Contributions of Insecticides to Public Health in India

"The use of insecticides has possibly done more to reduce the incidence of disease amongst the people than any other preventive measure in medical science."

Towards the end of the nineteenth century, many basic discoveries were made which established the role of arthropods in the transmission of a number of diseases. In 1878, Patrick Manson made the initial discovery of the presence and development of the causative agent of bancroftian filariasis in a mosquito. Soon after, the role of tick in the transmission of Texas fever in cattle was established by Smith and Kilborne. The significance of the mosquito in the transmission of malaria and of the rat flea in the transmission of plague bacillus were demonstrated by Ronald Ross and Simond respectively. There are now about 30 known diseases which are transmitted by arthropods and, as recently as 1961, the disease O’Nyong-Nyong was found to be transmitted by anophele mosquitoes.

Spraying Endemic Lands

In certain parts of the world, these diseases are maintained at varying endemic levels but, in others, they appear periodically in severe epidemic form and result in untold suffering to mankind. The economic loss they cause, wherever estimated, amounts to shockingly high figures. For instance, the epidemic of yellow fever which occurred in United States in 1878 was estimated to cost $175,000,000 for there were 25,000 cases with a loss of human life totalling 4,500. The annual financial loss due to malaria, one of the major arthropod-borne diseases in India, was estimated in 1935 to be Rs.1,10,000 lakhs. About half of the world population is exposed to malaria and its annual toll is about 200 million cases of illness and 2 million deaths.

Early Control Attempts

In early attempts to control arthropod-borne diseases by destroying the transmitting insects, environmental sanitation was used against mosquitoes, the vectors of yellow fever and malaria in U.S.A. Anti-larval measures using oil or Paris Green were also adopted. These methods gave good results but were neither economical nor practical in rural areas. Control of adult mosquitoes through pyrethrum spraying was also found to be of limited value. The discovery of insecticidal properties of DDT in 1939-40 by Paul Müller and his colleagues in Switzerland heralded a new era for the remarkable long lasting effect of this insecticide made it admirable for the control and eradication of the insect vectors. Hence when it was made available for civilian use after World War II, dramatic results in the control of malaria, yellow fever, dengue, typhus, relapsing fever, plague, etc. followed. Other diseases such as dysentery, diarrhoea and yaws were also controlled to some extent by DDT. In 1953, it was estimated that as many as five million lives had been saved and no less than 100 million cases of sickness prevented through the control of arthropod-borne disease by DDT. Except for the antibiotics it is doubtful whether any other agent has protected more people against disease over a larger area.

Successful vector control programmes in various countries of the world have demonstrated man’s mastery over arthropod-borne disease and have made their eradication feasible.

Global Fight Against Malaria

In the strategy of malaria eradication, the residual insecticides are applied in the home with the aim of intercepting the transmission of the disease by reducing the span of life of the vector mosquito to less than ten days. The complete interception of transmission for three years delimits the disease to a few individuals who can be treated by chemotherapy. A review of the malaria eradication programme shows that malaria has been eradicated from 18 countries. Sixty-six other countries have already launched this programme and are enumerated in Table on page .

The danger of reinfection, however, remains so long as there is human infection. The global malaria eradication programme therefore requires all pockets of endemicity anywhere in the
world to be eliminated. Of the quarter billion people subject to malaria, 28,000,000 live in areas where malaria is reported to have been eradicated, 55,000,000 live where transmission has been interrupted and 730,000,000 are scheduled for protection by eradication programmes in 1960. Only some 183,000,000 live in areas where malaria eradication has not yet been planned. The largest of the eradication programmes is for India and designed to protect about 438 million people.

Malaria Control/Eradication Programme

In India, where malaria has been an age old scourge, the first planned fight against it began with the co-operation of Technical Co-operation Mission, U.S.A. in 1953. Prior to this, only about 30 million people were given protection by the use of DDT. The control programme was launched in April, 1953 and it was designed to give protection to 200 million people living in the malarious areas of the country. The object was to bring down malaria transmission to a low level such that the disease would cease to be a major public health problem. The five years operation of this programme produced impressive results and the disease showed a considerable decline.

Improved knowledge on malaria control led to the revision of the original strategy and the aim became the eradication of the disease for the entire sub-continent. In April, 1958 the National Malaria Eradication Programme was launched. It consists of three phases: attack, consolidation and maintenance. The attack phase is aimed at total interruption of transmission by spraying with residual insecticides on all roofed structures throughout the country. In the hypoendemic areas, this entails one round of spray (100 mg. DDT per sq. ft.) a year; in the endemic areas two or three rounds are necessary with a total dosage of 200 mg. per sq. ft. and in some instances 300 mg. per sq. ft. The attack phase is to be continued for 3-4 years depending on the results obtained. Surveillance operations are to be introduced from the third year of the attack phase to hasten up the process and facilitate rapid cleaning up of the malarial areas.

Use of residual insecticides is the essential feature of the attack phase. Since 1953, about 147,593,270 lb. of DDT have been used, with small amounts of BHC and dieldrin. As a result, malaria morbidity has been significantly reduced in the country. The proportional case rate of malaria (per cent of malaria cases to total diseases as clinically diagnosed) in each year of this programme has shown a decline and the figures are presented in Chart I. Estimates of actual morbidity and mortality are difficult but it
TABLE I

Malarious countries and territories* grouped according to their present position regarding eradication—as of January, 1960 (data from W.H.O. and other sources).*

1. Eradication completed (18 countries or territories including a population of 108 million living in one-malarial areas):—

<table>
<thead>
<tr>
<th>Country</th>
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<tbody>
<tr>
<td>Barbados</td>
<td>Gaza Strip</td>
<td>Lithuania (USSR)</td>
</tr>
<tr>
<td>Byelorussia (USSR)</td>
<td>Hungary (understood to be eradicated)</td>
<td>Moldavia (USSR)</td>
</tr>
<tr>
<td>Chile</td>
<td>Italy</td>
<td>Martinique</td>
</tr>
<tr>
<td>Corsica (French)</td>
<td>Latvia (USSR)</td>
<td>Netherlands</td>
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<tr>
<td>Cyprus</td>
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<td>Puerto Rico</td>
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</tbody>
</table>

2. Eradication programme in operation (66 countries, 893,501,000 exposed to malaria before initiation of programme):—

<table>
<thead>
<tr>
<th>Country</th>
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<tbody>
<tr>
<td>Afghanistan</td>
<td>Ecuador</td>
<td>Lebanon</td>
</tr>
<tr>
<td>Albania</td>
<td>El Salvador</td>
<td>Libya</td>
</tr>
<tr>
<td>Algeria</td>
<td>French Guiana</td>
<td>Malagasy (Republic of)</td>
</tr>
<tr>
<td>Argentina</td>
<td>Greece</td>
<td>Mauritius</td>
</tr>
<tr>
<td>Bolivia</td>
<td>Grenada</td>
<td>Mexico</td>
</tr>
<tr>
<td>Brazil</td>
<td>Guatemala</td>
<td>Nepal</td>
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<tr>
<td>British Guiana</td>
<td>Honduras</td>
<td>Nicaragua</td>
</tr>
<tr>
<td>British Honduras</td>
<td>Indonesia</td>
<td>Panama</td>
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<tr>
<td>Bulgaria</td>
<td>India</td>
<td>Panama Canal Zone</td>
</tr>
<tr>
<td>Burma</td>
<td>Iran</td>
<td>Paraguay</td>
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<tr>
<td>Cambodia</td>
<td>Iraq</td>
<td>Peru</td>
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<tr>
<td>Ceylon</td>
<td>Israel</td>
<td>Philippines</td>
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<tr>
<td>China (Taiwan)</td>
<td>Jamaica</td>
<td>Portugal</td>
</tr>
<tr>
<td>Colombia</td>
<td>Jordan</td>
<td>Portuguese India</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>Laos</td>
<td>Rumania</td>
</tr>
<tr>
<td>Dominica</td>
<td>La Reunion</td>
<td>Ryuku Islands</td>
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</tbody>
</table>

3. Preparing for malaria eradication:—

(a) Plan of operation—programme suspended (3 million exposed to malaria):—

<table>
<thead>
<tr>
<th>Country</th>
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<tbody>
<tr>
<td>Haiti</td>
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(b) Pre-eradication survey (5 countries, 85 million exposed to malaria):—

<table>
<thead>
<tr>
<th>Region</th>
<th>Country</th>
<th>Country</th>
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<tbody>
<tr>
<td>Bechuanaland</td>
<td>Pakistan</td>
<td>Saudi Arabia</td>
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<tr>
<td>Korea (Republic of)</td>
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<td>Somalia (UK)</td>
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</table>

(c) Pilot project (14 countries, 59 million exposed to malaria):—

<table>
<thead>
<tr>
<th>Region</th>
<th>Country</th>
<th>Country</th>
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</thead>
<tbody>
<tr>
<td>Cameroon</td>
<td>Nigeria</td>
<td>Somalia</td>
</tr>
<tr>
<td>Dahomey (Republic of)</td>
<td></td>
<td>South Rhodesia</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>North Borneo</td>
<td>Sudan</td>
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<tr>
<td>Liberia</td>
<td>Senegal</td>
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</tbody>
</table>

(d) Negotiations underway for a malaria eradication programme (12 countries, 62 million exposed to malaria):—

<table>
<thead>
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<th>Country</th>
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</thead>
<tbody>
<tr>
<td>Angola</td>
<td>Cuba</td>
<td>Malaysia</td>
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<tr>
<td>Belgian Congo</td>
<td>Ghana</td>
<td>Morocco</td>
</tr>
<tr>
<td>Central African Republic</td>
<td>Guinea</td>
<td>Mozambique</td>
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</table>

4. No malaria eradication programme yet contemplated (17 countries, 43 million exposed to malaria):—

<table>
<thead>
<tr>
<th>Country</th>
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<th>Country</th>
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<tbody>
<tr>
<td>Aden Protectorate</td>
<td>Gabon (Republic of)</td>
<td>Muscat and Oman</td>
</tr>
<tr>
<td>Australia</td>
<td>Gambia (Republic of)</td>
<td>New Hebrides</td>
</tr>
<tr>
<td>Bahrain</td>
<td>Hong Kong</td>
<td>Niger (Republic of)</td>
</tr>
<tr>
<td>Bhutan</td>
<td>Ivory Coast (Republic of)</td>
<td>North Rhodes</td>
</tr>
<tr>
<td>Brunei</td>
<td>Japan</td>
<td>Nyasaland</td>
</tr>
<tr>
<td>Cameroon (Br.)</td>
<td>Kenya</td>
<td>Papua and New Guinea</td>
</tr>
<tr>
<td>Cape Verde Islands</td>
<td>Macaco</td>
<td>Portugal</td>
</tr>
<tr>
<td>Chad (Republic of)</td>
<td>Maldives Islands</td>
<td>Qatar</td>
</tr>
<tr>
<td>Comore</td>
<td>Mauritania (Republic of)</td>
<td>Sao Tome and Principe</td>
</tr>
<tr>
<td>Congo (Republic of)</td>
<td></td>
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</tbody>
</table>

*Political entities are given as listed by the 1959 UN Demographic Year Book.
†Data are unavailable on malaria status or planning in Mainland China, North Korea, and North Vietnam.
would appear, from the available data, that malaria in India has been reduced from 75 million cases to less than 5 million. A new era in economic development and social progress has been initiated with its beneficial transformation of the life of the people. The average span of life in India is now 47 years, whereas before the eradication campaign it was 32 years. This improvement has resulted in better agriculture and industrial production. In the Terai region (Uttar Pradesh), land under cultivation and food grain production has increased and this region, once abandoned by its inhabitants because of the high incidence of malaria, has become a beautiful and prosperous area.

Control of Other Arthropod-borne Diseases
The use of DDT for malaria control in certain parts of the country has given the collateral benefit of significant decreases in deaths due to diarrhoea and dysentery. Further, the almost complete absence of human cases of plague in India and the insignificant number of cases of Kala-azar are due to the large scale use of insecticides. Typhus fever in epidemic form is rarely heard of and the incidence of scrub typhus is extremely low. However, attempts to control filariasis by the use of residual insecticides have not been successful because of the development of resistance in *C. fatigans* to insecticides such as DDT, BHC and dieldrin. Larvicidal and pyrethrum sprays, however, are being tried in their place.

Insect Resistance to Insecticides—A Serious Problem in Vector Control
The discovery of DDT and other persistent insecticides so revolutionized the control of vector borne diseases that it was believed by many public health workers that all insect vector problems were solved. But soon after their use in the field reports started coming of their failure. As far back in 1947, *Musca domestica* was reported to be resistant to DDT by Weismann in Italy and *Culex fatigans molestus* by Mosna in the same country. The number of species of public health importance resistant to synthetic insecticides now totals more than 52. Only three of the insects of public health importance, Tse-tse fly, black fly and the sand fly have so far not developed insecticide resistance. Furthermore, the extent of the geographic area in which resistance species have been found has expanded. The problem has become a very serious challenge and there have been several reviews on this subject by which the magnitude of the problem can be judged.

The control of fly borne disease has now gone beyond the scope of insecticides for resistance to DDT, BHC and dieldrin occurs in virtually every country of the world. Houseflies have even been reported to be resistant to pyrethrum in Sweden and in a widely scattered area of the United States. The control of houseflies has once more to be approached through sanitation.

Resistance by Mosquito
The resistance picture in mosquitoes is also quite serious. No less than 22 species of anophelines have now developed resistance to one or more of the chlorinated hydrocarbons. Of this number eight are resistant to DDT and twenty to dieldrin. About 14 species of culicine mosquitoes have also developed resistance to DDT or other insecticides. More than 5% of the malaria eradication programmes have now to confront resistant anophelines and the problem is extending every year. The control of filariasis by the use of residual insecticides has become impossible in India through the widespread development of resistance in *C. fatigans* to DDT, BHC and dieldrin. *A. culicifacies*, the major malaria vector was found to be resistant to DDT in various parts of the country.

Plague Still Possible
Resistance in other insects is equally serious. *Pediculus humanus humanus*, the vector of typhus and relapsing fever, has been reported to be insecticide-resistant in different countries of the world. In India, the collateral benefit of the control of plague was obtained through the large scale spraying for the eradication of malaria. The oriental rat flea *Xenopsylla cheopis*, the principal vector, has now been proved to be DDT-resistant in these parts of the country where this insecticide has been used for malaria control or for other purposes. This species was also found to be resistant to BHC and dieldrin whereasever this group of insecticides has been employed. With the appearance of the resistant strains, a resurgence of human plague can occur in the erstwhile plague endemic foci in India and the seriousness of the situation so arising cannot be overemphasized.

Insect pests like bed bugs, which were once amenable to insecticidal measures, has become highly resistant almost all over the world. Further, it has been reported that there is an increase of bed bug density in those parts of...
India where insecticides have been widely used, reports which have prejudiced the public to the spraying of the insecticides for malaria eradication, causing a serious operational problem.

Further outlook

It will be evident that insecticide resistance is a serious limitation to the chemical control of insects. It is now generally accepted that resistance to insecticides by all disease vectors is inevitable. In these circumstances more stress should be laid on the economic use of pesticides in the vector control programme avoiding a premature switch to substitute insecticides until susceptibility tests with the standard test kits* and epidemiological investigations indicate it to be absolutely necessary. At present we have three groups of insecticides; DDT and its analogues, the BCH-cycloidiene group, and the organophosphorus compounds. By a judicious use of these insecticides a delaying action can be fought. Meanwhile public health measures should be intensified wherever eradication is possible so that it may be attained before resistant strains have appeared.

Much progress has been made in the last decade towards better understanding of the mechanism and origin of resistance23,24. However, there are many gaps in present knowledge and meanwhile the practical problem broadens rapidly. What is needed is not so much the continuation of the present empirical approach to the problem of resistance but an intensification of the basic studies of the biology, ecology and physiology of the insect species concerned; for only on such information can development of alternative control measures be possible.

One of the most important consequences of the resistance problem has, however, been the realisation that chemical control cannot be taken as a substitute for sanitation practices, and that these methods are complementary to each other in the control of arthropod borne diseases. But the eradication of these diseases in underdeveloped countries would have been impossible, before the discovery of the insecticides, for sanitation measures require a large outlay of funds which are not available in these countries.

*The W.H.O. has done an excellent work in the standardization of test methods for the determination of susceptibility levels of insects of public health importance and standardized test methods are now available for mosquitoes, rat fleas, sand-fly and body lice25.

References

16Schoof, H. F., ibid, 1960, 1, 1.

* Rachel, where art thou?
Malaria still exerts a stranglehold on many millions around the world. It destroys lives, saps initiative and prevents good land from being cultivated.

SLOWLY UNDERMENDING HEALTH
Wearing up in violent epidemics, malaria still robs tens of thousands of lives every year, many strong children and adolescents. Death in such numbers may excite rage as long as malaria is not totally banished from the earth. Today these thousands of millions are still threatened by this disease. Malaria eradication - unanimously advocated by the Member States of the World Health Organization since 1953 - calls for much money, manpower and material. Countries that are in the grip of malaria cannot by themselves meet the whole cost of the campaign. International action must accordingly help to carry the programme forward, smoothly and steadily. A constructive way of demonstrating goodwill towards the underprivileged would be to make a full contribution to malaria work.

The world eradication programme, however, is not only an effort of humanitarian solidarity; it is also a thoroughly practical undertaking, for it lies within the heart of progress. It frees people from anxiety. It brings new land under the plough. It produces healthy, energetic, productive communities. It encourages the development of new industries. It creates new markets. There can be no doubt that malaria eradication is essential to man's prospering on earth.

Dr M. G. CANDAU
Director-General of the World Health Organization
SLAVES OF FEVER

for thousands of years

First there is shivering; the chattering teeth, convulsive fits, a skin icy to the touch and a temperature of 104 or higher. After the shivering comes the burning dry heat that drives you almost insane, the insatiable thirst, the booming in the head, the delirium and, worst of all, the hot prickly fire on the skin that is like an excursion to hell.
"...No attack could be mounted through the lowlands. Those commanders who tried inevitably failed, for the Jenerans repelled the troops in a way that the hill men with their primitive fire-arms could scarce hope to achieve...."

"...The island, a gem of green set in the sparkling blue of the sea, was a perfect paradise for one and mugular..."

"...The next thing that happened was that two ships in Beauty's phonon were coming for down with moolars. What an army! You didn't even have the right to be sick any more...."

While math is not the primary focus of this text, it appears in the context of describing a scenario involving a military campaign. The text mentions a specific ship named Beauty's Phonon, which is part of a larger military operation. The ships are described as moolars, and there is a reference to a battle against a hill people who are armed with primitive fire-arms. The text also includes a poetic description of the island, comparing it to a gem of green set in the blue of the sea.

King of Diseases

In modern warfare, diseases can be used as strategic weapons and the spread of disease can be a significant factor in military operations. The text mentions the Spread Disease, which is a term that appears to be used metaphorically to describe a disease that can spread rapidly and cause significant harm to a population. The Spread Disease is described as a weapon that can be used to achieve a military advantage.

The text also includes a reference to a mathematical equation, but it is not clear how it is relevant to the overall context of the text. The equation is presented as a way to describe the spread of a disease, but it is not shown how it is used in the context of the military operations described in the text.

The text concludes with a poetic description of the Spread Disease, comparing it to a weapon that can be used to achieve a military advantage.

An abbreviation

In the text, the abbreviation for Spread Disease is SD. This abbreviation is used throughout the text to refer to the disease. It is not clear how this abbreviation is used in the context of the military operations described in the text. The abbreviation is used consistently throughout the text, suggesting that it is an important term in the context.

The text concludes with a poetic description of the Spread Disease, comparing it to a weapon that can be used to achieve a military advantage.

The text does not include any specific mathematical equations or calculations. It appears to be focused more on describing the use of disease as a military weapon and the strategies used to combat it. The text includes a poetic description of the Spread Disease, which is used to convey the idea that it is a weapon that can be used to achieve a military advantage.

The text does not include any specific mathematical equations or calculations. It appears to be focused more on describing the use of disease as a military weapon and the strategies used to combat it. The text includes a poetic description of the Spread Disease, which is used to convey the idea that it is a weapon that can be used to achieve a military advantage.
SLAVES OF FEVER

the European interest? The answer to this question is probably yes. Smallpox was introduced into Europe in the 16th century, and by the end of the 17th century, it had become a common disease. It was particularly prevalent in England, where it was known as the "King's Evil." Smallpox was a terrible disease, and it was feared by the people, who believed that it was caused by the devil. The disease was particularly deadly, and it was estimated that it killed between 30% and 50% of those who were infected. The disease was transmitted through respiratory droplets, and it was highly contagious. People who were infected with smallpox were isolated to prevent the spread of the disease. The disease was treated with a variety of remedies, including the use of herbs and poisons. Despite these efforts, smallpox continued to be a major public health problem, and it was not until the 18th century that the first successful vaccine was developed. This vaccine was developed by Edward Jenner, who used the principle of vaccination to create a vaccine against smallpox. This vaccine was a major breakthrough in the fight against smallpox, and it led to the eventual elimination of the disease from many parts of the world.

DOS to the rescue

In the 19th century, the development of new vaccines and treatments for smallpox led to a dramatic reduction in the number of cases of the disease. This was achieved through the use of innovators and entrepreneurs who developed new vaccines and treatments. These innovators and entrepreneurs were often driven by a desire to make a profit, and they were willing to take risks in order to develop new vaccines and treatments. They were also motivated by a sense of social responsibility, and they believed that they had a duty to help alleviate the suffering of those affected by smallpox.

The search for a cure

The search for a cure for smallpox was a long and difficult process. It was not until the 19th century that the first successful vaccine was developed. This vaccine was developed by Edward Jenner, who used the principle of vaccination to create a vaccine against smallpox. This vaccine was a major breakthrough in the fight against smallpox, and it led to the eventual elimination of the disease from many parts of the world.

The history of smallpox vaccination is an important part of the history of public health. It is a story of innovation and entrepreneurship, and it is a story of hope and promise. The development of the smallpox vaccine is a testament to the power of human ingenuity and the importance of public health. It is a story that reminds us of the importance of investing in public health and in the development of new vaccines and treatments.

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This photograph is a piece of evidence. A ploughman, Benigno Madriaga, is working a field that has been lying fallow in one of the most malaria-ridden districts of the world, the high plains of Tabuca in the north of the island of Luzon in the Philippines. Since the 19th century, every effort to cultivate this fertile soil was frustrated by malaria which cut down the colonizers. Only some head-hunting Kalinga tribes were able to survive in the highlands. Today, after 15 years of systematic malaria work, the plateau of Tabuca has been opened up to the farmer. Benigno Madriaga, 32 years old, was one of the first to set himself up in the newly liberated land. The Kalingas don’t hunt heads any more but have settled down and are taking part in the life of the 25 villages that are developing on the plateau.

The example of Benigno Madriaga shows that eradicating malaria brings not only better health but also new crops, new prosperity and a new social life. Many such examples can be cited from many parts of the world (see map on page 48/49). The article overleaf is based on the numerous reports received by WHO on this matter.
THE CONTRIBUTION OF MALARIA ERADICATION TO SOCIAL AND ECONOMIC PROGRESS

Malaria is one of the world’s most deadly diseases, killing an estimated 500,000 people each year. It affects millions of people across the globe, with the highest number of cases and deaths occurring in sub-Saharan Africa. The disease is caused by Plasmodium parasites, which are transmitted to humans by the bite of infected mosquitoes.

For the Individual:
Malaria can have a significant impact on an individual’s health. Symptoms can range from mild to severe and include fever, headaches, muscle aches, and nausea. If left untreated, malaria can be fatal. The disease can also lead to complications such as cerebral malaria, which can cause seizures, coma, and death.

FOR THE NATION:
Malaria eradication is crucial for national development. It helps improve the overall health of a country, which can have a positive impact on economic growth and social development. By reducing the burden of malaria, countries can focus on investing in other important sectors such as education, healthcare, and infrastructure.

FOR THE WORLD:
Malaria eradication is a global challenge, and progress has been slow. However, recent advances in treatments and preventive measures provide hope for the future. With continued efforts, it is possible to eliminate malaria from the world. The ultimate goal is to create a world free from this devastating disease.

Cost of a Malaria Case
The cost of a single malaria case can be significant, considering the medical and non-medical expenses. This includes the cost of diagnosis, treatment, and any follow-up care. In addition, the lost productivity of the affected individual can have a financial impact on the family and community. The indirect costs, such as the emotional distress and stigma associated with the disease, can also be significant.

Cost of Endemic Malaria
In endemic areas, malaria can have a significant impact on the economy. The disease can lead to productivity losses, reduced school attendance, and increased healthcare costs. The costs associated with malaria can vary significantly depending on the context and the level of intervention.

Benefits of Eradication
Eradicating malaria could have numerous benefits, including improved health outcomes, reduced economic losses, and improved educational opportunities. It could also have a positive impact on environmental sustainability, as reducing the number of mosquitoes can help in controlling other diseases transmitted by mosquitoes, such as dengue fever.

The total cost per person treated over the course of a year at $1,200. This figure does not include the costs of surveillance and prevention activities, which would be significantly higher in endemic regions. The costs associated with malaria could be further reduced through improved diagnostic tools and targeted interventions.

The eradication of malaria is a complex and challenging task, but it is achievable with sustained effort and commitment. It is essential to continue to invest in research and development to find new and effective treatments and vaccines. With the right approach and resources, we can achieve a malaria-free world.
WORLD-WIDE OFFENSIVE AGAINST MALARIA

This map shows in dark grey the territories around the world where over 1000 million people are still endangered by malaria. The different kinds of malaria workers engaged in the world eradication campaigns are shown in white. Each figure represents 100 workers.
SEEN
by photographers of World Health around the globe

Two World Health photographers (Paul Atienza, Philip Borjas, Jean
Wolff, W. W. Schall, W. P. Anstal) asked back 1,000 photographs
from their travels through the world of nations (Mexico, Liberia,
Sudan, Tanzania, Benin, India, Tanzania, Philippines)
From among the vast collection World Health chose the following
perfectly for a world photo essay on the human vaccination campaign.
The campaign is aimed at stopping the transmission of malaria,
fighting the people who are not attacked by the disease (left),
and treating the last case even in the remotest of villages. The
medical teams are on the march towards eradication (see overview).
B. By appeal, on November 17, 1952, the United States made
a 48-billion-dollar offer to the Soviet Union for dollars and
other goods. The Soviets accepted the offer. The United
States then paid the Soviets the dollars and other goods.

The appeal was made by the United States because it
wanted to improve relations with the Soviet Union. The
Soviet Union agreed to the appeal because it wanted to
improve relations with the United States.

C. At the 1952 United Nations General Assembly, the
United States and the Soviet Union disagreed about
whether the Soviet Union should be given voting power
in the United Nations. The United States wanted to give
the Soviet Union voting power. The Soviet Union wanted
to keep the voting power for itself.

The United States and the Soviet Union were in agreement
about this issue. They wanted to have voting power in the
United Nations.
The smallest source of the house is sprayed with insecticide. The village headman in Liberia made a point of being there himself when his house was sprayed. He asked the team to start with his house. In this way he will show the village that he completely supports the campaign. The co-operation of the people is essential. They should understand that the insecticide sprayed on the inner walls of the houses will kill the mosquitoes who settle there to rest. The point of the operation is to prevent mosquitoes infected with the malaria parasite from infecting or reinfecting the population during a period of three years. In this time the parasite will die and cannot reproduce if there is no transmission. Once the malaria parasite has disappeared, the mosquitoes no longer present a danger, and spraying can be stopped. In some countries, the mass distribution of anti-malarial drugs is part of the eradication campaign. (Picture right). This method is a direct attack on the malaria parasite in the human bloodstream. For it to be successful, every individual in the community must take the drug with absolute regularity. The drawback of this method is that 100% participation is hard to achieve (see next page).
The most elusive nomads must also be covered by the malaria eradication campaign. The millions of wanderers in the world may be a danger for districts already protected from the infection. Coming from non-protected regions, the wanderers may import malaria parasites in their blood and infected mosquitoes in their belongings. They may be responsible for reintroducing malaria, which might cause large epidemics. Most nomads have herds of animals which they drive from fresh pastures from one watering-place to the next. Others are agricultural workers who set out at harvest time. All of them usually ignore national boundaries and have every kind of restraint on their liberty. The health check is generally regarded in the same light as the financial or the military-service check. Wars of the past that are thousands of years old hinder the application of science (see next page).
The search is on the look-out. Since some species of mosquitoes started to develop resistance to insecticides, the malariologists have to check constantly whether the insecticide used in the campaign continues to be effective. Does the coating on the wall reduce the killing-power of the insecticide? Is the drug free being applied? Malariologists also need to identify the type of parasite prevailing in a given locality. Where is the parasite found in the salivary glands of the mosquito. Are the mosquitoes caught in protected areas really free of parasites? Thousands of technicians and microscopists are busy on these tasks. In the laboratories, the search continues for the ideal weapon (see next page).
SEEN...

A new weapon has been found in the shape of antimalarial salt. Its effectiveness has already been demonstrated in regions where transport for spraying became difficult. Just as nicotine is added to salt for lice control, so antimalarial drugs are added to salt, which in turn is added to practically every dish served in the home. In this way, the malarial drug reaches all members of the population. The method was first tried out among Amazon indians by a Brazilian, Dr. Pestelli, and is now being successfully applied in several countries in Africa and Asia. It was well received by the people, because it is so very simple. Yet it represents but one step towards the total disappearance of the disease (see next page).
Victory will not be celebrated until the last case of malaria in the world has been found and cured. For several years after operations proper have been completed (insecticide spraying, distribution of drugs), health authorities will have to be on their guard, look into suspicious cases of fever and examine blood samples for parasites (as in Mexico, picture left). In the language of the eradication campaigners this is the surveillance phase; it is of considerable importance to prevent the disease slapping a return. In Roumania, the Danube delta used to be a stronghold of malaria but has now reached the surveillance stage. It has shaken off the yoke of disease; gangs and prosperity have returned (right). In 1962, eradication of malaria may be achieved throughout Europe, which will then be the first of the six WHO regions to have reached the goal.
THE FRONT LINE
against Anopheles

Georgeo Zottola, the Italian journalist and writer who published an outstanding book on man’s hunger throughout the world, went to Ceylon at the request of World Health to witness hand to hand fighting with malaria. The article which he brought back from his voyage tells of the enormous efforts pursued by Ceylon to rid itself of malaria, the disease that century after century raged the population of the island. He saw how the malaria teams live and work. Before setting out for Ceylon, he was received in Geneva by Dr Carlos Abravanel (Director of the Malaria Eradication Division of the World Health Organization), who spoke to him in these terms of the world malaria campaign: “It’s a real war, an all-out war. Half measures mean defeat.” The following pages tell what Georgeo Zottola experienced in Ceylon, in the front line of the world war against malaria and its deadly ally, the anopheles mosquito.
ON THE FRONT LINE

It was on a sultry afternoon that the plane set me down in Colombo among the tanned coconut trees. Even I, a man born of the city, could not have foreseen the transformation that was to follow. For me, the plane was a symbol of progress, and the coconut trees were memories of a simpler time. But for them, the plane was a sign of the modern world.

One of the worst years in the history of the island: 1914.

The disease raged without mercy. Without pity, the disease struck in 1914 and spiked in 1915, and I was one of the few to witness it. This is a tale of horror and devastation.

The kingdom of Yala, depopulated and deserted three centuries ago because of the fever.

Dr. Dubos, a French colonial officer, was assigned to investigate the causes of the fever. He was a man of science, but also a man of compassion. His mission was to find a cure, but his heart was filled with sorrow for the suffering.

Three million cases in 1936.

Today malaria only strikes one person in 25,000.

As darkness fell, I heard the wailing of the wounded. It was a sound that haunted me, a reminder of the cruel reality of war. The wounded were suffering, and I could do nothing to ease their pain. But I knew that I was not alone, that others were working to bring relief.

Ripples broke on the red sand as I sat on the terrace looking through some malaria files.

The war was not over, but the fighting had ended. The wounded were treated, and the injured were brought to safety. It was a moment of relief, but also a moment of loss. The war had been hard, and it had taken a great toll.

Still, I knew that I had to move on. I had a mission, and I was determined to see it through.
With a quiver of their leaves, shimmering trees saluted us as we passed.

The southern tip of De Vriesland appeared suddenly behind a clump of two trees.

We drove along toward what was called the dunes or the dunes, as they then were. Lastly, we entered into a park-like section of trees and dunes, called the Puttenkamp, which, a few kilometers, was the first point of the Puttenkamp. The Puttenkamp marks the point of departure of the Puttenkamp, where the road turns toward the sea.

The Puttenkamp was a large area of open land, free of trees and shrubs, with a sandy soil. It was a place where the farmers would plow their fields and let them dry before planting. The soil was rich in nutrients, and the area was ideal for agriculture.

We passed the Puttenkamp and then continued onto the Puttenkamp, which was a continuation of the Puttenkamp, but a bit farther away from the sea.

We drove into the dunes along a thread of sand, through the Puttenkamp, which was a continuation of the Puttenkamp.

Waves had broken across the sand beach.

Then we passed a narrow, sandy beach.

The junks were in the water.

Here, we continued, "Our step may not be known to the sound of the sea, and here is the juniper where the children laze and the sleeping buffalo.

We were about to enter the Puttenkamp, and we saw a sleeping buffalo. It was a large, fat animal, with a long, thick tail, and it was sleeping peacefully in the sand.

The buffalo was a common sight in the Puttenkamp, and we were reminded of the stories of how the buffalo would sleep through the day and get up at night to graze.

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I know you need millions but will you please accept my modest cheque
LETTERS TO WHO

We sang in the street

The Cooply Branch of the British United Nations Association sang Christmas carols in the street and sent the proceeds, £4, to the WHO Malaria Eradication Account.

We organized an auction sale

Sunday? And no address given for those you inspired to help.

"I enclose £5 against the Malaria and hope others will help to stamp out the disease. If three quarters of the fight is won, surely if people knew they'd try to pay for the completion."

From the editor of the Oriental Watchman and Herald of Health, Poona, India, came the following:

"Your guiding suggestion regarding the voluntary contribution to malaria eradication is very welcome... we are sending a cheque for 100 rupees to be credited to your account. We wish it could be more, but we trust that along with the amounts sent by others..."

So far, the Malaria Eradication Special Account has received donations from the richest countries in the world as well as from the poorest ones; some industrial firms, foundations and charitable organizations have contributed; Church dignitaries, private persons and school children have made gifts. All this leads the Organization to believe that the number of donors will grow if knowledge of the dimensions and importance of the world malaria eradication programme is more widespread and if it is realized that the money invested in this health endeavour will be regained in a few years.
RESIDUAL FUMIGANTS

Their Potential in Malaria Eradication

WILLIS MATHIS, B.S., RICHARD W. FAY, Ph.D.,
H. F. SCHOOF, Ph.D., and K. D. QUARTERMAN, M.P.H.

RESIDUAL fumigants offer a new technique of vector control which is potentially capable of revolutionizing the insecticidal approach to malaria eradication.

Current malaria eradication programs depend primarily on interrupting the transmission of the disease through the use of residual insecticides, chiefly DDT and dieldrin. Although considerable success has been achieved with this method during the past decade, similar accomplishment in some areas is being hampered by (a) development of vector populations resistant to these insecticides, (b) variation in the efficacy of residues caused by the type of surface to which they are applied, (c) destruction or removal of the insecticidal deposits by replastering, washing, or other modifications of the treated surfaces, and (d) variation in the behavior of the mosquitoes. Consequently, a method which would reduce or eliminate the influence of any of these factors would hasten the achievement of the ultimate goal of global malaria eradication.

That certain toxicants, such as lindane, DDVP, Diazinon, and malathion, possess fumigant properties is an established fact. Moreover, in recent studies of the effectiveness against Anopheles quadrimaculatus of malathion deposits on walls, it was noted that 75 to 100 percent of the mosquitoes remaining in the entrance cages attached to the outside of the animal-baited huts were killed.

The death of these mosquitoes was presumed to result from malathion vapor being carried to the entrance cages from the interior of the huts by air currents. The magnitude of the fumigant action of organophosphorus compounds against mosquitoes was first detected accidentally through the unexpected mortality of mosquitoes in use as "check" insects in laboratory tests. Apparently, they were killed by fumes from an unopened bag of fly bait containing malathion and DDVP. To confirm this premise, two cages of A. quadrimaculatus were placed 1.5 and 3.5 feet above floor level in a small room (5 by 9 by 10 feet) at sites approximately 7 to 10 feet from the same unopened bag of bait located at floor level in an adjoining room (10 by 14 by 10 feet). The rooms were unoccupied and closed to the exterior, and the connecting door remained open. All specimens died within 2.5 hours. The fact that the unopened bag contained a plastic liner emphasized the mobility of the vapor.

The authors are with the Technical Development Laboratories of the Communicable Disease Center, Public Health Service, in Savannah, Ga. Mr. Mathis is a medical entomologist, Dr. Fay is assistant chief, and Dr. Schoof is chief of the Biology Section. Mr. Quarterman is chief of the laboratories. (Manuscript received for publication March 23, 1959.)
To evaluate this fumigant action under less favorable conditions, the tests described below were conducted in an unoccupied two-room house and in two small huts.

**House Test**

Each room was 13 by 12 by 8 feet. One contained an exterior door and a window, and the other, two windows. All these and an interior door between the rooms were fully open. Cages of both susceptible *Aedes aegypti* (400 adults) and *Musca domestica* (200 adults) were placed in five positions in the two rooms as follows: room I-A, sheltered corner; room I-B, in open window; room I-C, above interconnecting door; room II-D, exposed corner; and room II-E, sheltered corner.

Four 5-pound bags of fly bait composed of 2.0 percent malathion and 0.5 percent DDVP were placed in room I on the floor, 5 to 8 feet from cage sites A, B, and C, and 13 and 17 feet respectively from sites D and E. The bait containers were double-paper bags lined with plastic. One was opened, and the others remained sealed. All specimens were exposed for 1 hour, during which time a gentle breeze (estimated 10 m.p.h.) passed through both rooms. After 24 hours, mortality for female houseflies was 21 to 24 percent at cage sites A, B, and C, and 2 and 0 percent at sites D and E. For female mosquitoes, the values were 95 to 99 percent at sites A, B, and C, and 64 and 52 percent at sites D and E.

**Hut Tests**

Each hut (8 by 8 by 8 feet) had 2 windows (3 by 3 feet) on opposite sides, both of which remained open during the entire experiment. In hut I, a single 5-pound open bag of bait containing 2 percent malathion and 0.5 percent DDVP was placed in the center of the floor; in hut II, three open 5-pound bags of the same bait were located one each at the apexes of a triangle (2 ft.) near the center of the floor. One hundred female *A. quadrinaculatus* were released in each hut at 3 p.m. 1 hour after the baits were installed, and at weekly intervals during the next 3 weeks. The morning following each release, all specimens, both living and dead, were collected and held for 24- and 48-hour mortality determinations. Results showed 100 percent mortality for each of the four weekly tests in each hut. The tests were discontinued after the fourth week.

During the fourth week, caged specimens (25 females per cage) were exposed for the same time interval at floor level, and at 2, 4, and 6 feet above the floor. In hut I, all specimens at floor level and at 2 feet were dead within 48 hours. At the 4- and 6-foot levels, 44 and 88 percent respectively were killed. In hut II, mortality was 100 percent for all positions. However, mortality at floor level in an untreated check hut was also relatively high (24 percent).

Subsequent tests were made to determine whether malathion or DDVP, or the combination of the toxicants, was responsible for the residual toxicity. Separate formulations of 2 percent malathion plus 0.5 percent DDVP, of 0.5 percent DDVP, and of 2.0 percent malathion were prepared in a granular inorganic material (A). A 5-pound lot of each formulation was bagged in a paper container, and the bag was left open and placed in the center of the hut floor. Both “free-flying” and caged *A. quadrinaculatus* were introduced into each hut at 3 p.m., 3 hours after the bait was installed.

The following morning all mosquitoes, whether “free-flying” or caged, were dead. With the combination of malathion and DDVP and with DDVP alone, all the specimens were knocked down 3.5 hours after exposure began. With malathion alone, only a few specimens were down after 4.5 hours of exposure.

Tests on the residual potency of these formulations were precluded because of the onset of cold weather.

**Discussion**

The potential of residual fumigants for controlling house-frequenting adult mosquitoes, although obviously successful in producing a high mortality for 4 weeks, has not been explored fully in these preliminary tests. Further studies under laboratory and field conditions are now in progress to determine which toxicant or combination of toxicants is most effective, the
duration of residual action under various environmental conditions, efficient methods of formulation in small, lightweight units, and the toxicological hazards. The possibility of toxicological hazards to the occupants of treated dwellings represents a principal question concerning the practical use of the fumigants. This aspect will require extensive study before the technique can be put into general practice.

If the use of residual fumigants proves feasible, it is readily foreseeable that this technique could result in important monetary savings by simplifying malaria eradication operations. Manpower requirements would be reduced drastically; the need for spraying equipment, with its attendant burdens of maintenance, as well as problems currently encountered with wettable-powder formulations, would be minimized; and other difficulties associated with residual spraying, such as the sorption of residues by certain mud surfaces, objections to the unsightliness of residues on some walls, and the modifications of treated surfaces by replastering, washing, and the like, would be eliminated. Although mosquitoes appear more susceptible to fumigant action than houseflies, the technique may be effective also against other types of house-frequenting insect vectors and pests.

Because of the many potential advantages which the residual fumigant technique may offer in malaria eradication and in the control of other mosquito-borne diseases, it is hoped that the encouraging results of these preliminary tests will stimulate other workers to investigate the many questions which must be answered before the technique may be adopted for general use.

REFERENCE


EQUIPMENT REFERENCE


Alaskan Research Advisory Committee

An Interagency Research Advisory Committee has been formed by representatives of the Alaska Department of Health, the U.S. Air Force Arctic Aeromedical Laboratory, and the Public Health Service’s Alaska Native Health Service and Arctic Health Research Center. Its purpose is to assist scientific investigators in medical and allied fields who wish to perform research in Alaska.

The committee is prepared to aid investigators sponsored by a recognized institution by explaining local situations, helping solve logistic difficulties, and making available Alaskan facilities.

Persons desiring such assistance should write to E. M. Scott, Chairman, Interagency Research Advisory Committee, Arctic Health Research Center, Box 960, Anchorage, Alaska.
STATEMENT BY LEROY E. BURNEY, M.D.
Surgeon General, Public Health Service

Live Attenuated Poliomyelitis Vaccine

For many years, the possible use of a live attenuated poliomyelitis vaccine, that is, a virus which has been grown in animals or eggs until it has lost its disease-producing potential without losing its immunizing ability, has been discussed. For more than 7 years, the problem has been under serious investigation.

The Salk vaccine, now in use and giving good results in protecting against paralytic poliomyelitis, is made from killed virus.

The main advantages visualized for a vaccine made from live attenuated virus are: (a) longer lasting immunity—although the Salk vaccine is believed to provide protection for some time, the actual duration of immunity is not yet known because it has been in use for such a short time; (b) ease of administration, with the live virus given orally instead of by injection; and (c) presumably lower costs of production.

At the present time three sets of strains are under investigation. These are most readily identified by the names of their developers, the Sabin, Lederle, and Koprowski strains, named respectively for Dr. Albert Sabin of the University of Cincinnati, Lederle Laboratories, and Dr. Hilary Koprowski of Wistar Institute of Philadelphia. The name of Dr. Herald Cox, of the Lederle Laboratories, is also associated with the Lederle strains.

Each set consists of three type strains. These sets of strains have now been administered to large numbers of persons in an attempt to determine: (a) their ability to produce adequate and durable levels of antibody, and (b) their safety in general use.

No untoward results have been reported in relation to these studies. Stated in this way, the facts appear impressive. It must be remembered, however, that many of the studies were designed to collect have not yet been fully assembled, analyzed, or made public.

The Public Health Service is following these developments closely. Our Division of Biologies Standards of the National Institutes of Health, for example, is conducting laboratory investigations aimed at characterizing the type strains. These investigations are of importance because the Service may be asked some day to license the products.

I also have appointed an ad hoc committee composed of outstanding experts in this field to keep me advised of developments with respect to live attenuated poliomyelitis vaccines. This committee consists of Dr. Roderick Murray, chairman, director of the Division of Biologies Standards, National Institutes of Health; Dr. David Bodian, Johns Hopkins University; Dr. William McCall, University of Pittsburgh School of Public Health; Dr. Alexander Langmuir, Public Health Service, Communicable Disease Center, Atlanta, Ga.; Dr. Joseph Melnick, Baylor University, and Dr. John E. Paul, Yale University Medical School.

This committee has met twice and considered all information now available on these vaccines. The committee finds a number of important issues remain to be answered or resolved before the live attenuated poliomyelitis vaccines can be considered other than in the experimental stage.

These issues cover such points as: apparent differences in the ability of the different strains to invade the nervous systems of experimental ani-

mals; transmission of virus from vaccinated persons to others; feasibility of feeding the three type strains simultaneously; effect of viruses in the intestinal tract, other than polioviruses, on the development of immunity to poliomyelitis; validity of surveillance of populations inoculated to date.

The committee has felt some concern because some of the trials of live attenuated poliomyelitis vaccine have not followed the recommendations of the World Health Organization Expert Committee on Poliomyelitis. It also has been concerned by apparent differences in the virulence for the nervous system of some of the virus strains being used. This aspect of the problem needs further study.

The experience thus far indicates that encouragement should be given to carefully conducted, small-scale studies designed in such a way that the laboratory and epidemiological surveillance could produce results upon which a judgment could be made.

Large-scale trials of live attenuated poliomyelitis vaccine in the United States are considered unproductive because so large a proportion of the population already has been immunized with killed vaccine.

The decision to permit such trials in other nations is, of course, one for their health and medical authorities. However, because the experimental vaccines are made in the United States and because our ad hoc committee has been studying reports on them, I feel that such information as we have should be made public so that not only our people but the peoples of other nations can have all current available information as exists on which to form their opinions and base their decisions.