (Davidson 1978). When it comes to general principles of mosquito control Knipling's recent (1979) book provides some guidance, based on great experience. As mentioned before, a knowledge of the dynamics of the insect population is essential, since the efficacy of the method employed depends on the mosquito population density at the time. Thus, while insecticidal measures are not greatly influenced by the density of mosquito population, the biological methods are most successful when the population density is high; on the other hand a genetic method such as release of sterile males offers more promise when the population density is low.

Theoretically, the prevention of development of insecticide resistance may be achieved to some extent by the 3 largely untried methods: (1) Early detection of the distribution and type of new foci of resistance and an attempt at elimination of such foci to impair the spread of resistance genes; (2) Spraying of unrelated insecticides in a checker pattern so that natural dispersal from square to square will dilute the build up of the frequency of resistant genes; (3) Release of susceptible male *Anopheles* which may introduce this gene into the mosquito population after mating with wild females. The feasibility of these methods depends on a number of factors which are not easily determined in the field.

A concentrated research effort may find new ways to attack the malaria parasite and its vector. Fields in which research is particularly important include the study of the behavior of mosquito vectors, methods of environmental control, better and more acceptable insecticides, and the development of new antimalarial drugs, to meet the challenge of resistant parasites.

Much has been written about the possibility of a prospective malaria vaccine, but the present experimental results, however encouraging, indicate the practical difficulties ahead. Although research on a malaria vaccine is gaining momentum, it seems that in tropical areas synthetic antimalarial drugs will be our most reliable weapon for some time yet.

In considering the 3rd group of alternative anti-mosquito measures, namely environmental changes, we are back to Howard's time. This is not unexpected, because during the halcyon years of 1955–1970 we have relied so exclusively on the use of cheap and convenient residual insecticides that we have forgotten how to use the time-honored methods of adaptation of ways and means amply provided by nature. Removal or alteration of potential breeding places of *Anopheles* larvae through various small and large scale drainage or reclamation schemes such as ditching, filling, species sanitation, etc. is today gaining ground. Naturally, these methods demand good knowledge of transmission of malaria by local vectors and are economical mainly in urban or semiurban zones with a high population density. Perhaps much more stress should be made in favor of the long-term financial and other benefits of some apparently expensive reclamation programmes such as the New Jersey mosquito abatement operation or the Tennessee Valley Authority. My own experience certainly confirms it, when I think of a sand-pumping sanitation scheme in Lagos, Nigeria which within a few years converted a pestilential salt-marsh into a site for a thriving suburb, badly needed for an industrial expansion.

Combination of these methods with elementary environmental sanitation, with a degree of personal protection by house screening, the use of mosquito nets, space spraying, taking of antimalaria drugs, etc. form what is often called "integrated control of malaria." It does not exclude the judicious use of larviciding, space-spraying, and residual insecticide spraying whenever applicable and forms part of the "new" strategy adopted in 1980 by the WHO.

These principles stress the need for greater flexibility of anti-malaria operations, the involvement of basic health services but above all the national will of developing countries expressed through decisions at the highest level to support anti-malaria services on a long-term basis. It is obvious that the participation of the community is essential in such a programme.

One need not be surprised by the fact that the past 5 years have seen an agonizing reappraisal not only of the original concept of global malaria eradication but also of the possibilities of substantial control of malaria in some parts of the world. Some explanation of these two lines of thought is required.

The World Health Assembly of 1978 emphasized that wherever malaria eradication has been achieved it should be maintained through an alert vigilance system able to protect the relevant country or area from an introduction of the transmission; at the same time all the available means should be deployed to achieve the goal of eradication wherever its prospects are good.

On the other hand in countries where only a degree of control is feasible this must be adapted to existing epidemiological and economic realities making wide use of antimalarial drugs, time-honored method of source reduction and residual insecticides. As mentioned before, the use of the latter is now limited because of resistance of vectors and increased cost. This is particularly true in tropical Africa, and a recent WHO study (Molineaux and Gramiccia 1980) stated (not too convincingly) that in the area of African savanna little or no effect of residual insecticide spraying could be expected. There is much hope that the present WHO programme of research and training in tropical diseases will provide some valuable replacements of the depleted and blunted magic bullets on which we relied in the past.

However, it seems that we cannot conquer malaria, a disease rooted in the physical environment of tropical areas and in their unsatisfactory socio-economic conditions, by a miraculous vaccine, drug or insecticide. All such scientific tools will be of value but their proper use will depend on factors closely related to human ecology in its broadest sense (Bruce-Chwatt 1979).

Within the general agreement on the urgency of better malaria control in the tropical world three major needs emerge: more rapid socio-economic development, improvement of basic health services and research into new control techniques.

Fifty years ago L. O. Howard wrote: "The harm done by insects to the human race appears to have been increasing . . . for many years, The realization of this fact has come to us only in comparatively recent times. And still more recently have we come to realize that we ourselves have created the conditions that have brought this about. But . . . we have at last awakened to the danger . . . and the time will surely come when we will have discovered means of holding them in check . . ." (Howard 1930).

Today's problems of malaria control are more difficult than at the time of Howard's life because we are conscious of their relationship with the unsolved dilemma of improving health conditions of two-thirds of mankind living in the developing tropical countries. These conditions are not likely to improve unless there is greater agricultural and industrial advance of the Third World countries combined with a curb of their population pressure, conservation of natural environment, better education of women, land reforms and sound investment policies. Such changes could be speeded up if wealthier countries realize the danger of a world unequally divided into rich and poor and accept the obligation of providing adequate technical and financial assistance to bridge the ever-widening and menacing gulf.

Whether this will happen in my lifetime or in the life-time of the generation of the "blood, sweat and mud malariologists" to which I belong, is a moot point. Not being optimistic by nature, I nevertheless express some hope. But, as Churchill said: "A hopeful disposition is not the sole qualification to be a prophet."

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THE 1981 LECTURER

LEONARD J. BRUCE-CHWATT, M.D., F.R.C.P.

Professor Bruce-Chwatt is a British Scientist and scholar of Polish origin who has had an illustrious career in tropical medicine and malariology. After receiving his M.D. degree at the University of Warsaw in 1930 he served as a Medical Officer in the Polish Army and continued his medical training in microbiology and serology at the State Institute of Hygiene in Warsaw and at the University of Paris. He also received the Diploma of Tropical Medicine and Hygiene at the London School of Hygiene and Tropical Medicine where he was awarded the Duncan Medal.

During World War II, he began long and fruitful research in malariology and Tropical Diseases in West Africa. These researches spanned 17 years from 1941 to 1958. In Africa he worked on both yellow fever and malaria. During this time he was appointed to the WHO Expert Panel on Malaria and somehow manged to find time to obtain a Master of Public Health Degree as a Rockefeller Foundation fellow at the Harvard School of Public Health.

Then in 1958 Leonard Bruce-Chwatt embarked on another career or rather subcareer—for the next 10 years he was Chief of Research and Technical Intelligence, Division of Malaria Eradication with WHO in Geneva. In 1968 he was appointed Senior Lecturer of the London School of Hygiene and soon became Professor of tropical hygiene and Director of the Ross Institute.

After retiring in 1974 he was appointed Professor Emeritus of Tropical Hygiene at the University of London. Since 1975 he has also served as an associate to the Wellcome Museum of Medical Science and Editor of "Tropical Doctor," a publication of the Royal Society of Medicine.

His many distinguished awards include: North Persian Forces Memorial Medal, 1951, Officer of the Order of the British Empire, 1953, WHO Darling Medal and Prize, 1974, Fellow of the Royal College of Physicians, 1974, Chevalier, the Sovereign Order of St. John of Jerusalem, 1975, Companion of the Order of St. Michäel and St. George, 1977, George MacDonald Memorial Medal and Prize, 1978.

During his 50 year career as scholar, scientist and physician he has written more than 250 scientific papers and 4 books, 2 of which have recently been published: "Essential Malariology" and "The Rise and Fall of Malaria in Europe".