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**DISEASE VECTOR CONTROL AND RESEARCH  
IN THE WHO SOUTH-EAST ASIA REGION:  
EDUCATION AND TRAINING NEEDS**

**Proceedings of a SEARO Workshop on  
Manpower Development for Disease Vector Control and Research  
Pattaya, Thailand, 1-6 February 1988**

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the WHO Regional office for South-East Asia  
the Fogarty International Center - WHO Collaborating Center  
for Research and Training in Biomedicine,  
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and the United States Agency for International Development**



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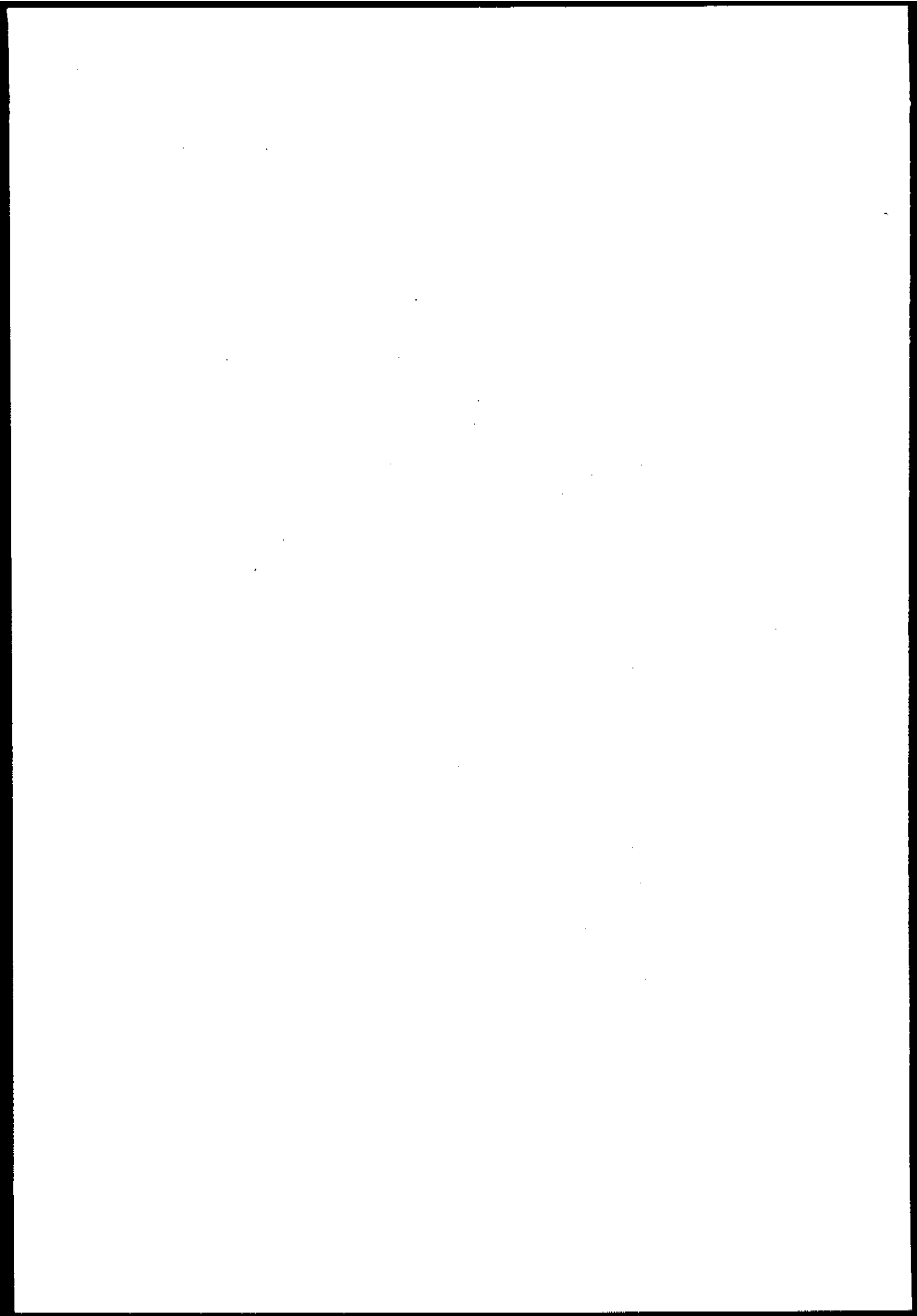
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## EXECUTIVE SUMMARY

Vector-borne diseases continue to be among the major health problems faced by most tropical countries as well as some temperate countries. In most of the tropical countries the control of malaria vectors still poses a serious problem. Dengue and dengue haemorrhagic fever (DHF) have spread further; and the control of their vector, *Aedes aegypti*, remains a challenge. *Aedes albopictus*, originally an Asian species, has now spread to parts of the Americas and other continents. Morbidity from filariasis and Chagas' disease continues to be high, and outbreaks of yellow fever still occur in Africa and the Americas. The recrudescence of leishmaniasis and African trypanosomiasis continues to present difficulties in several countries. Malaria, filariasis, DHF and Japanese encephalitis have reached high levels of endemicity in most countries in the South-East Asia region.

The control of vector-borne diseases is complex. The impact of socio-economic development on vector-borne disease hazards associated with land and water resource development projects has become further evident. Effective vaccines are not available for most vector-borne diseases, and there are no specific chemotherapeutic agents for many others. In the 1950s, widespread use of DDT and other new insecticides offered promise that malaria and other mosquito-borne diseases could be controlled. Today, however, vector resistance to insecticides is a serious impediment to most control programmes. Although basic research in vector biology, physiology and genetics has yielded some methods for controlling vectors, it is becoming increasingly apparent that the effective use of control methods requires a sound knowledge of the epidemiology of the specific disease. Biology, ecology and population dynamics have been further complicated by changes in delivery strategies, including primary health care and community participation, which require knowledge of the social, behavioural, and communication sciences.

Unfortunately, a serious constraint has arisen to overcoming control problems through use of entomological expertise: the number of medical entomologists and vector control specialists has been decreasing throughout the world, leaving a serious void in professional personnel. At the same time, education and training in these specialities have decreased and there are fewer career opportunities for those engaged in disease vector control.

In 1982, the US National Research Council, Board on Science and Technology took the initiative to examine this situation by sponsoring a workshop on US manpower needs and career opportunities in vector biology. This was followed by a study in the WHO Region of the Americas, co-sponsored by the Fogarty International Center - WHO Collaborating Center for Research and training in Biomedicine and the Pan American Health Organization, in which education and training needs for medical entomologists were defined.

This report deals with the results of a similar study conducted in the WHO South-East Asia region. Its five chapters present: a description of the rationale underlying country studies and workshops; an overview of the status of vector-borne diseases in the countries selected for study; the role and contribution of medical entomologists; needs for vector research and control manpower; country reports and proposals; and general recommendations. The report concludes that additional medical entomologists and vector control specialists are urgently required to deal with the continuing public health menace posed by vector-borne diseases and that an action plan should be developed for establishing and maintaining the technical manpower needed to meet national needs.

## CHAPTER 1

### INTRODUCTION

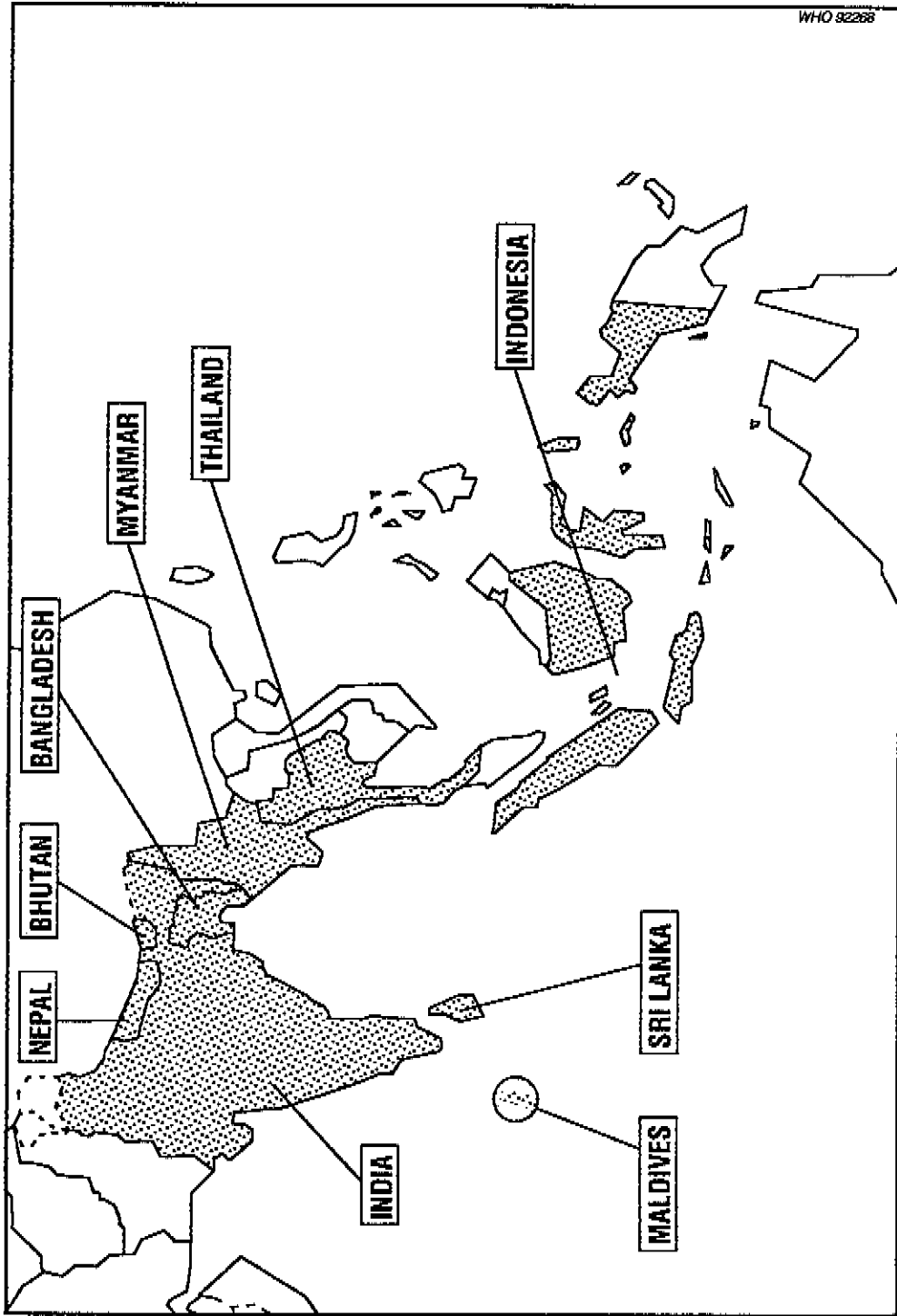
In recent years, newspapers in many tropical and sub-tropical countries around the world have revealed prevalent health hazards attributed to vector-borne disease: "Malaria Back Again", "Outbreak of Encephalitis", "Epidemic of Dengue Fever", "Kala Azar Returns", "Dam Project Triggers Malaria and Schistosomiasis". Statistics of the World Health Organization (WHO), based on submissions by member countries, verify the accuracy of the headlines.

Forty per cent of the world's population is still at risk to malaria. There are an estimated 100 million new cases each year. Many millions more are afflicted with parasitic diseases such as filariasis, onchocerciasis (river blindness), leishmaniasis (including kala azar), sleeping sickness, and Chagas disease. Every year millions are infected by such viruses as yellow fever or dengue. All of these diseases cause significant morbidity and mortality, resulting in serious losses in productivity in those countries least able to afford them.

Controlling vector-borne disease is a priority concern for most of the countries in which they are endemic, and the problems presented are paramount in nine countries in the WHO South-East Asia Region (WHO/SEARO) (See map). Four vector-borne diseases - malaria, filariasis, dengue/dengue haemorrhagic fever, and Japanese encephalitis - are endemic in most countries of the Region. A number of other vector-borne diseases are also present, among them plague, scrub typhus, murine typhus, chikungunya, Kyasanur Forest disease, and Congo-Crimean haemorrhagic fever. While these diseases may occasionally cause severe problems locally, they are not of major regional concern. Problems of schistosomiasis and guinea worm also abound, but are beyond the scope of this report, since they are either not transmitted by insects or arthropods or as in the case of the latter which is nearly eradicated from countries in this region.

Due to problems of drug resistance or the lack of effective drugs or vaccine, the methods of choice for controlling most of these diseases is vector control, usually through the use of insecticides. Vector control, therefore, is an essential component of any programme to control these diseases and must be integrated with other approaches. While biological and environmental approaches are increasingly used to control insect vectors of disease, routine vector control programmes must, for the most part, still rely on the application of chemical insecticides such as residual wall sprays or space sprays. The cost of insecticide purchase, transport, and application can amount to more than 50% of a national malaria control programme budget. Where programmes for the control of dengue vectors exist the proportional cost is similar. Thus, economic implications of such vector control programmes are obvious.

**The nine countries of the WHO/South-East Asia Region  
in which the control of vector-borne diseases is a priority concern**



The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

The need to involve medical entomologists \* and vector control specialists \*\* in organized vector control programmes is becoming increasingly important, especially in light of new concepts and strategies, such as integrated vector control and vector control as a part of primary health care. There is also a critical need for medical entomologists in research and in operational activities to determine the most cost-effective control approaches under specific circumstances. However, in many of these countries, there are few qualified persons to fill these roles.

In 1982, the US Board of Science and Technology for International Development (BOSTID) of the National Academy of Sciences convened a workshop to examine the need for field studies in vector biology as a necessary step toward developing new or improved strategies to control vector-borne diseases. This workshop assessed needs for medical entomologists in the United States. It recommended that manpower assessments be conducted in developing countries to define the number of professional vector biologists needed for teaching, basic and applied research and for vector control programme management. The workshop also sought to define career incentives that would attract vector biology specialists to public health programmes (Manpower Needs and Career Opportunities in the Field Aspects of Vector Biology, Report of a Workshop, National Academy Press, Washington, D.C., 1983).

Discussions of this subject between staff of the WHO Division of Vector Biology and Control (WHO/VBC) and the Fogarty International Center (FIC) of the US National Institutes of Health (NIH) affirmed WHO's interests and role in promoting the education and training of vector biologists and control specialists at the graduate level in developing countries. It also affirmed WHO's recognition that such specialists would need to be assured of a suitable career structure to enable them to participate meaningfully in disease control programmes. In its role as a WHO Collaborating Center for Research and Training in Biomedicine, the FIC directs some of its activities towards strengthening international collaboration in biomedical research and research training in support of WHO programmes, particularly when these activities would enhance NIH collaboration with scientists in member countries. In this case, the development of medical entomology manpower worldwide was seen to enhance the opportunities for US medical entomologists to interact with qualified professionals elsewhere.

These discussions led to the development of a joint WHO/FIC cooperative project:

- (a) to establish a global profile of what medical entomologists and vector control specialists are contributing to vector-borne disease research and control;
- (b) to assess education, training, and career placement needs to enhance the participation of these key health specialists in the planning, implementation, and evaluation of vector-borne disease programmes; and
- (c) to develop plans to meet the manpower needs in countries where vector-borne disease programmes are being conducted.

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\* A medical entomologist is a scientist concerned with all aspects of the biology and control of insects and other arthropods responsible for disease transmission. This speciality requires a knowledge of the following subjects: systematics for identification of arthropod vectors; the biology, habits, and life cycles of insects and other arthropods of medical significance; epidemiology, and control of vector-borne diseases; and techniques for the testing and evaluation of repellents, insecticides, and biological control agents.

\*\* A vector control specialist is a medical entomologist, a sanitarian, or an engineer specially trained for taking measures of any kind directed against a vector of disease and intended to limit its ability to transmit the disease.

The first such project was carried out in 1986 in the WHO Region of the Americas through collaboration between the FIC, the Pan American Health Organization (PAHO/WHO) and WHO/VBC. It was felt that the PAHO experience could be a model for other WHO regions interested in the subject. Following the PAHO study, the South-East Asia Regional Office of WHO (SEARO) expressed interest in adapting the project methodology to its member countries.

## PLANNING

Two planning meetings were held at SEARO, New Delhi, in 1987. Participants included representatives of the co-sponsoring agencies: SEARO, WHO/VBC, the US Agency for International Development (USAID) in India, and the FIC.

## COUNTRY STUDIES

It was decided that in-depth country reviews of manpower needs in medical entomology should be carried out in four countries: India, Indonesia, Myanmar and Thailand. The reviews were to be carried out by WHO staff members or consultants in collaboration with national counterparts. Guidelines for the country studies, adapted from the PAHO study, were finalized by the co-sponsors. The same guidelines were also proposed for use by nationals in five remaining countries: Bangladesh, Bhutan, Maldives, Nepal and Sri Lanka.

## REGIONAL WORKSHOP

It was decided to hold a regional workshop on "Manpower needs in Medical Entomology and Vector Control" in Thailand from 1-6 February 1988. It was agreed that two participants would be invited from each of the nine endemic member countries already identified. Annex I contains a list of participants.

The objectives of the workshop were:

1. To review the present situation in SEARO member countries with regard to employment opportunities, employment status, requirements, deficiencies, etc. for medical entomologists and vector control specialists in and their contributions to disease vector research and control;
2. To identify the need for strengthening contributions of medical entomology to national vector-borne disease control programmes; and
3. To develop draft country proposals to strengthen capability in medical entomology research and control of vector-borne diseases.

It was agreed that the workshop would rely on active participation by country representatives. Working groups would be formed from each of the nine countries to develop draft country proposals for manpower development in disease vector control and research in accordance with a standard format. A series of general recommendations relevant to the region as a whole would be derived from presentations and discussions. Annex II contains a list of the working papers presented at the workshop.

In the planning phase it was recognized that the PAHO and SEARO projects would differ. PAHO focused on education and training of professional medical entomologists (M.Sc. and Ph.D. degrees) for research and control, but did not go into the details of operational programmes. The SEARO project would consider the needs for all types of entomological personnel, including entomology technicians. Further, while the PAHO project concentrated on case studies prepared in four countries as examples for review by others in the region, the SEARO project would produce a more comprehensive assessment based on four in-depth country studies, supplemented by five others that followed a similar but more abbreviated format.

The proceedings of the SEARO workshop have been distributed as an internal WHO document (Manpower Development for Disease Vector Control and Research, Report of a Regional Workshop, Pattaya, Thailand, 1-6 February 1988)(SEA/VBC/39).

## CHAPTER 2

### OVERVIEW OF THE CURRENT SITUATION IN THE SOUTH-EAST ASIA REGION

This chapter presents highlights of the nine country studies and proposals for future action, supplemented by information presented during discussions at the regional workshop. Complete summaries of each country study and draft proposals for medical entomology development are presented in Chapter 3.

These studies confirm the presence of four major vector-borne diseases in the region: malaria, lymphatic filariasis, dengue/dengue haemorrhagic fever, and Japanese encephalitis. In addition, plague, leishmaniasis, scrub typhus, and Kyasanur Forest disease are present to a greater or lesser degree in some countries (see Table 1).

**TABLE 1**  
**OCCURRENCE OF VECTOR-BORNE DISEASES IN THE REGION**

COUNTRY	MALARIA	LYMPHATIC FILARIASIS	DENGUE/DHF	JE	PLAGUE	LEISHMANIASIS	SCRUB TYPHUS
Bangladesh	X	Z	Z			Z	
Bhutan	X	Z		Z			
India	X	X	Z	Y		Y	Z
Indonesia	X	X	X	Z	Z (2)		
Maldives	X (1)	X	X				
Myanmar	X	X	X	X	X		Z
Nepal	X	Z		Y		Y	
Sri Lanka	X	X	Z	X			
Thailand	X	X	X	X			

X Major health problem for which there is already a control programme

Y Major health problem but no control programme yet

Z Occurs

(1) No indigenous cases since 1984, but still considered a threat

(2) Last outbreak in 1970

\* For consistency, this report uses the terms "assistant entomologist" and "entomologist" when referring to personnel with the B.Sc., M.Sc. and Ph.D. degrees. Inasmuch as entomology technicians, insect scouts, and other non-professional entomology workers serve a valuable function, they are also included in the discussions.

## STATUS OF VECTOR-BORNE DISEASES

### Malaria

A high level of endemicity exists in Bangladesh, Bhutan, Indonesia, Myanmar, Nepal, Thailand, and in the eastern areas of India contiguous with Myanmar, where Plasmodium falciparum predominates and drug resistance is common. The greater parts of India and Sri Lanka are predominantly P. vivax areas where drug resistance has not posed a problem. Since this review was undertaken, drug-resistant P. falciparum has become a more important problem in Sri Lanka. No indigenous cases have been reported in the Maldives since 1984.

### Dengue/Dengue haemorrhagic fever (DHF)

Dengue haemorrhagic fever associated with high mortality rates is present in Myanmar, Indonesia and Thailand. Other countries in the region have recorded only sporadic cases of classical dengue, which is a mild type of infection with practically no fatality, and occasionally DHF. Most of the countries, however, have a very high potential for a rapid build-up of epidemics.

### Lymphatic Filariasis

The northern parts of Bangladesh, Myanmar, India, Nepal, and Sri Lanka remain highly endemic with the nocturnally periodic form of Wuchereria bancrofti. The problem is on the increase due to haphazard growth of urban areas with poor municipal environmental services. Brugia malayi and W. bancrofti occur in Thailand as well as Indonesia, where B. timori is also found. Bhutan and the Maldives show negligible infection rates.

### Japanese encephalitis (JE)

Japanese encephalitis virus, originally isolated in Japan, has spread westward and now occurs in almost all countries in South-East Asia. In its spread westward, permanent foci seem to have been established in a few regions of India (West Bengal, Bihar and Uttar Pradesh), Nepal and Thailand. Myanmar which showed JE activity in 1987 has not recorded any case since 1980. Bangladesh, Bhutan, Indonesia, the Maldives, and Sri Lanka, have reported sporadic outbreaks.

## CONTRIBUTIONS MADE BY MEDICAL ENTOMOLOGISTS

Medical entomologists have a vital contribution to make to both the efficacy and the economy of disease vector control programmes. Guidance of such programmes requires continuing operational research on such issues as: vector identification and incrimination, vector biology and behaviour, vector distribution, dispersion and densities, vector response to insecticides and other control measures, the role of secondary vectors, the effect of cultural practices on vector status and vector response to control, and vector-borne disease impacts of development projects.

As the vector control component of vector-borne disease control programmes is approximately 50-60% of the overall annual expenditure of such programmes, the potential economic losses due to misguided or inadequately executed operations can be quite colossal. Medical entomologists have contributed and are still contributing, in collaboration with epidemiologists and health planners, to the success of disease control efforts throughout the region. Where such contributions somehow fail to be recognized, or to be used in programme operations, the ensuing losses in human lives, public health and public funds may be considerable.

The following are several examples from the Indian and Thailand reports that illustrate the direct contributions made by medical entomologists to control several of the prevalent vector-borne diseases:

- One of the important recent contributions of medical entomologists relates to cutaneous leishmaniasis, hitherto believed to be an anthroponotic infection in India. Entomologists at the National Institute of Communicable Diseases (NICD) found that there are two transmission routes, urban and rural. Urban infections were found to be transmitted from person to person by Phlebotomus sergenti and P. papatasi, while rural infections are zoonotic, being transmitted from the desert gerbil, Meriones hurrianae, to humans by P. salehi.
- Studies carried out in India by entomologists in India's NICD and National Malaria Eradication Programme revealed that DDT can be utilized for malaria control in areas where the vector, Anopheles culicifacies, is resistant to it. Due to the excito-repellent effects of DDT, the vector is driven out of human habitations where it would normally rest. Thus, a rational application of DDT, even in areas where the vector is resistant, is saving millions of rupees that would have been spent on expensive substitutes.
- In Thailand, tests for susceptibility of DDT have been conducted with vectors and suspected vectors at least once each year in indicator areas. Where refractory populations have been encountered, a series of time exposures has been obtained to permit the establishment of a regression line. Such tests have led to a timely switching to other insecticides in areas where epidemiological data suggested that resistance was hampering the success of the programme.

#### CHANGING ROLE OF MEDICAL ENTOMOLOGISTS

There have been changes since the late 1960s in the individual country strategies for controlling malaria and other vector-borne diseases. The changes began with recognition of the difficulties entailed in malaria eradication. The most important of these changes are as follows:

1. The change in strategy from malaria eradication to malaria control for all countries of the region, except the Maldives, although all of the countries still retain eradication as their ultimate objective;
2. Control of malaria and other vector-borne diseases as part of the primary health care system;
3. Promotion of self-protection and community participation to control malaria and other vector-borne diseases;
4. Reduced reliance on residual house spraying and increased utilization of all available methods in an integrated approach to control;
5. Establishment of programmes for control of vector-borne diseases other than malaria, or conversion of the malaria programme to a general vector-borne disease control programme.

These changes have spawned a great demand for more sophisticated entomological services. Instead of focusing on a single control method (e.g. residual house spraying) for a limited number of vectors (e.g. *Anopheles* mosquitos), the medical entomologist today must be equally familiar with larviciding, space spraying, biological control, source reduction, water management, the design of applied field research, and the essentials of epidemiology. Furthermore, the medical entomologist must be familiar with all disease vectors posing a problem in the country.

Medical entomologists engaged in today's integrated vector-borne disease control programmes fulfil one or more of the following functions:

1. Design and conduct entomological surveys as an integral part of epidemiological studies to characterize the dynamics of disease transmission (e.g. seasonal fluctuations in transmission and potential for man-mosquito contact);
2. Plan and organize entomological activities to collect baseline data for planning, implementing, and evaluating control measures;
3. Organize entomological research (e.g. monitor changes in receptivity to control measures in certain areas, determine the entomological factors involved in non-response to control measures, and forecast incipient epidemics, pandemics, etc);
4. Establish baseline data on the susceptibility of vectors to insecticides and develop a system for monitoring the level of susceptibility;
5. Determine the operational implications of resistance to learn whether or not an insecticide should be replaced;
6. Test new or alternative insecticides and methods of application, conduct field trials of biological control agents to evaluate their efficacy, and participate in field studies on integrated vector control;
7. Develop biological and environmental management methods of control as alternatives to chemical control, including such strategies as the introduction of appropriate engineering methods, source reduction, legislative methods, and intersectoral coordination supported by health education and community participation, emphasizing prevention;
8. Formulate an affordable control strategy for containment or elimination of each vector-borne disease which takes into account specific local conditions;
9. Devise methods for the control of common pests in rural and urban areas using community participation;
10. Implement and evaluate field and classroom training courses for staff, using well defined, specific learning objectives.

An important problem of vector-borne disease control programmes is how to gain the commitment of SEARO member countries to integrate vector-borne disease control with the primary health care system. To gain active community participation, the entomologist must be competent in selecting methods that are appropriate and feasible under local circumstances for initial and continuing maintenance tasks.

**MANPOWER NEEDS**

This table summarizes the current entomology personnel in each country, positions required for control and research, and the current shortfall.

**TABLE 2**  
**MANPOWER\* IN MEDICAL ENTOMOLOGY**

COUNTRY	CURRENT POSITIONS			POSITIONS REQUIRED			SHORTFALLS		
	Control	Research	Both **	Control	Research	Both **	Control	Research	Both **
Bangladesh	99	7	-	91	15	-	-	8	-
Bhutan	-	-	0	-	-	1	-	-	1
India	643	90	-	1 176	259	-	533	169	-
Indonesia	55	30	-	459	47	-	404	17	-
Maldives	-	-	0	-	-	3	-	-	3
Myanmar	-	-	27	-	-	31	-	-	4
Nepal	-	-	10	-	-	18	-	-	8
Sri Lanka	4	1	-	14	3	-	10	2	-
Thailand	27	21	-	262	21	-	235	0	-
<b>TOTAL</b>	<b>828</b>	<b>149</b>	<b>37</b>	<b>2 002</b>	<b>345</b>	<b>53</b>	<b>1 174</b>	<b>196</b>	<b>16</b>
							<i>(TOTAL SHORTFALL 1 386)</i>		

\* Includes entomologists and assistant entomologists with a college degree, but not entomology technicians and insect collectors

\*\* In these countries, entomologists are expected to do both research and control

Except for Bhutan and the Maldives, all countries employ entomologists in their vector-borne disease control programmes. Cross-national comparisons are difficult, however, because of considerable country-to-country variation in types of entomology positions, qualifications for the positions, and levels of responsibility. For example, some countries have only one category of entomologist, but differentiate titles by location or responsibility (e.g. headquarters, regional, state, provincial, or zonal entomologist; or research entomologist). Most countries have more than one category of entomologist (such as senior entomologist, entomologist, and assistant entomologist). Other position titles in use include junior assistant entomologist, entomology assistant (technical officer), entomology technician, insect collector, insect scout, and community insect scout. Indonesia has seven different categories, Bangladesh has six, and the other countries list two or four.

In general the categories of assistant entomologist, entomologist, and senior entomologist are professional positions that require a B.Sc., M.Sc., or Ph.D. degree. However, there is no uniformity. An assistant entomologist in one country may be required to have an M.Sc. degree, in another a B.Sc. degree, and in another a high school diploma with special training.

All of the countries identified a need for additional entomologists. Equally important, they have stressed the need for advanced study to improve the skills of entomologists already employed (e.g. encouraging B.Sc. holders to obtain an M.Sc. degree, and those with an M.Sc. degree to obtain a Ph.D.). There is a special need for training in the design and conduct of applied field research projects.

Evident from the country reports is an acute shortage of trained medical entomologists and vector control specialists at the various levels of most operational programmes and research groups. Most control programmes are being carried out with insufficient entomological input. As indicated in Table 2, the shortfall in manpower has reached a staggering figure of nearly 1 200 persons for control operations and nearly 200 for research activities.

A number of constraints impede the development of manpower. Only a few institutions in the region provide diploma and degree courses due to lack of trained and qualified faculty. Existing curricula are mostly based on old concepts. Specific job-oriented courses are lacking that are especially fitted to the primary health care delivery systems. There is also a lack of qualified entomologists to fill existing research positions. However, the biggest constraint is the lack of suitable and attractive career structures, resulting in either stagnation or a rapid turnover of personnel.

**TABLE 3**  
**EDUCATION, TRAINING AND RESEARCH INSTITUTIONS**

COUNTRY	UNIVERSITIES PROVIDING M.Sc., Ph.D. IN MEDICAL ENTOMOLOGY	CENTRES FOR IN-SERVICE TRAINING	RESEARCH	
			UNIVERSITIES	RESEARCH INSTITUTIONS
Bangladesh	0	2	3	1
Bhutan	0	0	0	0
India	1*	8	10	23
Indonesia	2	3	2	3
Maldives	0	0	0	0
Myanmar	0	0	2	1
Nepal	0	1	0	0
Sri Lanka	0	1	3	1
Thailand	1**	1	5	3
<b>TOTALS</b>	<b>4</b>	<b>16</b>	<b>25</b>	<b>32</b>

\* While only 1 university awards the M.Sc./Ph.D. in Medical Entomology, 70 universities offer a M.Sc./Ph.D. in zoology

\*\* Mahidol University offers both degrees under two different facilities - Faculty of Sciences and Faculty of Tropical Medicine

As is evident in Table 3, only four universities in the region offer the M.Sc. or Ph.D. degree in medical entomology. Mahidol University in Thailand is the only institution offering both degrees under the faculties of science and tropical medicine. While 70 universities in India provide M.Sc./Ph.D. courses in zoology, only one university offers a medical entomology degree. Graduates in zoology must obtain further training in medical entomology for full competency.

There are 16 centres for in-service training in the region, while 25 universities and 32 research institutions are directly involved in research relevant to vector-borne disease control programmes.

Table 4 provides information on the number of people requiring medical entomology education and training in the 9 countries. The totals for the region are: B.Sc., 405; M.Sc., 128; Ph.D., 27; for job-oriented short courses of 3-6 months duration, 992; and refresher training, 473. Extensive funding for training and fellowships is required, as it would be extremely difficult for the countries to meet these needs from internal resources.

**TABLE 4**  
**NUMBERS OF PEOPLE REQUIRING EDUCATION AND TRAINING NEEDS**

COUNTRY	BASIC EDUCATION			JOB-ORIENTED SHORT COURSES 3-6 MONTHS	REFRESHER COURSES *
	B.Sc.	M.Sc.	Ph.D		
Bangladesh			2	12	65
Bhutan		1		3	
India		60	10	150	75
Indonesia	368	30	7	384	
Maldives	2	1		3	
Myanmar	2	2		24	10
Nepal		1	2	10	10
Sri Lanka		12			
Thailand	33	21	6	406	313
<b>TOTAL PERSONS</b>	<b>405</b>	<b>128</b>	<b>27</b>	<b>992</b>	<b>473</b>

\* Usually given annually

In addition to providing new positions, efforts should be made to develop a career structure to assure stability for a cadre of medical entomologists within the framework of the national health administration. Presently, only two countries in the region (India and Indonesia) have such a structure.

#### RESEARCH STRENGTHENING

All countries represented at the workshop expressed the need for more research in medical entomology/vector biology. In addition, there was a consensus that more research should be directed to improving disease vector-control efforts. There is considerable variation in the resources and capabilities of the different countries for conducting basic and applied/field research.

Two countries (Bhutan and the Maldives) have no medical entomologists and no facilities for either basic or applied research. Nepal has no facilities for basic research and limited facilities for applied research. Three countries (Bangladesh, Myanmar and Sri Lanka) have the capability for both basic and applied research, but the facilities need strengthening. Three countries (India, Indonesia and Thailand) have substantial resources for both basic and applied/field research at a combination of universities, research institutions, and research units which are part of control programmes. However, these three countries identify a need to enhance their research programmes through institutional strengthening, curriculum development, advanced training, and recruiting additional entomologists.

Overall research capability is still weak in the region, even though the existing M.Sc. programmes in medical entomology provide research training. This is reflected in the small number and quality of research proposals submitted for financial support to the UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases. It would be useful to offer regularly scheduled short courses on the design of applied field research projects and on the preparation of research proposals. Such courses should be included in M.Sc. degree programmes.

The need to strengthen medical entomology research capability is apparent from the following problems identified in most of the country reports:

1. Failure to incriminate the vector of a disease in a particular areas because of inadequate entomological expertise. For instance, the identity of the local malaria vectors has never been verified in some of the malaria programmes in the region.
2. Inadequate updating of knowledge on vector bionomics, which is essential for planning any control programme. As an example, residual spraying has been continued in some

countries although it is no longer effective because local environmental determinants have changed.

3. Inability to update information on vector resistance to insecticides. Failure to change insecticide as soon as necessary or changing to an ineffective insecticide can be an expensive error.
4. Inadequate evaluation of vector control methods in use. Failure to adequately evaluate the effectiveness of residual spraying or other control methods can result in loss of time, effort and money as well as a failure to control the disease vector and ultimately reduce disease morbidity.

Choice of the wrong vector control strategy or a failure to monitor and evaluate its impact can cost a country several millions of dollars a year, a sum that could be repaid many times over by investing in the education, training, and retention of competent entomologists. Locally conducted laboratory and field research could help appreciably to solve many of the problems noted. Country participants consider research to be urgently needed in the following areas:

1. Vector biology studies, including human-vector contact studies, vector biting habits, host preference, and flight range of vectors (9 countries);
2. Effectiveness of community participation in vector control (7 countries);
3. Development of integrated vector control methods (6 countries);
4. Research on various aspects of biological control of vectors (6 countries);
5. Studies to confirm the vector status of malaria, Japanese encephalitis, and filariasis (4 countries);
6. Susceptibility studies of various vectors (4 countries);
7. Studies to determine the effectiveness of environmental management (3 countries);
8. Studies to determine effectiveness of personal protection measures (3 countries);
9. Research to develop alternative vector control methods (2 countries);
10. Research to determine reasons for persistent transmission of malaria in spite of long-term spraying with a residual insecticide (2 countries).

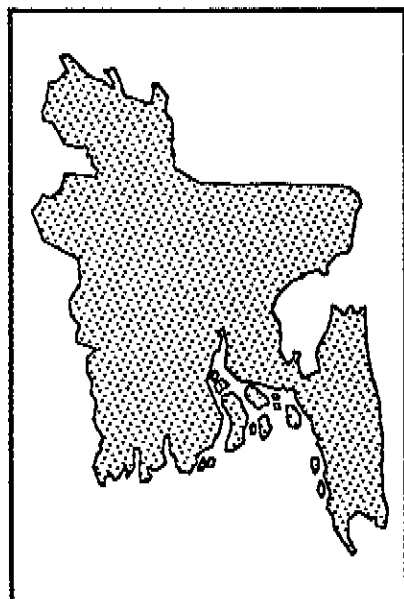
## CHAPTER 3

### COUNTRY REPORTS AND DRAFT PROPOSALS

This chapter presents summaries of country reports, supplemented with information presented by country representatives at the workshop. Each country section includes the manpower situation and the problems being tackled, manpower needs for research and control, and recommendations for meeting these needs. The manpower development proposals prepared by each country at the workshop are integrated into the summaries.

In view of the number and variety of countries involved, it is not surprising that there are considerable differences in the background and status of personnel referred to as entomologists and entomology workers. For consistency, the entomologists and assistant entomologists referred to in the following pages are at B.Sc., M.Sc., and Ph.D. level. Inasmuch as entomology technicians, insect scouts, and other non-professional entomology workers serve a valuable function, they are also considered in the discussions.

#### BANGLADESH



#### COUNTRY FINDINGS

The important vector-borne diseases in Bangladesh are malaria, leishmaniasis (kala azar), filariasis, and dengue.

Malaria poses the most serious problem. Although the four principal vectors of the disease are still susceptible to DDT, the effectiveness of residual spraying is lessened by the exophilic and exophagic behaviour of two of the vectors. The total number of reported malaria cases rose from 30 250 in 1985 to 41 408 in 1986, with an alarming increase in the percentage of *P. falciparum* cases from 39% to 54%.

Cases of kala azar have been reported during the last 2-3 years from about 15 districts, but the total scope of the problem is not known.

Bancroftian filariasis is known to be endemic in the northern part of the country.

The only disease vector control programme is the Malaria Control Programme, which is carried out through the integrated primary health care system. The approximate annual expenditure for malaria control is about 150 million taka (US\$ 5 million) excluding the pay and allowances of personnel. This constitutes about 6% of the total health budget.

Research on vector biology and control of the Malaria and Other Parasite Disease Control Unit (MPDCU) focuses on epidemiological investigations and vector surveillance. Research at the Institute of Epidemiology, Disease Control and Research (IECDR), and at the Medical Entomology Department of the National Institute of Preventive and Social Medicine (NIPSOM) includes mosquito biology and testing of insecticides.

Faculties of several universities are also involved in research on mosquito biology. Ongoing research includes studies on the bionomics of the vector of kala azar, evaluation of insecticide-impregnated mosquito nets, field trials to determine the effectiveness of DDT residual spraying on *An. dirus*, and studies of seasonal prevalence.

A broad range of future research needs is identified for malaria, leishmaniasis, filariasis, dengue, and Japanese encephalitis. Proposed research should emphasize the development and testing of cost-effective methods for control of each of the vectors, studies on the ecology and bionomics of each of the major vectors, studies of self-protection measures, motivation for community involvement, and improved surveillance methods.

There is a need to develop a disease vector control research unit in the Directorate of Health Services to carry out this broad range of research, as well as to improve the disease vector research potential of the universities and health research institutions.

#### **MANPOWER NEEDS**

National authorities have identified a need for a total of 106 medical entomologists: 91 for the control programme and 15 for research. At present, there are 99 positions available in the malaria control programme and 7 in research. These research entomologists work in the MPDUC: 3 in the IECDR; and 3 in the NIPSOM.

Eight more entomologists are needed to conduct applied field research to determine the effectiveness of malaria control methods currently in use, to field test alternative techniques, and to develop background information as a basis for control of other vector-borne diseases such as leishmaniasis, filariasis, and dengue. Since the available entomologists come from the Malaria Control Programme, there is a need for training in the biology and control of vectors of the other diseases as well as in research methodology.

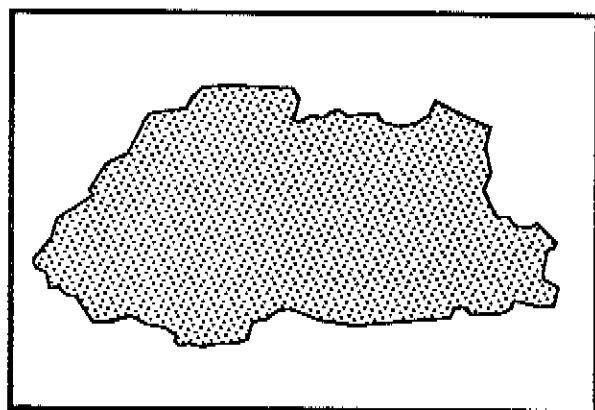
#### **MAJOR RECOMMENDATIONS AND PROPOSALS FOR MEETING THE NEED**

Since the supply of entomologists within the country appears adequate, the principal need emphasizes institutional development for both training and research, as well as advanced training to improve the quality of the available entomological services and to enhance the career potential of the entomologists.

1. The existing educational and research facilities for medical entomology and vector biology in the universities and postgraduate institutions in the country should be expanded to enable them to meet government needs for competent graduate entomologists to carry out programmes on research and control of disease vectors. Although the three universities (Dhaka, Chittagong, and Rajshahi) offer an M.Sc. degree in zoology with specialization in medical entomology, it was considered desirable to add faculty for a degree programme in medical entomology. It was also considered necessary to expand and upgrade the teaching of medical entomology in institutions such as NIPSOM and IEDCR. Course/curricula on medical entomology and vector biology and control should be redesigned to reflect the needs of integrated programmes of vector control utilizing all available methods.
2. The disease control programme under the Primary Health Care/Directorate of Health Services should be reorganized as an integrated vector-borne disease control and research programme.
3. All vacant posts should be filled. Entomologists involved in research should be given additional training in the design and conduct of applied field research, with special reference to field testing and evaluation of vector control methods.
4. At least two entomologists should receive advanced study abroad leading to the Ph.D. degree in medical entomology/vector biology.
5. Six fellowships should be provided for short courses (diploma/certificate) in medical entomology/vector biology and for research methodology.
6. In-service orientation/refresher courses should be provided for entomological and other field personnel in the control programme.

7. Health inspectors and assistant health inspectors should receive training on vector surveillance and control.
8. Graduate entomologists under the Health Services Directorate should receive higher education in medical entomology to the M.Sc. level.
9. International support will be required for two Ph.D. and six short course fellowships outside the country. Funds and logistic support will also be needed to strengthen training and research facilities in the existing institutes.

## BHUTAN



### COUNTRY FINDINGS

For the past 27 years malaria has been considered the most important vector-borne disease in Bhutan, and as such has warranted a large-scale vertical effort. The malaria eradication programme is currently the only vector-borne disease control programme. The malaria budget takes about 7% of the total health budget, excluding the costs of insecticides and drugs which are obtained through external assistance.

In 1986 there were 19 916 reported malaria cases with 37 deaths, which means that approximately 15% of the total population suffered from malaria in that one year.

Since there are no medical entomologists in Bhutan, the only entomological information available is that provided by the occasional external short-term consultant. In spite of the existence of the malaria eradication programme for many years and visits by a series of short-term consultant entomologists, the malaria vector is not yet identified and the bionomics of the potential vectors are not known.

A few cases of filariasis and leishmaniasis (kala azar) have been reported, and the vectors of dengue and Japanese encephalitis in neighbouring countries have also been detected in entomological surveys in Bhutan. However, little specific information on the disease and their vectors in Bhutan is available.

### MANPOWER NEEDS

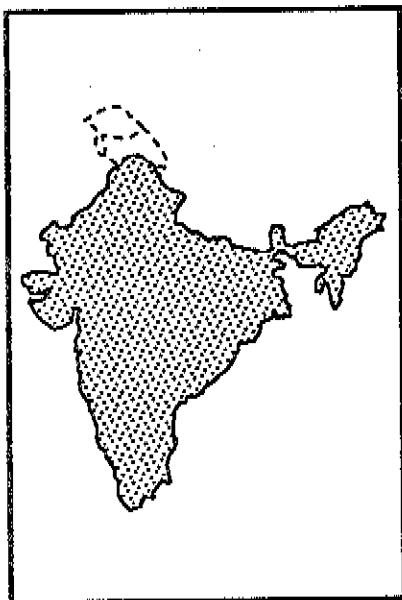
There is no qualified entomologist in the country. One candidate is currently undergoing in-service certificate training through a WHO fellowship and is expected to work as an entomology technician upon completion of the programme. At least 7 entomological personnel are needed: one M.Sc. degree holder for leadership; and 2 entomology technicians and 4 insect scouts for field work. It is envisaged that these personnel will be responsible for both control and research.

No facility exists in the country for the education and training of entomological personnel or for the conduct of entomological research on the biology and control of disease vectors.

## MAJOR RECOMMENDATIONS AND PROPOSALS FOR MEETING THE NEEDS

1. The fellowship will be necessary for a suitable candidate to work toward the M.Sc. degree in medical entomology, preferably in a neighbouring country in the region.
2. As a short-term measure, it is recommended that the malaria medical officer receive training to cope with the entomological aspects of the programme.
3. Two technicians and 4 insect scouts should be recruited and trained.

## INDIA



### COUNTRY FINDINGS

The important vector-borne diseases in India are malaria, filariasis, leishmaniasis (kala azar), Japanese encephalitis (JE), dengue/dengue haemorrhagic fever, Kyasanur Forest disease (KFD), and plague, for which only surveillance is needed at present.

At present, 93% of the 789 million population are at risk from malaria. While surveillance operations cover the entire population-at-risk and anti-malaria treatment is provided to all cases detected, the vector control measures that are carried out cover only 44% of the population-at-risk.

Nearly 304 million people are exposed to the risk of Bancroftian filariasis, with the risk being primarily to people in rural areas. Filariasis is prevalent throughout India except in the north western states and union territories.

Leishmaniasis (kala azar) is endemic in the states of Bihar (71.68 million) and West Bengal (51.80 million). The incidence of kala azar in 1986 was 17 241 cases with 70 deaths.

Prior to 1970 Japanese encephalitis cases were reported only in South India. Since 1973, large-scale outbreaks began to occur in the northern and north eastern parts of the country, with 3 000 - 4 000 cases reported yearly. In 1986, three districts in Uttar Pradesh were affected, and the total number of cases reported was 1 733 with 615 deaths.

Classical dengue transmitted by *Aedes aegypti* is endemic in India. The vector species occurs in the Indo-Gangetic plains, north western plains, eastern coastal areas and river valleys. A series of epidemics started in 1956 the latest occurred in Maharashtra in 1986. Dengue haemorrhagic fever manifestations were recorded in 1963 and 1964 in Calcutta with concurrent involvement of chikungunya virus.

Kyasanur Forest disease is a zoonotic viral infection transmitted by ticks. The infection has only been reported in the State of Karnataka. In 1986 there were 213 cases reported with 14 deaths.

India was one of the pandemic areas for plague. The last case of human plague was recorded in 1966 in Karnataka and only surveillance is required at present.

Miscellaneous vector-borne infections, mainly of arboviral origin, are commonly present throughout the country.

There are two national vector-borne disease control programmes: the National Malaria Eradication Programme (NMEP) and the National Filariasis Control Programme (NFCP). NMEP is also responsible for the control of other vector-borne diseases. Fifty percent of the national health budget is spent on the control of vector-borne diseases by the Indian Government.

Considerable basic and applied research is being carried out at numerous institutions throughout the country. Research is supported by different agencies, such as the Ministry of Health and Family Planning which supports the research of the National Institute of Communicable Disease, the NMEP, the *P. falciparum* containment Programme, and the NFCP. The Indian Council of Medical Research coordinates the research carried out by the Malaria Research Centre, Vector Control Research Centre, Centre for Research in Medical Entomology, National Institute of Virology, Rajendra Memorial Medical Research Centre and 6 regional medical research centres. Research on various aspects of vector biology and control is also carried out at some of the universities, a few of the city operations, and in many of the states.

In spite of the substantial amount of research already in progress, there remain problems which can only be solved by research to control the vector-borne diseases. Fourteen such problems are listed for malaria, including:

1. The need to develop a methodology for planning and evaluation of bio-environmental methods of vector control;
2. The need for greater knowledge of vector ecology, distribution, and vector incrimination;
3. The need for studies on socio-cultural factors influencing anti-vector activities, studies of appropriate health education activities and community participation, and innovative methods of stimulating the use of personal protection measures;
4. Cost-analysis of anti-malaria activities;
5. Cyto-taxonomic studies of certain species of mosquitos.

Additional research requirements are identified for DHF, filariasis, Japanese encephalitis, plague, leishmaniasis, and Kyasanur Forest disease. The need was also identified for developing integrated vector control methods, as appropriate, for control of a combination of disease vectors.

#### MANPOWER NEEDS

Approximately 800 medical entomologists are employed in India's various disease vector programmes. One hundred and twenty five are in the national programmes under the Ministry of Health and Family Welfare. Most others are with state governments and municipal corporations. Nevertheless, there is a problem of recruiting and retaining qualified entomologists. In the NMEP, for example, there were 72 entomology positions at zonal level, with only 42 filled at the time of the study.

Sixty-six entomologists are employed by the various research institutions under the Indian Council of Medical Research. An indeterminate number of additional entomologists in universities are engaged in research.

Additional medical entomologists will be needed to meet the increasing recognition of the importance of vector-borne diseases and the need for vector control strategies to be based on a sound knowledge of the ecology and bionomics of the vector species, as well as on integrated disease control approaches emphasizing community participation through the primary health care system. By the year 2000 at least another 150 senior medical entomologists will be required for control programmes and 35 senior research entomologists for operational research.

If NMEP is converted to a National Vector-borne Disease Control Programme, as the Indian Government has proposed, additional medical entomologists will be needed to conduct research, carry out field testing of control methods, and supervise efforts against the other important vector-borne diseases. In addition to the existing programme for control of malaria and filariasis, entomologists would be required to work on problems involving control of dengue/dengue haemorrhagic fever, Japanese encephalitis, plague, leishmaniasis, scrub typhus, and Kyasanur Forest disease.

#### **MAJOR RECOMMENDATIONS AND PROPOSALS FOR MEETING THESE NEEDS**

It will be necessary to increase the number of entomologists, develop an attractive career structure for them, and provide them with the means to carry out entomological field investigations. To accomplish this, the following recommendations and proposals were submitted:

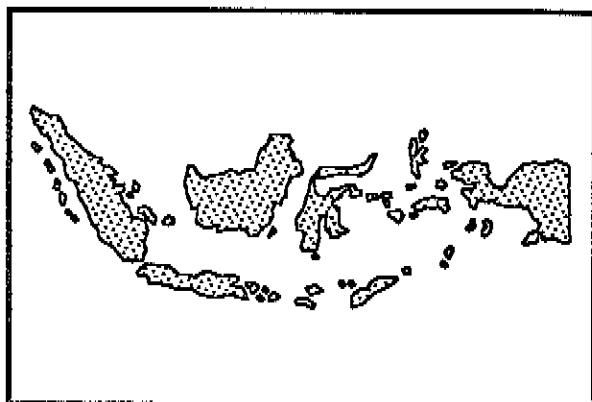
1. The number of candidates for the M.Sc. degree in medical entomology should be increased in institutions currently giving such degrees. Although 70 universities are producing M.Sc./Ph.D. graduates in zoology, only one university has re-oriented its curriculum to provide an M.Sc. degree in medical entomology and a second intends to do so. However, two institutions are insufficient for a country the size of India.

To promote job-oriented teaching in medical entomology, additional institutions should be identified to offer the M.Sc. degree. A systematic plan for both professional and in-service training should be formulated, keeping in mind the current needs and expected future requirements. Curricula of current training courses should be revised and updated.

2. The possibility should be explored of offering a 9 month M.Sc. course in medical entomology, patterned after that of the Liverpool School of Tropical Medicine. Such a course would greatly help in preparing more qualified professionals and also improve career prospects for the in-service B.Sc. graduates with research and control experience in medical entomology.
3. Facilities and faculties should be developed to award a Ph.D. degree in medical entomology in Indian universities/research institutions. Until this is accomplished, at least five fellowships per year should be provided for training abroad to obtain the Ph.D.
4. Efforts should be made to constitute a cadre of medical entomologists within the framework of national and state health administrations in order to maintain availability of skilled manpower. The cadre should be on a par with the cadre of scientists in the Ministry of Defence, Department of Science and Technology, and the Indian Council of Medical Research.
5. There is an urgent need to reorganize the administrative structure so that there are time-bound promotions for medical entomologists. This would help retain entomologists and encourage greater productivity. Once inducted at a lower level, such a system would eliminate the need for entomologists to cross-over to other positions to obtain promotions. It would be similar to the practice in the Indian Council of Medical Research. Such a policy is essential for retaining expertise in highly specialized fields.

6. Programmes at the peripheral level should be managed by qualified entomologists of at least the B.Sc. level to assure effective programme implementation. This can be accomplished over a period of time by replacing sanitarians holding high school qualifications with qualified entomologists.
7. It is strongly recommended that working conditions be improved by providing proper laboratory services and transport for work in the field, including adequate staff to assist in field research and operations.

## INDONESIA



### COUNTRY FINDINGS

Malaria and dengue/dengue haemorrhagic fever are serious public health problems. Filariasis presents a problem of lesser degree. Japanese encephalitis occurs but is not considered to be a priority public health problem. Plague remains as a potential threat.

Malaria continues to be a public health problem of high priority, although the situation in Java and Bali has improved considerably in the last few years. The potential for malaria transmission remains high because of the importation of malaria cases from the Outer Islands. The two main vectors in Java and Bali, An. aconitus and An. sundaicus, are resistant to DDT in some areas.

The malariogenic potential in the Outer Islands is very high but there is a lack of information on malaria prevalence, vector biology, vector distribution and effectiveness of control measures.

Cases of dengue haemorrhagic fever (DHF) have been reported throughout the year from 26 of the 27 provinces and from more than 162 of the 301 districts and municipalities. The vectors Ae. aegypti and Ae. albopictus occur throughout the country. There were 13 588 cases of DHF reported in 1985.

Filariasis is endemic in the slum sections of urban areas and in many rural areas. Although it is recognized as an increasing health problem in many areas, there is a need for more information on the magnitude of the problem, the distribution of the disease and the numerous potential vector species.

Since the late 1950s, plague has only appeared in two mountainous areas of Central Java. The last outbreak was in 1970, but plague-infected fleas were recovered from rats in 1972 on the slopes of Mount Merapi.

Programmes have been established for the control of malaria, dengue, and filariasis.

Considerable research has been and is currently being carried out by the Directorate of Vector-borne Disease Control, as well as by the Biology Section of the Health Ecology Research Centre in Jakarta and its Vector Control Research Unit in Central Java. This includes large-scale field trials of insecticides against malaria vectors, use of insecticide-impregnated bed nets, biological control, testing of alternative methods of mosquito control, source reduction, and community participation.

Research needs are different for the Outer Islands as compared to Java and Bali. Since comparatively little information is available on the disease vectors in the Outer Islands, basic research is needed to identify vectors, their distribution and bionomics, and susceptibility to insecticides.

A need has been recognized for developing a country-wide list of problems requiring research. Some have already been identified, such as:

1. development and testing of alternative insecticides;
2. testing of biological control agents;
3. information on the vectors of filariasis and appropriate methods for their control; and
4. more information on the role of the community in integrated vector control.

#### **MANPOWER NEEDS**

The entomological staff for the control programmes at the central level includes 11 entomologists and 6 assistant entomologists (6 doctoral, 5 masters, 2 baccalaureate and 4 high school graduates). This is considered adequate to meet the needs at the central level.

However, at the provincial, district, and municipal levels there is a great shortage of entomologists. Needs are estimated at: 2 entomologists and 3 assistant entomologists per province (27 provinces), 2 assistant entomologists per district or municipality (247 districts and 54 municipalities), and 1 assistant entomologist per health center (5 300 health centres). The shortage of entomologists for the control programmes is estimated at 404 for technical guidance of the operational programmes, including both entomologists and assistant entomologists at B.Sc., M.Sc., and Ph.D. levels. For the ongoing applied field research programme, there is an estimated shortage of 17 entomologists with the M.Sc. or Ph.D. degrees.

The Biology Section of the Health Ecology Research Centre in Jakarta and its Vector Control Research Unit in Central Java have identified a need for additional research entomologists. However, the actual number of entomological personnel required to meet the research needs for the whole country has not been determined.

#### **MAJOR RECOMMENDATIONS AND PROPOSALS FOR MEETING THE NEEDS**

Indonesia has developed a plan for five categories of professional entomologists and two categories of non-professional entomological workers at the health centre and community level. The plan is based on the conduct of disease vector control activities at the community level through the primary health care system. It also envisages the incorporation of the professional categories of entomology positions into the government's career development scheme. This is considered essential for recruitment and retention of competent entomologists.

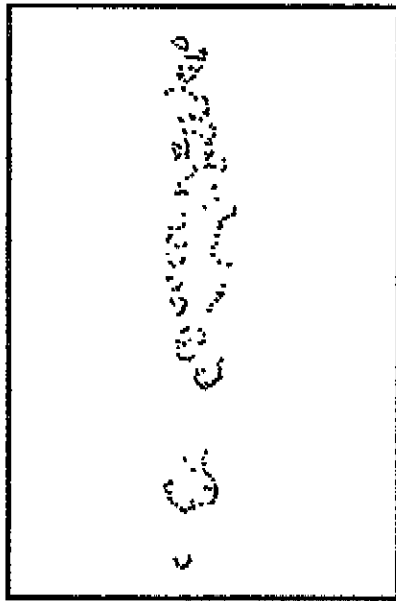
Integral to this plan is the development of adequate facilities and faculty for training entomologists for both research and control programmes. The only academic course offering an M.Sc. degree in medical entomology is given by the Faculty of Graduate Studies at Bogor Agricultural University. In the first 8 years of this course, there were 40 students enrolled, 25 M.Sc. degrees granted, and one student was awarded a Ph.D. degree. This equates to an average of 3.5 new entomologists per year.

A proposal for institutional strengthening has been submitted through official channels. Unless additional funding, facilities, and staff become available both at the university and training centre level, it will not be possible to meet

Indonesia's future needs for medical entomologists in disease vector control programmes. The proposed recommendations include:

1. Preparation and submission of a long-range plan for future organizational structure and manpower requirements for consideration under Indonesia's fifth five-year plan;
2. Establishing and filling proposed positions as soon as possible;
3. Collaboration between vector-borne disease control and research programmes in developing a detailed five-year plan of relevant research project requirements, addressing in particular the needs of the Outer Islands where there is a shortage of basic information on disease vectors;
4. Critical appraisal of the number and type of research scientists required, based on the comprehensive long-term plan of research projects required throughout the country; and
5. Further development and strengthening of the medical entomology M.Sc. course at Bogor University and all other educational and training courses in medical entomology for personnel at different levels.

## MALDIVES



### COUNTRY FINDINGS

The major vector-borne diseases in the Maldives are dengue and filariasis, with the entire population of 189 400 at potential risk. Although malaria was a serious problem, the vector-borne disease control programme successfully eradicated it. No indigenous malaria cases have been reported since 1984. However, in view of the possibility of imported cases leading to a reintroduction of malaria, the Maldivian Government recognizes the need for continuing surveillance and the technical manpower required for this.

The filariasis control programme was started in 1969, when the disease could be found in nearly all 202 islands of the Republic. The vector, Culex quinquefasciatus is found in all the inhabited islands. In Male, the capital, drug administration and larviciding substantially reduced filariasis prevalence, with only 183 cases reported during 1985-1986. The slide positivity rate was reduced from 5.4% in 1969 to 0.06% in 1985.

The first outbreak of classical dengue occurred in 1979 and fewer cases have occurred periodically since then. The suspected vectors are Ae. aegypti and Ae. albopictus, both of which are found on most of the islands.

### MANPOWER NEEDS

There are no medical entomologists in the country, no institutions for training entomologists, and no facilities for conducting entomological research. The primary need is to recruit and train one head entomologist and two assistant entomologists. This entomology team would provide technical guidance and management and assist in the planning, organizing, and implementation of disease vector control and research activities. This is particularly important in terms of maintaining the gains in eradicating malaria, controlling filariasis, and preventing the spread of dengue.

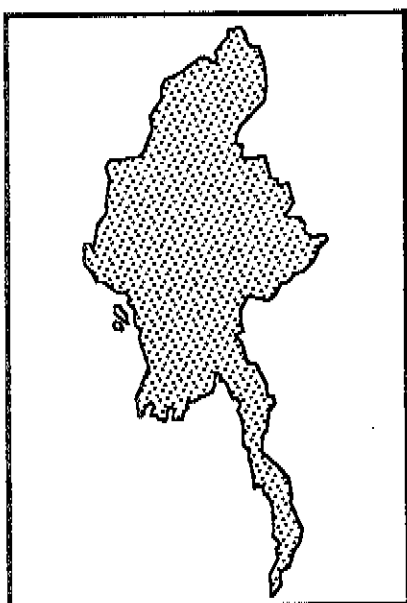
## MAJOR RECOMMENDATIONS AND PROPOSAL FOR MEETING THE NEEDS

It is proposed to have one national staff member trained to the level of M.Sc. in medical entomology or in biology with supplementary training in medical entomology. The assistant entomologists should be given a diploma or certificate course in vector control. Training should cover both control operations and research methodology. Fellowships will be required to provide this training abroad.

The disease vector control element should be further developed and strengthened in the curricula of national health manpower training programmes.

## MYANMAR

### COUNTRY FINDINGS



Myanmar has a long history of serious vector-borne disease problems, which as a group constitute the leading public health problem in the country. Malaria has been accorded first priority, out of sixty diseases/conditions, followed by dengue/dengue haemorrhagic fever (priority 15), plague (priority 21), filariasis (priority 56), and Japanese encephalitis (priority 59). Although scrub typhus and murine typhus also occur, they are not considered to be serious public health problems.

The only organized control effort is a general vector-borne disease control (VBDC) programme aimed specifically at the control of malaria, filariasis, dengue/dengue haemorrhagic fever, and Japanese encephalitis.

The number of reported malaria cases has increased each year from about 42 000 in 1981 to about 65 000 in 1985. A cause for concern is the high percentage of P. falciparum cases, which have accounted for more

than 85% of the total cases in the past 4 years. Considering the widespread P. falciparum drug resistance this poses a serious challenge to the control programme.

Of the 37 anopheline species found in Myanmar, 8 have been incriminated as vectors, with 5 considered important. Of these 5 vectors An. minimus and An. balabacensis are most important. They exhibit exophilic and exophagic behaviour which limits the effectiveness of DDT residual spraying even though they are still susceptible. A third important vector (An. annularis) has developed high levels of resistance to DDT in a part of its range, limiting the effectiveness of this insecticide.

Dengue haemorrhagic fever has been reported in 12 of 14 states. Between 1970 and 1986, the mean annual incidence of cases was 2 556 with 108 deaths. The vector Aedes aegypti is found throughout the country below an elevation of 900 m.

Filariasis is also considered one of the priority public health problems. So far, Wuchereria bancrofti is the only filaria parasite found in Myanmar, and the only known vector is Culex quinquefasciatus.

Outbreaks of Japanese encephalitis were reported in 1976, but since 1980 no case has been reported.

Only 99 cases of plague were reported in 1981. Plague has a fairly high priority for control though the number of human cases remains low. The infection is in rodent and associated flea populations in several parts of the country.

Research is currently being conducted by the VBDC programme on the bionomics of malaria vectors, susceptibility of vectors to insecticides, and on the vectors of filariasis, dengue, and Japanese encephalitis. The Rodent Control Demonstration Unit has ongoing research on plague ecology and surveillance, identification of fleas, lice, and mites, and testing of insecticides and rodenticides.

The Department of Medical Research is involved in research on mosquito taxonomy, mosquito genetics, and the biological control of mosquitos.

In the future, priority will be given to applied field research focused primarily on the development and testing of vector control methods. Before substantial progress can be made, the needs for additional entomologists and training of existing entomologists will have to be met.

Vector-borne disease research is being conducted by the VBDC Programme, the Department of Medical Research, the Rodent Control Demonstration Unit, and the University of Yangon. National authorities have recognized the need to coordinate research efforts of these institutions, and to ensure that the research is relevant to the objectives of the VBDC Programme.

#### **MANPOWER NEEDS**

##### **Control Programme Placement**

At present the VBDC Programme is being supported by one senior entomologist, 7 entomologists, and 19 assistant entomologists. There is one fully qualified medical entomologist (M.Sc. degree from London School of Hygiene and Tropical Medicine) and one candidate for an M.Sc. degree at the Liverpool School of Tropical Medicine and Health.

In spite of their designation as "entomologists" most of the incumbents have had little formal training in medical entomology beyond that obtained through participation in job-oriented short courses. The primary need is for in-service training and education of the present entomologists to better prepare them to carry out control and research duties. Within the VBDC Programme additional personnel are needed to form 2 teams for applied field research, including 2 M.Sc. entomologists, 2 B.Sc. assistant entomologists, and an appropriate number of technicians and insect collectors. The additional entomologists are needed to facilitate problem-oriented field studies on alternative control methodologies and field trials of new chemical/biological agents and to determine changes of vector distribution and habits.

There is a need for a career development structure within the government, because promotional prospects for entomology staff within the VBDC Programme are less than for scientific officers in other departments or institutions.

##### **Research**

The Head of the Medical Entomology Research Division of the Department of Medical Research is a Medical Officer with an M.B.B.S degree. There are 2 Senior Research Officers (one M.Sc. in parasitology and one B.Sc. in biology), and one Research Officer with a B.Sc. in zoology. Four additional senior scientists are needed, including two entomologists at the M.Sc./Ph.D. level.

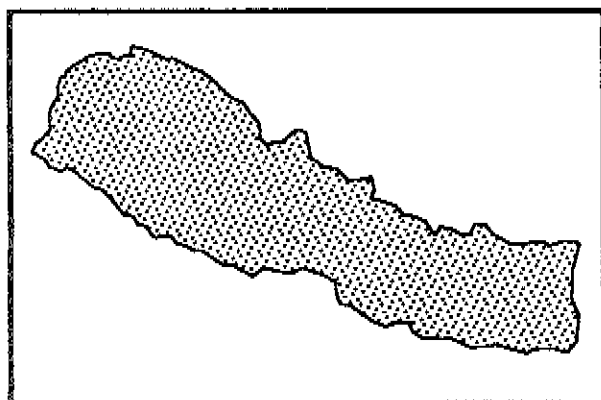
### Training Requirements

In addition to the basic education needs at the M.Sc. and Ph.D. levels, there are continuing needs for job-oriented short-courses that can be met by sending entomologists abroad for suitable courses as scheduled. Such courses include the 3 month advanced malariology course sponsored by WHO and the Governments of Thailand and Italy; the 3 week WHO/DANIDA course; and the 5 month intensive WHO/USAID/GOM (Government of Myanmar) course on Medical Entomology and Vector Control.

### MAJOR RECOMMENDATIONS AND PROPOSALS FOR MEETING THE NEEDS

1. Additional entomologists and assistant entomologists should be recruited and trained to meet the shortfall identified in the proposal for manpower development. Since no institutions in the country provide M.Sc. level course work in medical entomology, it will be necessary to obtain such training abroad, for which fellowships will be needed.
2. In view of existing government regulations on the frequency and length of travel abroad, a long-range objective should be to provide the necessary training in Myanmar. Possibilities should be explored for developing a M.Sc. course in medical entomology at a local institution such as the Institute of Medicine in Yangon.
3. Assistant entomologists requiring training should receive job-oriented training abroad on current trends in control strategies and methodologies and be afforded an opportunity to study operational and research techniques used in countries with similar problems. Fellowships will be required.
4. Support should be sought from the organization and conduct of local short courses for orientation of new entomological personnel, refresher training for entomologists/assistant entomologists, advanced entomological techniques, and medical entomology/vector control orientation for medical officers. A course for training-of-trainers should be also developed.
5. Considerable research is already in progress, but the quality of the research should be improved through advanced training in research methodology.
6. Since there are a limited number of sanctioned positions for entomologists in the VBDC Programme, the opportunities for promotion are scarce, and there is little opportunity to exercise leadership in research and development for the control of disease vectors. A career development structure should be established for entomology staff.
7. Adequate budget support should be provided to enable entomology teams to carry out field investigations.

## NEPAL



### COUNTRY FINDINGS

Malaria is a vector borne disease of greatest concern and receives high priority among health problems. Nearly 10.4 million people are at risk. Despite control efforts, the number of cases has gradually increased reaching about 16 000 cases by the early 1980s and doubling by the mid 1980s with a peak of 42 321 cases in 1985. The percentage of *P. falciparum* cases has also increased gradually from 6% to nearly 19%. Chloroquine-resistant *P. falciparum* has been reported in several regions of the country.

Of the 35 anopheline species in Nepal, four have been confirmed as malaria vectors. Of these four vectors, one has developed resistance to DDT and the other three have exhibited behavioural changes which have reduced the effectiveness of residual spraying.

Japanese encephalitis (JE) first appeared in 1978 and its prevalence has steadily increased. In 1986, there were 1 194 reported cases. Very little is known about the epidemiology or vectors of JE in Nepal. Because of the potential for epidemic outbreaks and the high fatality rate, JE is second to malaria in national concern. There is, however, no separate programme for JE and its control which is the responsibility of the Public Health Division and district personnel of the primary health care system.

Although leishmaniasis (kala azar) had virtually disappeared from Nepal following the intensive DDT spraying for malaria during the 1960s, it has recently reappeared. The entomology and epidemiology of leishmaniasis in Nepal have not been well studied.

Many indigenous cases of lymphatic filariasis have been identified throughout the country, but there is no certainty as to the vector, and the epidemiology has not been studied. The prevalence and distribution of the disease and its public health importance have not yet been determined.

The National Malaria Eradication Organization is conducting the malaria control programme which is now being integrated into the general health services. There are no other disease vector control programmes in Nepal. Control of the other vector-borne diseases is the responsibility of the integrated public health care delivery system, and the only medical entomologists are employed in the malaria programmes.

#### **MANPOWER NEEDS**

The malaria programme has an adequate number of trained and experienced personnel. The primary need is for additional medical entomologists to provide technical guidance and management of activities to determine the nature and extent of the problem posed by the other vector-borne diseases described above and to develop appropriate control strategies.

Seven additional entomologists and four assistant entomologists are needed to strengthen the national level entomology section, the research and training divisions, and the regional level entomology field teams.

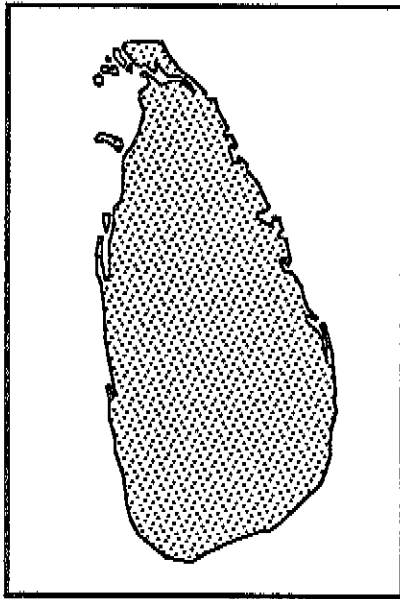
#### **MAJOR RECOMMENDATIONS AND PROPOSALS FOR MEETING THE NEEDS**

It has been recommended that a long-term plan be prepared for disease vector control, and that a national policy be adopted for control of all vector-borne diseases to support the current integration of malaria and the other diseases within the health service.

If a more comprehensive vector control programme is implemented, additional entomologists and assistant entomologists should be recruited and trained to meet the needs of research, training, and field investigations. Since this type of education and training is not available in Nepal, fellowships should be provided. As an interim measure, until such time as a manpower development plan can be implemented, it is recommended that the malaria entomologists be given in-service training on the biology and control of the other disease vectors.

Since most of the entomologists occupy temporary positions and have little or no promotion potential, it is essential that entomology positions be established in a career development structure in order to recruit and retain competent people.

## SRI LANKA



### COUNTRY FINDINGS

The main vector-borne diseases in Sri Lanka are malaria, lymphatic filariasis, dengue/dengue haemorrhagic fever, and Japanese encephalitis (JE). Six to eight million people are at risk from malaria, four to five million from filariasis and six million from Japanese Encephalitis. Ten percent of the total health budget is spent on malaria control, and 0.3% on filariasis control. There were epidemics of Japanese Encephalitis in 1985, 1986 and 1987 with significant mortality, which have caused serious concern. Filariasis is under reasonable control. Dengue/dengue haemorrhagic fever is not a serious problem, but vigilance needs to be maintained.

### MANPOWER NEEDS

In keeping with the Provincial Administration set up and the policy of the Ministry in having a Vector-Borne Disease Control Programme to include all Vector-Borne Diseases (malaria, filariasis, Japanese Encephalitis, Dengue Haemorrhagic Fever) the existing vertical campaigns (Anti-Malaria Campaign, Anti-Filariasis Campaign) will cease to function operationally.

Each province will have its own Vector-Borne Diseases Control Unit to combat the Vector-Borne disease problems pertaining to that Province. At the centre a core of specialists will be maintained both at the Anti-Filariasis Campaign and Anti-Malaria Campaign Headquarters for purposes of research, training and guidance of the speciality concerned. The Director, Vector-Borne Disease Control will be in overall charge of the National Vector-Borne Disease Programme, and will determine Vector-Borne Disease Control Policy, monitor and evaluate the programme for the Deputy Director General (PHS).

As such, manpower needs envisaged in entomology would be nine (9) entomologists, one each per province and 3 to be retained at the centre for purposes of research and training. (Anti-Malaria Campaign, Anti-Filariasis Campaign, Medical Research Institute).

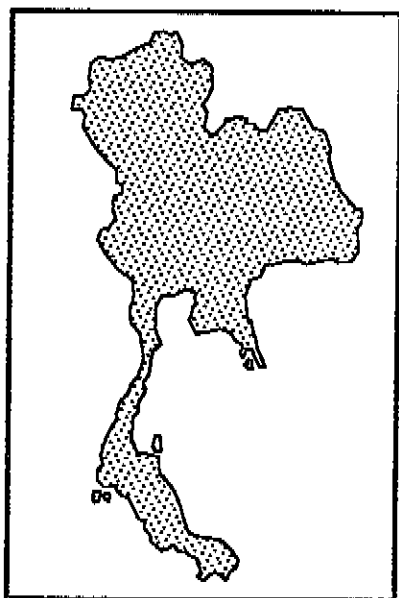
At present there are only four (4) entomologists. Hence, an additional eight (8) entomologists should be trained for the above Vector-Borne Disease Control Programme.

### MAJOR RECOMMENDATIONS AND PROPOSALS FOR MEETING THE NEEDS

In light of the government reorganization to provide for 9 provinces, each with a separate administration, a minimum of 9 entomologists are required for Vector-Borne Disease Control should be recruited and trained.

New entomologists are recruited through the Sri Lanka Scientific Services at the level of the B.Sc./M.B.B.S. They are expected to earn a Masters Degree in Medical Entomology within the first 5 years of service, preferably at a university within the region or extra-regional. Within a period of 5-10 years service, they may obtain a Ph.D. Degree. Provision of adequate financing will be required.

## THAILAND



### COUNTRY FINDINGS

The most important vector-borne diseases in Thailand are malaria, dengue haemorrhagic fever (DHF), Japanese encephalitis (JE), and filariasis.

Forty million people are at risk from malaria. The incidence has decreased from 420 000 cases in 1982 to 300 000 cases in 1987.

Forty one million people are at risk from DHF. In 1987, there were 150 000 cases with 777 deaths.

Thirty million people are at risk from JE. Outbreaks have been reported every year since 1969.

At risk from filariasis are 6.9 million people. Both Brugian and Bancroftian filariasis are present. The estimated population at risk from Brugian filariasis is 5.5 million, with 1.4 million at risk from Bancroftian filariasis.

There is a national programme for malaria control and a specialized project for control of filariasis. Control of DHF and of JE is integrated under the General Communicable Diseases (GCD) Division. Despite residual house spraying, malaria persists in hilly and forested areas where all three of the local vectors are exophagic. The impact of insecticide spraying on vector density and malaria incidence in these areas is unknown. Efforts are being made to replace residual spraying with other methods, but these other methods have not yet been evaluated.

Research on vector species is being carried out by universities and by the Malaria Division.

Thailand has analysed its entomological services in relation to the vector-borne disease control programme and has concluded that there has been ineffective control due to the lack of professional entomologists. The impact of this situation is as follows:

Malaria	Field entomology teams have had insufficient guidance from Headquarters. Residual house spraying has continued in some areas with inadequate evaluation of its effectiveness, particularly in light of the reported exophagic habits of the vectors.
DHF	In the absence of experienced entomologists at the central, regional, and provincial levels, preventive measures and epidemic interventions have been carried out without the technical guidance of medical entomologists. Effectiveness of methods is known, but in light of the number of DHF cases, control is obviously inadequate.
JE	Control operations have been carried out with inadequate knowledge of vector bionomics and susceptibility to the insecticide in use.
Lymphatic Filariasis	The local mosquito vectors are insufficiently known and little baseline entomological information is available.

Currently, 44 research projects on various aspects of vector biology and control are being conducted by CDC/Malaria (7), CDC/GCD (4), Department of Medical Sciences (15), and by the four universities (18). Many of these are basic research studies.

Future research needs are largely related to applied field research and include such topics as: field trials to determine cost-effectiveness of control methods; evaluation of anti-vector measures; longitudinal studies of bionomics of vectors; studies on self-protection; and community participation and effectiveness of biological control agents.

#### MANPOWER NEEDS

Thailand has identified a need for additional medical entomologists at the national level (22), the regional level (11), the provincial level (72), and in the municipalities (130), totalling 235 new positions.

Certain entomologists also need to receive advanced academic training to the Ph.D. level. In the central programme, advanced training would enable them to better facilitate activities of the regional and zonal entomology teams. Research entomologists also require advanced training on research methodology to ensure proper planning and adequate execution of ongoing research projects.

#### MAJOR RECOMMENDATIONS AND PROPOSALS FOR MEETING THE NEEDS

1. There is a scarcity of highly trained manpower in medical entomology within the Ministry of Public Health (MPH), and the entomology teams in vector-borne disease control programme other than malaria are poorly developed. To rectify this it is proposed that a "Center for Disease Vector Control" (CDVC) be instituted in the CDC.

The CDVC would provide integrated and centralized entomological services to all of the vector-borne disease control programmes. This would result in better utilization of highly trained staff and other available manpower, comprehensive coordination of vector control, attraction and retention of qualified and experienced staff by offering career opportunities within the MPH, and better vector control training for personnel engaged in primary health care.

2. In the context of integrating the CDC programmes with primary health care, it is proposed that a position be established for one M.Sc. level vector control specialist (VCS) to support the Provincial Health Office in vector-borne disease control.

In view of the increasing incidence of DHF, particularly evident in urban areas, one VCS (B.Sc. level) should be posted at each of 130 municipalities except in Bangkok where one M.Sc. level VCS should be assigned.

To support the entomological and vector control activities at provincial and municipal levels, technical support should be strengthened through the GCD regional centres. One VCS (B.Sc. level) should be assigned to each centre after receiving job-oriented training.

3. To carry out this proposed programme, the following new entomology posts should be created by the Government of Thailand in the CDC (3 Ph.D., 6 M.Sc., and 18 B.Sc.), by the Office of the Permanent Secretary of State for Public Health (72 M.Sc.) and by the Ministry of Interior (Municipalities) (1 M.Sc. and 130 B.Sc.).
4. A special effort should be made to strengthen the existing mechanism for coordination and cooperation among entomologists within the Ministry of Public Health and the universities.
5. A long-term plan for strengthening institutional research capability through manpower development should be developed without delay.

## CHAPTER 4

### GENERAL RECOMMENDATIONS

Numerous recommendations were made at the workshop on the basis of findings and discussions of the various country reports. They pertain to actions appropriate for consideration at national, regional, and global levels. Those of general concern to the region were agreed upon by workshop participants at the final session.

#### ADDRESSING THE OVERALL PROBLEM

In recognition of:

- the scarcity of training manpower for vector-borne disease control in many of the countries;
- the insufficient deployment of entomological teams in control programmes; and
- the need for more qualified entomological expertise in the context of primary health care.

It was recommended that:

- Countries consider the organization of unified, comprehensive, and coordinated disease vector control activities;
- Countries review their entomological manpower needs in the context of long-term national health planning policies in order to optimize the productivity and efficiency of entomological manpower;
- A review of medical entomology manpower for research and control of vector-borne diseases receive more emphasis in the comprehensive health manpower planning reviews being conducted in many of the countries.

#### ADDRESSING TRAINING NEEDS

Training modules in medical entomology/vector biology should be incorporated into the undergraduate diploma and degree courses for health personnel (e.g., multi-purpose health workers, sanitarians, health inspectors, and other primary health care personnel). Many countries already utilize such personnel in vector-borne disease control activities. Highly qualified medical entomologists/vector control specialists are needed to provide such training and supervise the work of these ancillary personnel.

To promote career development for medical entomologists, the following training courses should be introduced in the region:

- Entomology and vector control courses for those graduates with at least five years experience who are already in service;
- A short regional course for research personnel on the preparation of research proposals/protocols and research methodology; and
- A three month in-service training course for field staff at the national level.

## **ADDRESSING RESEARCH NEEDS**

In recognition of the essential and interactive role of basic and operational research, an appropriate balance of both should be promoted throughout the region to ensure the development of more effective and innovative approaches for control of vector borne diseases. Training and development of manpower to apply these approaches will be required.

Inter-country research coordination and collaboration should be encouraged among the region's institutions to address problems of mutual interest and to best utilize limited technical manpower.

Manpower capability should be strengthened at existing national research centres to conduct research of immediate relevance to control activities, including studies on vector competence, genetics, and vector bionomics, and advanced research to explore new methods to reduce vector competence and make more effective use of biological control agents.

## **COURSE OF ACTION**

Efforts should be made to establish cadres of medical entomologists and vector control specialists in each country and to maintain a supply of skilled manpower.

Country proposals for manpower development prepared at the regional workshop should be reviewed by the responsible national authorities and converted to action plans at an early date.

## **THE ROLE OF WHO**

The WHO Regional Office for South-East Asia should support comprehensive health manpower planning reviews and coordinate country efforts for the improvement of manpower development for disease vector control and research.

WHO should coordinate efforts and assist, where appropriate, in making full use of the available expertise in the region through Technical Cooperation Among Developing Countries (TCDC).

The WHO Regional Office for South-East Asia with support from WHO/HQ, should assist the countries in obtaining the external financial assistance needed to implement country proposals.

## CHAPTER 5

### SUMMARY AND CONCLUSIONS

This project set out to assess education and training needs of medical entomologists for research and control of vector-borne diseases. The results show that the countries of South-East Asia which have vector-borne diseases clearly need greater inputs from medical entomology experts in programmes to control vector-borne diseases. Countries recognize that facilities for both training and research should be expanded and strengthened and that incentives are needed to recruit and solidify medical entomology manpower.

The nine endemic countries of the region differ greatly in population (131 000 to 789 800 000), area (289 sq km to more than 3 million sq km), topography, climate and vector-borne disease endemicity. Yet, the problems identified and the needs are remarkably similar, the difference being largely one of magnitude.

All countries saw a need for academic training for medical entomologists from the baccalaureate through the doctoral level. All indicated that fellowships would be needed to obtain this training abroad when not available at home. In addition, most of the countries identified a need to develop curricula for new courses or to revise and update current courses. In some cases, revision or organization of job-oriented short courses was suggested.

Most of the countries expressed the need for more entomologists to work in control programmes. In all but one of the countries more entomologists were sought to work in research programmes.

Some countries reported difficulty in filling vacant entomology positions, a situation apparently related to the need in a number of countries to establish a career development structure that would provide incentives for advancement. One country, for example, indicated that six of its seven entomologists had been classified as "temporary employees" for fifteen years or more.

Several countries identified the need for more highly qualified entomologists (preferable at the Ph.D. level) to be assigned to national headquarters. Upgrading the qualifications of headquarters' entomologists would enable better analysis of entomological field data, more effective planning of operational programmes, and better technical guidance for field researchers as well as control personnel.

Five of the countries indicated a need for additional budget support, transport and travel facilities to enable the entomologists to carry out necessary investigations in the field.

A number of countries identified *P. falciparum* parasite resistance to anti-malaria drugs as a serious technical problem. According to the Eighteenth Report of the WHO Expert Committee on Malaria (Technical Report Series No 735, WHO, 1986), "One of the safest ways of reducing the spread of resistant parasites is to reduce or interrupt malaria transmission". Under these circumstances the only way to reduce transmission is through the judicious use of all available methods of vector control, the planning of which is the responsibility of the medical entomologist.

Nearly all countries identified problems that are impeding vector-borne disease control and which can only be solved through laboratory or field research. All nine countries are seeking greater input of research results into their control programmes. While Bhutan and the Maldives have no entomologists, and consequently no on-going research, both countries have identified problems requiring entomological research. On-going research programmes in the other seven countries range from a few small projects conducted by malaria programme field personnel to an elaborate series of research projects conducted by a research unit of the control programme, a research centre, and/or universities. In these countries, existing entomologists need advance training and education. Alternative positions should be created for qualified entomologists to conduct urgently needed research.

Each country also identified the need to develop a long-range research plan. It was apparent to several countries that vector-borne disease research efforts required coordination within their countries, as well as coordination and collaboration on a regional basis to address problems of mutual interest. The reported research needs indicate that many problems are shared by two or more countries, and some by all in the region.

The project has confirmed the nature and extent of problems facing disease vector control programmes in South-East Asia and the need to support medical entomology training and research to solve them. Considerable concern was expressed about the prospects for implementing project recommendations. It was agreed that participants should urge their governments to review and amend the draft country manpower development proposal, converting it into an action plan for the development of the technical manpower required to meet national needs. Finally, there was a consensus that medical entomology manpower development should be enhanced through the programme of Technical Cooperation Among Developing Countries (TCDC) and that each of the countries should request the WHO Regional Office to coordinate TCDC activities.

## ACKNOWLEDGEMENTS

The co-sponsors wish to acknowledge the Rockefeller Foundation for a grant to support preparation of this report; the Pan American Health Organization for making available findings from the assessment of education and training needs for medical entomology in the Americas; and Dr Norman Gratz, previously Director, Vector Biology and Control Division, WHO, Geneva for his leadership in initiating the global assessment of medical entomology manpower development to improve the effectiveness of vector-borne disease research and control.

Special thanks are extended to the Government of Thailand for hosting the regional workshop and providing the excellent local support of the Thai Ministry of Public Health, particularly to Dr Supamit Chunsuttiwat, Dr Somthas Malikal, Dr Chusak Prasittisuk and Dr Uthai Sudsukh, whose technical and managerial contributions have been essential in making the workshop a success. The governments of the nine countries participating in the project are also gratefully acknowledged. The dedication of their country delegates in preparing country reports and draft proposals to address the medical entomology manpower needs of their countries has been critical to the completion of the project. A note of additional thanks to Dr R. Slooff, Division of Environmental Health, WHO/HQ, and Dr A.B. Knudsen, Training Unit, Division of Control of Tropical Diseases for final editorial work leading to the printing of this report. The list of the project participants is provided in Annex 1.

## OBITUARY

All those involved in the planning and execution of the Pattaya Workshop were deeply moved to learn, several weeks later, of the death of Dr Kalayanmani Dixit, Chief Malaria Eradication Organization, Nepal, as a result of injuries sustained in a traffic accident which took place during the meeting. His frank comments and constructive observations will be remembered by all those in attendance. Our sympathy goes out to Dr Dixit's family and friends.

The prompt action undertaken by the Thai Government in securing the best possible medical attention in an attempt to save his life is warmly acknowledged.

## ANNEX I

### LIST OF PARTICIPANTS AND OBSERVERS

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## ANNEX II

### WORKING PAPERS

Dr P. Abeykoon - Health Manpower Development in South-East Asia

Dr J. Akiyama - Role and Need of Medical Entomologists for the Control of Vector-Borne Diseases in the Context of PHC

Dr Y.H. Bang - Role and Need of Vector Control Specialists for Urban Vector/Pest Control

Dr A. Fonaroff - Follow-up and Impact of FIC-WHO Collaborating Centre/PAHO/WHO Project on Medical Entomology Education and Training Needs for Research and Control of Vector-Borne Diseases in the Region of the Americas

Dr I.A.H. Ismail - Needs of Manpower Development for Disease Vector Research

Dr R. Pal - Needs for Action

Dr K.M. Rashid - Manpower Requirements for National Vector-Borne Disease Control Programme

Dr R. Slooff - The Role of the World Health Organization in the Development of Vector Biology and Control Manpower at the National Level.