

## MALARIA: RETROSPECT AND PROSPECT<sup>1</sup>

MARK F. BOYD

The selection of a subject for the presidential address has to me been the most arduous duty of the presidential office. To those of you who know of my long interest in the subject of malaria, the presentation of a dissertation in this field may seem natural. The fascinating complexity of this subject, however, makes very difficult the selection of a phase that can be comprehensively discussed in a short period. After considerable deliberation, it appeared that an attempt to appraise the current character of the problem afforded by malaria might be the most appropriate.

Malaria, like the weather, seems to have always been with the human race, at least within recorded times, and, as Mark Twain said about the weather, it seems that very little is done about it, certainly little in relation to its magnitude. The appropriateness of the comparison would seem enhanced when the derivation and original significance of this word are considered. The supplantation of the terms "intermittent fever," "ague" and many others by the word "malaria," which at one time alluded to their supposed meteorological etiology, is quite recent. However in our employment of this term in the singular form, we should never lose sight of the fact that it is used collectively, being now indiscriminately applied to the diseases produced by all species of the plasmodia to which man is host.

To the welfare of the human race malaria presents a medical and public health problem of the first magnitude, whether considered from the viewpoint of range of distribution, of morbidity or of mortality. From the first standpoint, there are but few

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regions potentially favorable into which it has not already been introduced and where it has not successfully established itself endemically. As a cause of morbidity it is the peer of all other infections, and as a cause of mortality it is formidable. Despite the general distribution of the plasmodial species and the common denominator of anopheline transmission, malaria as a world problem presents an extraordinary diversity of, and variation in, local incidence, probably unparalleled by any other disease.

More than half a century has elapsed since Laveran's discovery of these parasites, and forty years have passed since Ross discovered the means of their transmission. These were milestones in the progress of our general knowledge of the parasitic diseases; they made possible the precise definition of this group of infections, and brought our concepts of their etiology and transmission into the field of tangibility. The elapsed interval is sufficiently long to justify a query as to whether we, as the beneficiaries of this heritage, have made adequate use of this knowledge, either to deal with the basic problem these diseases present or to build on this foundation a sturdy structure of further facts.

On the side of medical knowledge we may ask whether our understanding of the properties of these parasites, and of the various interactions of these with their hosts is comparable to our contemporaneous comprehension of these phases of diphtheria, typhoid fever, tuberculosis, pneumonia and yellow fever, to mention only a few other infections. From the technical standpoint the *in vitro* cultivation or extracorporeal preservation of the parasites, in a manner worthy of the designation, has not been effected. From a pathological standpoint our knowledge of their life cycle possesses at least one important lacuna, and our comprehension of their metabolism and of its effect on the host is very meager. Even so simple a procedure as the detection of the parasites, as a means of precise diagnosis, is not so extensively used by physicians as its simplicity warrants or as modern standards of practice require. The deficiency is gross, and the more glaring by reason of the classical character of these basic studies and the influence of the malarial on human welfare. We must

confess that to date the consequences of these discoveries in proportion to their magnitude have been relatively small.

From the standpoint of public health it must be mentioned that the principal measures of malaria control, the employment of protection from mosquito attacks, the use of mosquito larvicides, and the provision of drainage as a deliberate preventive of fevers and agues, are measures of considerable antiquity, antedating by decades and centuries the knowledge of malaria transmission. These discoveries rationalized time-hallowed empirical practices, but as yet have not added anything radically new to control procedures. The application of these measures has not been devoid of change in the subsequent years, but these changes have not been revolutionary, but of the evolutionary character of refinement and improvement.

Likewise the therapeutic employment of cinchona and its derivatives antedates the modern knowledge of malaria etiology. In this field, however, the recent introduction of several synthetic drugs of marked parasitocidal powers marks the most noteworthy exception to be made to this general indictment.

The greatest application of these discoveries has been in the field of epidemiology, in which the many-faceted characteristics of incidence have been considerably elucidated. Although the malarias are long-established endemic infections over vast areas in the tropics and subtropics, and in many portions of the temperate zone, the conditions of incidence in one region may present seemingly paradoxical differences from those under which the disease occurs in another, variations which we now know are largely attributable to differences in the habits of the local transmitting anophelines. As a consequence control procedures must be adapted to regional or local circumstances; a simple program of universal applicability cannot, with our present knowledge, be advanced.

Thus considering the malaria problem from a world wide standpoint, it must be confessed that over much of the affected area it remains in a well-nigh primitive condition. The extension of the application of time-hallowed procedures successfully demonstrated in the Canal Zone, West Africa and the Malay States,

has as yet been relatively limited, certainly limited in proportion to the needs of the situation. Such control measures have been applied more widely in the subtropics and temperate zone than within the tropics proper.

With the results of several successful demonstrations available, it may be asked why these have not stimulated greater emulation in other endemic areas. The chosen or appointed leaders of the affected people have in some instances displayed an ignorance of the possibility for relief, or an apathy to the demonstrations. To most it is likely that the possibilities with available local resources have seemed too limited, or a lack of knowledge of the methods of malariological investigation has prevented an adequate analysis of the scope and character of the local problem. Many a problem when first envisaged appears unsolvable, but when analyzed into its components the vulnerability of these to attack becomes apparent. Final solution then simply awaits orderly and systematic attack on the components. Such we believe is the situation of the malaria problem in many countries.

Attention should be called to the fact that many malaria situations have either been created or intensified by human agency. Agricultural practices may favor the breeding of certain anophelines, construction work may unintentionally obstruct drainage or collect water, and the deliberate impounding of water for power, livestock or fish culture, affords additional breeding opportunities.

These animadversions are not to be interpreted as a criticism of the technical efficiency of the measures at present available. The economic status of different regions affected by the malaria problem varies greatly, in general being lowest within the tropics proper. Undoubtedly the real or imagined cost of malaria control has deterred its initiation in many places. It is further recognized that the general extension of control measures must necessarily be paid for by the populations to be benefited, and that consequently whatever measures are adopted should be of a character that the public funds of the community can afford. Many places could afford small annually recurring outlays for malaria protection that would give good returns if intelligently and economically expended. On such a basis we believe that malaria

control can be successfully extended to many places now regarded as of a low economic status.

This premise is supported by the fact that over most of its area of incidence the recurrence of malaria is of long standing. It has been present for generations and centuries. It is an endemic, not an epidemic. The situation is usually chronic, not acute. It should rarely require the quick assembly of relatively large funds for its immediate suppression. A careful survey should reveal the scope and character of the problem, from which a project for its solution by the utilization of the measures of the highest degree of permanence could be evolved. An attempt to execute such a project within one season or even two or three seasons might exceed the resources immediately available. But if reasonably divided into portions that can be executed annually over a period of five, ten or more years, depending upon the funds available annually, completion of the entire project within a reasonable period of time is practicable. Malaria control should not be a campaign, it should be a long term program. It cannot be accomplished or maintained by spasmodic effort. It requires the adoption of a practicable program, the reasonable continuity of which will be sustained for a long term of years.

The costs of malaria control measures, such as drainage or the control of water, and mosquito-proofing, involve a relatively high capital outlay but the subsequent annual costs for maintenance will be relatively low. If unfortunately neglected for one or more seasons, such measures will still give appreciable service. The initial cost of using larvicides of the general category, or the mass treatment of infected persons, is low, but these measures require repetition, not only in any year but annually thereafter, and in the long run will prove costly. Their employment should be distinctly temporary. Furthermore, if for any reason their repetition is suspended for one or more seasons, the diminished incidence effected by their employment may be abruptly lost.

It is our conviction that with the means at present available we will more economically utilize our resources, more quickly achieve our goal, and more firmly hold our position by the employ-

ment of the practices with the highest degree of permanency. We should "build out" malaria.

It should be pointed out that a different policy would be justifiable, economic resources permitting, in the face of the acute situation of an epidemic. Yet since epidemics may leave a residuum of endemicity, permanent measures should have a place in such a program.

The residual endemic malaria problem of the United States is now largely rural, and is not yet being adequately attacked by available methods. This neglect cannot be ascribed to insufficient resources, as adequate means could be afforded for this purpose if a reasonable program were initiated and sustained.

However there are vast areas, largely in the tropics, where the control of malaria by available means would cost sums beyond the range of local economic resources. It is likely that in these regions malaria will continue to be endemic until cheaper control methods, based upon new viewpoints of the problem, are devised. New viewpoints require new facts. It is probable that one of the reasons why Laveran's discovery has not been more fruitful is the limitation of animal experimentation, since no laboratory animal is known which is susceptible to these parasites. This deficiency is now partially overcome by the opportunity to study malaria which the malaria therapy of syphilis affords, and the availability of certain species of monkey parasites. New viewpoints may perhaps be achieved from the synthesis of drugs which are true causal prophylactics, or which destroy the fixed tissue cell stages of the parasites, from successful active immunization, the discovery of agents which are more effective and durable repellents of anophelines, and the recognition of vulnerable points in the cycle or habits of anopheline species which can conveniently and economically be applied to their detriment, the so-called naturalistic methods of control. The control of anophelines in the fish ponds of Batavia is the most striking example of known possibilities in this connection. However great the need for advances in these directions, the necessity to extend the application of our available knowledge in areas such as the United States, where it is economically practicable, is still greater.