

This report contains the collective views of an international group of experts and does not necessarily represent the decisions or the stated policy of the World Health Organization

Urban vector and pest control

Eleventh report of the
WHO Expert Committee on
Vector Biology and Control

World Health Organization
Technical Report Series
767



World Health Organization, Geneva 1988

ISBN 92 4 120767 1

© World Health Organization 1988

Publications of the World Health Organization enjoy copyright protection in accordance with the provisions of Protocol 2 of the Universal Copyright Convention. For rights of reproduction or translation of WHO publications, in part or *in toto*, application should be made to the Office of Publications, World Health Organization, Geneva, Switzerland. The World Health Organization welcomes such applications.

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat 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 mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by the World Health Organization in preference to others of a similar nature that are not mentioned. Errors and omissions excepted, the names of proprietary products are distinguished by initial capital letters.

ISSN 0512-3054

PRINTED IN SWITZERLAND

88/7550 - Schuler SA - 7000

CONTENTS

	Page
1. Introduction.....	7
2. Urbanization and its consequences	8
2.1 Urbanization	8
2.1.1 The urban environment	8
2.1.2 Urban population growth.....	10
2.1.3 Urban growth and health	11
2.2 Consequences of urbanization	12
2.2.1 Socioeconomic aspects	12
2.2.2 Health aspects of vector and pest proliferation.....	13
3. Urban vectors and pests.....	13
3.1 Mosquitos.....	13
3.1.1 <i>Aedes</i> spp	13
3.1.2 <i>Culex</i> spp	16
3.1.3 <i>Anopheles</i> spp.....	16
3.1.4 Other species	17
3.2 Sandflies	17
3.3 Fleas	18
3.4 Triatomine bugs	18
3.5 Lice.....	18
3.6 Tsetse flies	19
3.7 Blackflies	19
3.8 Ticks.....	19
3.9 Mites.....	20
3.10 Synanthropic flies	20
3.11 Bedbugs	21
3.12 Cockroaches	21
3.13 Ants	22
3.14 Other arthropod pests	23
3.15 Rodents	23
3.16 Snails	23
4. Present status of urban vector and pest problems and of their control	24
4.1 Situation analysis by WHO region	24
4.1.1 African Region.....	24
4.1.2 Region of the Americas	25
4.1.3 Eastern Mediterranean Region.....	27
4.1.4 South-East Asia Region.....	29
4.1.5 Western Pacific Region	30
4.2 Methods for control of vectors and pests in urban areas.....	32
4.2.1 Chemical methods.....	32
4.2.2 Biological control methods	34
4.2.3 Environmental management measures.....	36
4.2.4 Other methods	36
4.2.5 Integrated vector control strategies	41
4.3 Constraints	42

	Page
5. Types of urban vector and pest control programmes	43
5.1 Countries in temperate areas.....	43
5.2 Countries in tropical areas	45
5.3 Single-disease control programmes	45
5.4 Mosquito abatement districts.....	46
5.5 Role of municipalities in urban vector and pest control	47
5.5.1 General powers and duties of a municipal council	47
5.5.2 Powers and duties in respect of public health	48
6. Planning of future urban vector and pest control programmes.....	49
6.1 Comprehensive vector and pest control.....	49
6.2 Involvement of nongovernmental organizations and the private sector	50
6.3 Political will and legislation	51
6.4 Community participation	51
6.5 Intersectoral collaboration	53
6.6 Primary health care strategy	54
6.6.1 Primary health care in urban areas	55
6.6.2 Vector control within primary health care	55
6.6.3 Vector control core group	56
6.7 Planned urbanization	57
6.8 Conclusions	58
7. Training of vector control staff and personnel	58
7.1 Training of administrators and managerial staff	59
7.2 Training of technical staff	60
7.2.1 Vector biology and ecology	60
7.2.2 Recognition and identification of vectors.....	60
7.2.3 Biological control methods	61
7.2.4 Chemical control methods	61
7.2.5 Techniques	61
7.2.6 Data gathering, analysis and interpretation	62
7.3 Training of inspectors and field and community workers.....	62
7.3.1 Practical aspects of vector biology and control.....	62
7.3.2 Surveillance and geographical reconnaissance.....	62
7.3.3 Use and maintenance of equipment	63
7.3.4 Pesticides, formulations, and safe use.....	63
7.3.5 Biological control agents.....	63
8. Health education of the public.....	63
8.1 Types of health education.....	64
8.1.1 Regular health education.....	64
8.1.2 Health education to popularize control measures	64
8.1.3 Health education to motivate and sustain community participation.....	65
9. Applied research.....	65
9.1 Environmental management.....	66
9.2 Biological control.....	67

	Page
9.3 Chemical control methods	67
9.3.1 Adulticides	67
9.3.2 Larvicides	67
9.3.3 Insect growth regulators	68
9.4 Bioecological research	68
9.5 Behaviour-modifying factors	68
9.6 Protectants and exclusion measures	69
9.7 Integrated vector control	69
10. Recommendations	69
10.1 Urbanization	69
10.2 Environmental management	70
10.3 Biological control	71
10.4 Future organization of vector control	71
10.5 Vector control core group	73
10.6 Training	73
10.7 Research	74
10.8 Community participation	75
10.9 Health education	75
10.10 Legislation	76
Acknowledgements	76
References	77

WHO EXPERT COMMITTEE ON VECTOR BIOLOGY AND CONTROL

Geneva, 15–21 September 1987

Members*

- Dr S.S. Bekheit, Director, Research Institute of Medical Entomology, Cairo, Egypt
Dr L. Calheiros, Director, Department of Endemic Diseases, SUCAM, Brasilia, Brazil
Mr G. Challet, Manager, Orange County Vector Control District, Santa Ana, California, USA (*Vice-Chairman*)
Dr P.K. Das, Deputy Director, Vector Control Research Centre, Pondicherry, India (*Rapporteur*)
Professor T. Hristova, Associate Professor, Research and Coordination, Centre of Ecology and Environmental Protection, Bulgarian Academy of Sciences, Sofia, Bulgaria (*Chairman*).
Professor A.Q. Khan, Ex-Additional Director-General of Health Services, Dhaka, Bangladesh
Dr J.Z.L. Ng'weshemi, Epidemiologist, Regional Medical Officer, Coast Region, United Republic of Tanzania
Mr Ng Say Kiat, Head, Vector Control and Research Department, Ministry of the Environment, Singapore
Dr C. Yang, Vice-Director, Institute of Parasitic Diseases, Jiangsu, China

Secretariat

- Dr C.S.S. de Silva, City Microbiologist, The City Microbiological Laboratory, Maligakande, Colombo, Sri Lanka (*Temporary Adviser*)
Professor M.S. Mulla, Professor of Entomology, College of Natural and Agricultural Sciences, University of California, Riverside, California, USA (*Temporary Adviser*)
Dr N. Rishikesh, Scientist/Biologist, Ecology and Control of Vectors, Division of Vector Biology and Control, WHO, Geneva, Switzerland (*Secretary*)
Dr R. Slooff, Director, Division of Vector Biology and Control, WHO, Geneva, Switzerland
Dr A. Smith, Scientist/Entomologist, Bexhill-on-Sea, England (*Temporary Adviser*)

* Unable to attend: Dr J. Mouchet, Office de la Recherche Scientifique et Technique d'Outre-Mer (ORSTOM), Paris, France.

URBAN VECTOR AND PEST CONTROL

Eleventh report of the WHO Expert Committee on Vector Biology and Control

1. INTRODUCTION

The WHO Expert Committee on Vector Biology and Control met in Geneva from 15 to 21 September 1987. Dr A. Davis, Acting Assistant Director-General, opened the meeting on behalf of the Director-General and pointed out that, by the end of the century, about 50% of the world's population might be living in urban areas and that a significant proportion of them, especially in developing countries, would be living in overcrowded, relatively poor and unhygienic conditions. Measures for their health and well-being, including protection from disease vectors and pests, are prerequisites for the achievement of the goal of health for all by the year 2000. Public services are usually unable to keep up with rapid urbanization, with the result that the urban poor suffer from the harsh consequences of both underdevelopment and industrialization, particularly where proper precautions to prevent proliferation of vectors have not been considered in the planning stages. The global magnitude of the problem of urban vectors and pests needs to be defined, with emphasis on the vectors that are instrumental in causing morbidity and mortality, especially in the developing countries in the tropics. The Committee was requested to assess the available methods of vector control with regard to their cost-effectiveness and use at all levels. Emphasis should be placed on a progressive shift away from heavy dependence on chemicals and towards integrated control strategies that incorporate alternative measures such as environmental management, biological control and other simple, innovative approaches. Similarly, a comprehensive approach directed against a number of vectors and pests might prove more cost-effective and affordable than vertical programmes entailing duplication of effort, waste of manpower and higher costs. The organizational arrangements that could best take primary responsibility for vector control in different urban situations would also need careful consideration.

Joint UNICEF/WHO meetings and other discussions have made it increasingly evident that, in urban as in rural areas, primary health care is an appropriate strategy for achieving universal coverage on an equitable basis.¹ The Committee was requested to give special attention to the extent to which urban vector control can be incorporated within the primary health care system, with the emphasis on equity, community participation and intersectoral collaboration.

The Chairman commented that all participants recognized the significance of the growing problem of vector control in the wake of rapid urbanization and stressed the timeliness of this important Expert Committee meeting on vector control in urban areas.

2. URBANIZATION AND ITS CONSEQUENCES

2.1 Urbanization

2.1.1 *The urban environment*

Published definitions of "urban area" vary from country to country and largely relate to total numbers of inhabitants (*I*). An urban area is essentially a man-made environment, encroaching on and replacing a natural setting and having a relatively high concentration of people whose economic activity is largely of the non-agricultural type. It is characterized by high-density housing inhabited by various socioeconomic groups, some of whom live under slum conditions, and by an administrative infrastructure and public services that vary widely between the different sections of the area.

Particularly in the developing countries, the local authority administering such an urban area may be unable to afford the infrastructure needed to maintain the routine environmental sanitation and health services it is required to provide. The resulting failure to maintain drains, poor cleaning and scavenging services, the irregular removal of household refuse, and the improper disposal of solid wastes and night soil, result in widespread environmental pollution, the formation of pools of stagnant and waste water, and the accumulation of heaps of refuse.

¹ UNICEF/WHO *Interregional Consultation on Primary Health Care in Urban Areas, Manila, Philippines, 7-11 July 1986*. Unpublished WHO document, SHS/IHS/86.1.

The influx of large numbers of people who have migrated from rural to urban areas, together with the natural increase in the urban population, continues to add to the demand for such basic services. The lack of adequate housing facilities, in these circumstances, produces a change in the urban environment characterized by the proliferation of squatter settlements and the development of slum conditions. These settlements are, typically, collections of temporary housing units, constructed of almost any kind of material such as cardboard, polythene, scrap wood and metal. They are unauthorized and are set up on any available space, very often on water-logged low-lying areas or marginal land. Because of the lack of a piped water supply, toilets and household refuse disposal facilities, these settlements create the most unhygienic and insanitary pockets within the urban environment.

There are considerable differences between the outlying areas, where there is contact with the original natural environment, and the central districts, where most if not all of the space is taken up by buildings. The quality and adequacy of the water-supply and sanitation systems, which have a direct bearing on the proliferation of vectors and pests, are often related to the social status of the inhabitants.

The impact on vector and pest populations is twofold; the autochthonous species that are remnants of the natural environment in which the city has been built persist to a greater or lesser extent, but are usually confined to peripheral or suburban areas. Meanwhile, various tropical or even ubiquitous species connected with man and with human activity are often imported and invade the built-up areas. The situation varies greatly from one district of a city to another, depending on the density of the human population and its interface with the adjoining rural environment, as well as on the quality of the urban development.

The hygiene measures based on coercive legislation which made it possible to control certain vectors during the first half of this century are now often inadequate or cannot be applied. The growth of consumption, even in the poorer districts, has increased the *per capita* amount of waste produced by the population. Since the population has also increased substantially, the resulting problems have now reached considerable proportions and overwhelmed the municipal authorities, which frequently lack the means to install sanitation infrastructures, let alone to keep them operational. Social structures are often very loose, so that newer arrivals are not,

a priori, receptive to community-based activities, and ways of mobilizing them must therefore be found.

2.1.2 Urban population growth

During the past 30 years, significant increases have taken place in both world population and in urbanization. World population grew from 2.5 billion in 1950 to nearly four billion in 1985, and is expected to exceed six billion by the year 2000 (Table 1). In 1950, out of a total world population of 2.5 billion, 28.6% were living in urban areas; by 1975 this proportion had reached 39.3% and by the year 2000, if present trends continue, nearly half the world's expected population of over six billion will be residing in urban areas. In all regions, there will be ever-increasing proportions of the population living in urban areas.

It is not only the increase in size of the urban population that is alarming, but also the rate at which it is occurring. In 1950, there were seven main urban agglomerations with a population of five million or more; by 1980, there were 26 and, by the end of this century, there will be 60 such cities, of which 45 will be in the less-developed regions of the world. By the year 2000, there are likely to be 24 cities with over 10 million people.

This rapid growth is not confined solely to capitals and large metropolitan areas but also affects secondary and tertiary cities, often reducing their ability to develop the necessary urban services

Table 1: Global urbanization trends 1950-2000

Area	1950		1975		2000 ^a	
	Total population (millions)	% living in urban areas	Total population (millions)	% living in urban areas	Total population (millions)	% living in urban areas
Africa	218.8	13.2	401.1	24.4	813.1	37.7
Asia	1 367.7	16.0	2 255.4	26.4	3 636.3	38.1
Europe	391.9	54.8	473.1	67.1	539.8	78.7
Latin America	163.9	40.9	324.0	60.4	463.7	74.8
North America	166.0	64.6	236.8	76.5	296.1	86.4
Oceania	12.6	64.5	21.3	71.6	32.7	78.2
Union of Soviet Socialist Republics	180.0	39.4	255.0	60.5	315.0	76.3
World	2 501.2	28.6	3 967.0	39.3	6 253.1	49.6

^aEstimated figures (1).

and leaving large sections of their populations living in poverty and squalor.

The direct result of this urban population explosion has been a tremendous increase in the number of squatter settlements and of the urban unserved and underserved. For many countries and cities the problem is of such magnitude and urgency that the term "urban crisis" is not an exaggeration. An analysis of the urban and rural population of 150 countries shows that in 68 the urban population accounted for more than 50% of the total in 1985. This number will be increased to 97 countries by the year 2000. In many countries, massive migration from rural to urban areas is the cause of the major portion of this urban growth. For example, the growth rate in Lagos, Nigeria, is 14% per annum, mainly owing to migration, and in Bombay, India, approximately 1000 rural migrants are added each day to the seven million people in the city, of whom about three million constitute the slum population.

In 1981, it was estimated that 79% of the population of Addis Ababa lived in slums and squatter settlements. This may be an extreme case, but other major cities of the developing world are not far behind. By the end of the twentieth century, the urban poor may represent a quarter of mankind.

The above trends in population growth and urbanization also show that, in the near future, most of the existing rural villages will become small urban centres. These trends call for urgent action, and possible solutions to the resulting problems must be sought well in advance.

2.1.3 *Urban growth and health*

Three main groups of factors simultaneously and, perhaps, synergistically affect the health of the low-income population group in the cities. The first, essentially economic in origin, includes low income itself, limited education, an inadequate diet, overcrowding and insanitary conditions. The second group is related to the man-made urban environment, with its industrialization, pollution, traffic and stress. The third is the result of the social instability and insecurity that have become almost characteristic of life in certain urban areas, leading to alcoholism, drug addiction, sexually transmitted diseases and a variety of other hazardous conditions. In many cities, especially in developing countries, the most densely

populated areas are those where the low-income population group lives.

These three groups of factors contribute to ill-health and to the prevalence of malnutrition, diarrhoea, acute respiratory infections, and the transmission of communicable and vector-borne diseases, which are among the most important causes of mortality and morbidity, especially in the vulnerable groups of the urban population, such as mothers, infants and children. For example, in the large slum area of Port-au-Prince in Haiti, over 20% of newborn infants die before 1 year of age and another 10% or more succumb in the second year. This mortality rate is almost three times that of those in the higher-income group in the same city, whose rates are comparable to those in the urban areas of developed countries. This difference is also seen in many other cities in the world.

2.2 Consequences of urbanization

High population density, cramped living conditions and inadequate sanitary facilities lead to a highly polluted environment, contaminated by human and animal wastes, rotting garbage, trash and the excreta of various domestic animals. This environment is highly conducive to the proliferation and spread of diseases, and promotes infestation by mosquitos, rodents, cockroaches, houseflies, fleas, lice and many other arthropod vectors of disease and pests.

2.2.1 Socioeconomic aspects

In many cities, enormous and rapid growth has not been accompanied by good sectoral planning systems which would allow them to cope with the influx of migrants. In a very short time, the large numbers of migrants, their needs and their poverty, lead to a rapid deterioration in the living conditions because of the already limited capacity of the city to provide employment, housing, basic sanitation, and health care to the existing population. Cities must therefore be the main target of development planners, including health service planners.

Any rapid rate of urban growth, as already pointed out, is probably the result of migratory flows combined with natural growth. Such migrations have a profound impact on the transmission of diseases and on other potential risks to health. The

overload on the public services, the inadequacy of the social infrastructure, congestion, the pollution of the air and of drainage ditches, the scarcity of housing, and lack of water and electricity and garbage collection in parts of cities have given rise to the large urban slums and shanty towns in developing countries previously mentioned. Highly precarious housing conditions, sometimes associated with lack of land tenure, contribute considerably to the persistence of slum conditions in some cities.

Areas where extreme poverty prevails, which can frequently be found in many large and medium-size cities, together with areas where the physical and environmental conditions are not so unsatisfactory but which also lack basic services, may house as much as 50% of the total population or even more. Very often, extremely poor people set up their shacks around, or even within, neighbourhoods having the best living conditions and highest socioeconomic standards. Health problems associated with transmissible diseases may thus be created that affect all parts of a town or city.

2.2.2 *Health aspects of vector and pest proliferation*

The consequences of urbanization on health have been reviewed by a WHO Expert Committee (2), which identified four aspects of the adverse effects of unplanned urbanization relating to human waste disposal, housing, solid wastes and the large volumes of refuse produced; to these must be added the lack of proper water supplies and adequate waste-water disposal systems. If adequate steps are not taken to deal with these problems, vector and pest proliferation and the transmission of diseases, such as those listed in Tables 2 and 3, will result.

3. URBAN VECTORS AND PESTS

3.1 Mosquitos

3.1.1 *Aedes spp*

Aedes aegypti is probably the most dangerous urban vector in tropical areas. It is a vector of the dengue virus, including its haemorrhagic form, against which there is no vaccine, and is also a

Table 2. Urban mosquito pests and vectors of disease, and their potential habitats

Potential breeding habitats in urban areas	<i>Anopheles</i> spp (malaria; filariasis)	<i>Culex</i> spp (filariasis; diseases caused by arboviruses)	<i>Aedes</i> spp (diseases caused by arboviruses)
Open drains		x	x
Storm-water canals	x	x	x
Sewerage systems		x	
Cesspools	x	x	
Cesspits		x	
Coirpits		x	
Marshy swamps	x	x	x
Septic tanks		x	
Depressions	x	x	x
Quarries	x	x	x
Ant traps		x	x
Cement water tanks	x	x	x
Roof-top water tanks	x	x	x
Domestic water containers	x	x	x
Refuse containers	x	x	x
Cemetery flower vases		x	x
Manholes	x	x	
Distribution boxes	x	x	x
Ornamental pools	x	x	x
Water wells	x	x	x
Construction sites	x	x	x
Water collection or pipe leakages	x	x	x

vector of other important diseases, e.g., urban yellow fever and chikungunya virus disease. It has proliferated thanks to the increasing number of breeding sites provided by the large-scale storage of water in ceramic jars, tanks and drums because water supplies are inadequate, and the inability of garbage disposal services to remove all small plastic, metal and glass containers. *A. albopictus*, largely a south-east Asian species, with a tendency to breed in discarded motor vehicle tyres, is a vector of dengue and a potential vector of yellow fever. It has recently spread to the USA and Brazil, most probably with shipments of tyres from Asia. *A. polynesiensis* is the sole vector of filariasis in Polynesia; it is also involved in dengue transmission and has adapted to urban domestic breeding places in Papeete, Tahiti. *A. pampaensis* in Kenya, *A. caspius* and *A. mariaae* around the shores of the Mediterranean and *A. taeniorhynchus* in South America have become pests in cities in the vicinity of their larval breeding sites, especially when they are swept towards them by favourable winds. *A. caspius* is a vicious pest in Khartoum, Sudan, where it breeds extensively in nearby sewage effluent. *A. sollicitans*, a vector of eastern equine encephalomyelitis

Table 3. Urban disease vectors and pests other than mosquitos and their potential habitats

Vector or intermediate host	Disease carried	Potential breeding habitats in urban areas															
		Refuse collection sites	Refuse dumps	Slaughter houses	Food stores	Food establishments	Substandard houses	Dirty garments with poor personal hygiene	Stepwells	Sewage filters	Animal shelters	Excrement	Unsanitary latrines	Canals	Ponds	Springs	Rodent burrows
Houseflies (mechanical carrier) Sandflies	Trachoma, diarrhoeal diseases	x	x	x	x	x	x				x						
	Leishmaniasis (any form)					x	x				x						
Trickling filter flies (Psychoda spp) Fleas	Plague, typhus fever due to <i>Rickettsia typhi</i> , tularaemia					x	x				x						x
	Diarrhoeal diseases					x	x										
Bedbugs Cockroaches (mechanical carrier) Lice	Typhus fever due to <i>Rickettsia prowazekii</i> , relapsing fever					x	x										
	Scabies (dermal infection) American trypanosomiasis (Chagas' disease)					x	x										
Mites Triatomine bugs	Plague, typhus fever due to <i>Rickettsia typhi</i> , spirillosis, streptobacillosis					x	x										
	Dracunculiasis Schistosomiasis					x	x										

in the USA, is a serious pest in New Orleans and other cities in the southern USA, where breeding occurs in floodwaters. *A. vexans*, which has a cosmopolitan distribution, is an important pest in both developing and developed countries.

3.1.2 *Culex* spp

Culex quinquefasciatus is the main vector of bancroftian filariasis in the tropics and subtropics around the Indian Ocean, in the Caribbean, and in the Americas and the Western Pacific. In addition, it is a considerable nuisance in all tropical and subtropical urban areas, disrupting the inhabitants' sleep to the extent of causing fatigue from lack of rest. Nearly all breeding sites of *C. quinquefasciatus* in urban areas are man-made and include blocked drains, septic tanks, cesspools, pit latrines and other sources of stagnant polluted water, such as small discarded containers. There has been a great increase in urban breeding of *C. quinquefasciatus* in recent decades associated with rapid and uncontrolled urbanization. In central and southern China, *C. pallens* has had similar ecological success and poses the same problems as the species previously mentioned. *C. pipiens* and *C. molestus* are essentially species of temperate zones, where they are occasional pests. *C. pipiens* has been implicated as a vector of bancroftian filariasis in Egypt. *C. sitiens* is an urban pest in towns in India, where it breeds in pits containing water. *C. tritaeniorhynchus*, an important vector of Japanese encephalitis, breeds in the outskirts of cities in the Republic of Korea and can sometimes bite people within the city itself. In coastal cities of West Africa, such as Accra, Ghana, *C. thalassicus* has come to be regarded as a pest.

3.1.3 *Anopheles* spp

Since most species of *Anopheles* breed in clean water fairly free of organic matter, and the density of urban structures sometimes eliminates the places in which they can establish breeding sites, *Anopheles* generally breeds much less frequently in city centres than in the periphery. There may, however, be small zones within the city that are not built up, such as parks, market gardens or waste ground, where conditions are favourable for *Anopheles*. In addition, a few species of *Anopheles* have adapted to living in town or city centres. The best known of these is *A. stephensi*, which is an important vector

of urban malaria in India and which has adapted to breeding in roof reservoirs, other domestic water storage containers, wells and flooded basements of buildings. It has developed into an urban species and is found in much higher numbers in many cities in India than in the surrounding countryside. *A. arabiensis*, a species belonging to the *A. gambiae* complex, breeds extensively in standing water and blocked storm-water drains in cities in Nigeria (e.g., Sapele) and has been incriminated as a vector of urban malaria. In Mauritius, it breeds in roof tops and gutters. *A. sacharovi*, breeding in the outskirts of Adana, Turkey, was the vector in a major outbreak of malaria in that city during the late 1970s. *A. albimanus* was responsible for a malaria outbreak in Choluluteca City, southern Honduras, in 1978–1981. In Port Moresby, Papua New Guinea, *A. farauti* breeds in ditches and flooded land in and around the city. *A. sondaicus*, breeding in nearby coastal swamps, presents a threat as a malaria vector in some cities in south-east Asia.

3.1.4 Other species

Eretmapodites chrysogaster is a local urban pest in some towns in Africa, where it can be found breeding in large numbers in small discarded containers. *Mansonia titillans* is a pest mosquito of São Paulo, Brazil, where it breeds in standing water within the city. Other species of *Mansonia*, such as *M. africanus* and *M. uniformis*, breeding in nearby ponds and swamps, are serious pests in some towns in south-east Asia and Africa. The latter species is a vector of filariasis in some countries in south-east Asia.

3.2 Sandflies

Phlebotomus sergenti is probably the sole vector of anthroponotic cutaneous leishmaniasis in the urban areas of several countries in the Mediterranean region, and also in India and south-east Turkey. It breeds in the vicinity of buildings and the adult rests extensively indoors in cracks and crevices in the walls. The visceral form (kala azar) is generally found in rural areas, but urban foci have been found in Madras and Calcutta (India), and Alexandria (Egypt). *P. argentipes* has been implicated as the vector in India and *P. langeroni* in Egypt.

3.3 Fleas

Xenopsylla cheopis, *X. astia* and *X. braziliensis* are potential vectors of plague (caused by *Yersinia pestis*) and typhus fever (caused by *Rickettsia typhi*) in urban areas of developing countries in tropical climates. *Pulex irritans*, the common flea, *Ctenocephalides felis*, the cat flea and *C. canis*, the dog flea, are urban pests throughout the world. In developed countries in the temperate zone this problem is quite severe both because of the many cats and dogs and the widespread use of central heating, which facilitates flea breeding. *Tunga penetrans*, the jigger flea, is a nocturnal species which occurs in urban as well as rural environments if the soil is sandy. This species burrows under the skin of humans and causes lesions which can become infected; the problem is intensified where overcrowding occurs.

3.4 Triatomine bugs

The triatomine bugs include several species that are vectors of *Trypanosoma cruzi*, the causative agent of American trypanosomiasis (Chagas' disease). These bugs spend much of their life cycle in cracks and fissures and other hiding places in the walls and ceilings of human dwellings and animal shelters. *Triatoma infestans* is the commonest domestic vector in South America. *Rhodnius prolixus* is an important vector in the northern countries of South America and is occasionally found in periurban areas. *Panstrongylus megistus* is a locally important vector in parts of Argentina, Brazil and Paraguay.

3.5 Lice

Pediculus humanus, the body louse, thrives where people live in conditions of poor personal hygiene; the slum conditions existing in some cities lead to high levels of louse infestation. It is a vector of typhus fever due to *Rickettsia prowazekii*. In recent years, many cases of louse-borne typhus have been reported from Burundi, Ethiopia and Rwanda. Louse-borne relapsing fever caused by the spirochaete *Borrelia recurrentis* is limited essentially to Ethiopia and the Sudan, although there are occasional reports of its occurrence in South and Central America. *P. capitis*, the head louse, and *Phthirus pubis*, the pubic louse, are not vectors of disease, but are pests throughout the world wherever personal hygiene is poor.

3.6 Tsetse flies

Tsetse flies (*Glossina*) occur only in the African tropical region. The ecological requirements of *Glossina* are such that they are hardly suited to an urban environment, but some cities may contain small wooded areas, serving more or less as parks, and these may harbour quite considerable tsetse populations. This is the case with *Glossina palpalis gambiensis* in Ouagadougou, Burkina Faso and *G. fuscipes* in Brazzaville, Congo. As cities are extended, the outlying districts may impinge on *Glossina* breeding sites. This accounts for the cases of sleeping sickness transmitted by *G. palpalis* that have occurred in the cities of Douala (Cameroon), Bamako (Mali), and Matadi (Zaire).

3.7 Blackflies

Several large cities in Africa, such as Bamako, Brazzaville, and Kinshasa, have been built on the banks of large rivers which abound in breeding sites for blackflies of the *Simulium damnosum* complex. Onchocerciasis transmission in these cities by such blackflies is minimal since the bites are shared among a large number of people; each person thus receives only a very small number of parasites so that the pathological effects of parasite accumulation do not appear. *S. pertinax* also presents a similar pest problem in Rio de Janeiro, Brazil. In recent years anthropophilic species of blackflies have become established, breeding in waste-water disposal channels, and in rivers traversing cities in urban areas. These flies are now posing a health hazard to many people living in cities. Their bites always cause local reaction and discomfort, but in some cases systemic and allergic manifestations also appear, requiring medical attention.

3.8 Ticks

Rhipicephalus sanguineus, the brown dog tick of tropical areas, and *Dermacentor variabilis*, the dog tick of North America, are brought into dwellings by dogs. They normally only bite dogs, but can cause extreme annoyance to man and transmit spotted fever due to *Rickettsia rickettsii* or *R. cenori*.

3.9 Mites

Sarcoptes scabiei var. *hominis* is the causative agent of scabies. It burrows and breeds in the human epidermis, particularly in the more humid areas of the skin, and causes intense itching and constant scratching by the infested person, which may lead to streptococcal or staphylococcal sepsis of the infested area. Scabies is most prevalent in urban areas where extremely unhygienic personal conditions exist. The mite is transmitted principally by direct skin-to-skin contact and to a lesser extent through contact with infested garments and bedclothes.

House dust mites, which give rise to respiratory allergies, and Dermanyssidae, which are associated with domestic birds, have mainly been studied in the temperate countries; many species are also found in the tropics, where their relevance to public health needs to be better determined.

3.10 Synanthropic flies

Flies of the families Muscidae, Calliphoridae, Chloropidae and Sarcophagidae, whose primary breeding sites are a wide variety of animal and human wastes, are of considerable importance in urban areas. They infest urban as well as other environments and may be found extensively in semi-industrial stock-breeding areas adjacent to some cities.

The common housefly, *Musca domestica*, can be a serious urban pest throughout the year in tropical areas and during the summer months in temperate zones. It breeds around houses in decaying food and garbage and is attracted to a wide variety of domestic foods, garbage, animal faeces, dead animals and rotting vegetation, upon all of which it feeds indiscriminately, discharging saliva from its fleshy proboscis on to the various food materials and then ingesting the saliva containing dissolved nutrients. The link between number of houseflies and incidence of diarrhoeal disease has been demonstrated in several situations. The enteric infection most closely linked to transmission by houseflies is bacterial dysentery (caused by *Shigella* spp). Houseflies also settle on the human body to feed on sweat and on open wounds and sores, and infections of the skin, eyes and wounds can be carried from person to person in crowded conditions in this way. The lesser housefly, *Fannia* spp, and the bazaar or face fly, *M. sorbens*, have similar habits to those of the common housefly. The blowfly, *Chrysomya putoria*, breeds

extensively in latrines, and bluebottles, *Calliphora* spp, greenbottles, *Lucilia* spp, and fleshflies, *Sarcophaga* spp, breed in decomposing meat or fish. In suburban areas where cattle may be housed, the stable or storm fly, *Stomoxys calcitrans*, is a vicious biter, chiefly below knee level; it is particularly active during warm cloudy weather. It breeds mainly in the excrement of domestic animals, chiefly cattle.

Flies belonging to the family Chloropidae, commonly known as eye flies (in south-east Asia) and eye gnats (in the USA and South America), are both important pests and vectors of diseases such as conjunctivitis, pinta, and yaws. Members of the genus *Hippelates* are common in periurban areas in the Americas, while *Siphunculina* species are pests and vectors in south-east Asia. Both groups breed in soil containing organic matter and moisture provided by watering or rain.

The Congo floor maggot, *Auchmeromyia luteola*, and the Tumbu fly, *Cordylobia anthropophaga*, are of more local occurrence in towns in Africa and are responsible for myiasis, the latter species mainly affecting children.

3.11 Bedbugs

Three species of Cimicidae are found in human dwellings: *Cimex lectularius*, which is cosmopolitan, *C. hemipterus*, found throughout the tropics, and *Leptocimex boueti*, which is confined to tropical Africa. These insects are prevalent in human dwellings in urban as well as in rural areas. While bedbugs are very annoying pests they have never been shown to be important in the transmission of disease.

3.12 Cockroaches

Fewer than 10 of the 3500 species of cockroach identified throughout the world have become commensal with man; they are associated with poor hygiene. These primitive insects are saprophagous and nocturnal, and require warmth, food and shelter to survive and proliferate. In tropical regions the warmth is provided by the prevailing climate, but in temperate areas the widespread use of central heating has led to their becoming serious pests, no longer restricted to boiler rooms and kitchens but now present throughout houses, apartments, offices and even centrally heated buses, trains

and aircraft galleys. Cockroaches feed on many types of foodstuff, in addition to household wastes such as garbage and sewage. Although they prefer starchy or sugary food, they will feed on almost any substance if more desirable food is not available. Through their habit of regurgitating fluids while feeding, often defecating at the same time, they are serious, and to many people, revolting pests, spreading filth and ruining foods, fabrics and book bindings. They also produce secretions that give a persistent and unpleasant smell to areas occupied by them. Heavy infestations may produce allergic reactions in some people. They may also play a role in the mechanical spread of pathogenic bacteria, including those of diarrhoeal diseases. Very large amounts from both private and public sources are spent annually on cockroach control in the urban areas of developed countries. The most prolific species are ubiquitous, occurring in both developed and developing countries, and include the German cockroach, *Blattella germanica*, the American cockroach, *Periplaneta americana*, the Oriental cockroach, *Blatta orientalis*, and *Periplaneta brunea*. Other globally less common, but nevertheless widespread species, particularly in the southern and western hemispheres, are the Australian cockroach, *Periplaneta australasiae*, and the brown-banded cockroach, *Supella supellectilium*.

3.13 Ants

The principal ant of public health importance is the Pharaoh's ant, *Monomorium pharoensis* L. This minute tropical ant, a domestic pest in hot countries, where it is sometimes known as the "sugar ant" because of its predilection for infesting sugar-bowls, has become a pest of permanently heated premises, such as hospitals, bakeries and even centrally heated high-rise domestic apartment blocks in temperate countries. For many years infestations in hospitals were regarded simply as a nuisance but it has recently been shown that these ants are able to carry bacteria, including *Salmonella*, *Pseudomonas*, *Staphylococcus*, *Streptococcus* and *Clostridium* spp. The tiny workers can penetrate the smallest gap and have been found in sterile packs and saline drip tubes. Other species of ant, such as the fire ant and the Argentine ant, are important pests in urban and periurban situations in the western hemisphere.

Many other species of ant infest households. Studies in the United States of America showed that ants were the most frequently

mentioned household pest. In addition to the nuisance caused by contamination of food, some species inflict painful stings and bites. Infested buildings usually contain many nests, often situated in inaccessible places, such as wall cavities and foundations.

3.14 Other arthropod pests

There are many other urban pests of generally lesser importance. These include termites, wood-boring beetles, silverfish, booklice and woodlice, which can attack the fabric of buildings. Other pests include clothes moths, pests of stored products, scorpions, spiders, common wasps, and bees.

3.15 Rodents

The three main cosmopolitan urban rodent pests are the roof or black rat, *Rattus rattus*, the Norwegian rat, *R. norvegicus*, and the house mouse, *Mus musculus*. Rodents consume large quantities of stored food products, gnaw and damage human property, including electrical systems, and contaminate food products with their faeces and urine, sometimes transmitting such diseases as leptospirosis and salmonellosis in the process. They can also play an important part as reservoirs of plague, typhus fever due to *Rickettsia typhi*, haemorrhagic fever with renal syndrome and Lassa fever. Other rodents of local importance include the Asian lesser bandicoot rat, *Bandicota bengalensis*, the Polynesian or Hawaiian rat, *Rattus exulans*, the African multimammate rat, *Mastomys natalensis*, and the Asian house-shrew, *Suncus murinus*.

3.16 Snails

Surveys have shown that schistosomiasis is a public health problem in inner city areas in Africa, e.g., in Addis Ababa, Dar-es-Salaam, Harare, Kampala, Kinshasa and Lusaka, as well as in Brazil and some other countries in South America. Ideal breeding conditions for vector snails (*Bulinus* spp and *Biomphalaria* spp) are provided in irrigation areas close to townships, and disease transmission is also favoured, as the farmers work barefoot and defecate and urinate along watercourses. Urban transmission of schistosomiasis is an ever-increasing problem of development because of migration of people from rural areas.

4. PRESENT STATUS OF URBAN VECTOR AND PEST PROBLEMS AND OF THEIR CONTROL

4.1 Situation analysis by WHO region

4.1.1 African Region

It is estimated that 33% of the population in tropical Africa will live in urban areas by the year 2000. The chief factors responsible for this phenomenon are the high annual population growth rate in Africa and the extensive immigration of people from rural or war-affected areas. This rapid and often uncontrolled urbanization has brought about drastic environmental changes that have influenced the proliferation of vectors of diseases and/or pests.

The major vectors of malaria in the African Region, *Anopheles gambiae* s.l. and *A. funestus*, are mainly rural species and usually breed in the rural environment. Urbanization, which does not provide these vectors with appropriate breeding sites, has therefore generally contributed to a reduction in the prevalence of malaria in most of the urban areas in African countries. However, risk of malaria transmission will be permanently maintained in Cape Verde and the Comoros, where *A. gambiae* s.l. breeds in concrete tanks and cisterns, and in Mauritius, where *A. arabiensis*, a member of the *A. gambiae* complex, has acquired the ability to breed on the flat tops of houses and in roof-gutters. Some town centres in Nigeria support extensive *A. arabiensis* breeding, as they provide a better environment for this species than for *A. gambiae* s.l., which is more prevalent in the rural areas surrounding the towns.

Lymphatic filariasis is transmitted in both urban and rural areas of the east coast of Africa by *Culex quinquefasciatus*. Although this species has not yet been incriminated as a vector in Central and West Africa, its proliferation, as a result of urbanization, increases its importance as a pest.

A. aegypti, the vector of yellow fever and dengue in urban areas in Africa, is widespread. It was involved in the 1987 yellow fever epidemic which occurred in Ogbomosho city, Oyo State, Nigeria, causing hundreds of deaths. Urbanization will encourage the multiplication of this species, since it breeds in man-made containers and water storage pots. The same trends have been seen with *A. albopictus*, a species restricted to Madagascar, Réunion and the

Seychelles; in Réunion, it was involved in the dengue epidemic of 1978.

As regards *Xenopsylla cheopis*, the vector of plague, its multiplication on rats, because of sanitation problems, will increase the risk of plague transmission, particularly in Madagascar, as occurred during the latest epidemic in the capital, Antananarivo.

The other vectors and pests found in African cities are flies, cockroaches, bedbugs, lice and fleas. Tsetse flies and blackflies are local nuisances in some urban areas. The Congo floor maggot and the Tumbu fly are responsible for myiasis in Central Africa. The main rodent pests are *Rattus rattus*, *R. norvegicus* and *Mus musculus*.

Responsibility for the control of these vectors is generally assigned to the municipal authorities, which collect annual taxes in return for the services provided. Vector control is generally achieved through source reduction and pesticide application. In Benin, Burkina Faso, Côte d'Ivoire and Niger, vector control activities are, however, carried out at the request of individual citizens who, in turn, pay the municipalities. In Zimbabwe, the municipality hires a private company for control activities in the capital city.

Health education on vector source reduction, personal protection and community participation is being promoted in a number of countries. Difficulties are encountered in obtaining community participation in places where municipalities collect taxes for the vector control services.

The problem of insufficient or completely non-existent financial resources is one that faces all the countries of the Region. Shortages of trained personnel and the lack of an appropriate career structure for vector control specialists are the main obstacles to the good management of urban vector control activities. This problem is, however, being overcome following the establishment in 1980–81 of postgraduate courses in medical entomology at the Universities of Abidjan in Côte d'Ivoire, Jos in Nigeria, and Nairobi in Kenya, and the establishment of courses for middle-level personnel jointly organized by DANIDA and WHO.

4.1.2 *Region of the Americas*

Urbanization in Latin America and the Caribbean is proceeding at an annual mean rate of 3.8%, but some cities are experiencing much higher growth rates. In 1984, there were 285 cities in this Region with over 100 000 inhabitants; many of them have vector

problems related to inadequate water supply, sewer systems, and solid waste disposal.

The most important urban mosquito is *Aedes aegypti*, the vector of urban yellow fever, dengue and dengue haemorrhagic fever/dengue shock syndrome (DHF/DSS) in the Americas. Urban yellow fever has been absent since 1954, but the sylvan cycle continues in many countries and the threat of reinvasion by the virus is ever present. All four serotypes of dengue virus have circulated in this hemisphere, most notably in the pandemic of dengue-1 in the Caribbean, northern South America, Central America, and Mexico during 1977-79 and the epidemic of DHF/DSS in Cuba in 1981, which resulted in 158 deaths. During the 1960s, *A. aegypti* was eradicated from 23 countries in the Americas but, by 1987, only 5 of these countries were still free from this vector.

A. albopictus was found to be established in the United States of America in 1985, where it now occurs in 13 states, and in Brazil in 1986, where it is found in 4 states. This vector of dengue in Asia, which occurs in both urban and rural areas, could become involved in the transmission of this disease in the New World.

Of the anophelines in the Americas, none is a truly urban or domestic species but there are important urban foci of malaria in several countries of the Region, usually resulting from the expansion of the urban area into the rural habitat of *A. darlingi* or *A. albimanus*, or where larval habitats, such as rice fields, border the cities and towns.

Culex quinquefasciatus is the vector of *Wuchereria bancrofti* in the urban areas of several countries along the coastal plain of Central and South America, especially along the Atlantic seaboard. *Triatoma infestans* is a vector of American trypanosomiasis (Chagas' disease) in urban, suburban, and rural areas in several countries of South America, and synanthropic flies and cockroaches are important pests. The most important urban rodent species are the roof rat, Norway rat, and house mouse. Rural human and animal plague appears periodically, but has not been an urban problem for many decades.

Most vector control in the Americas is carried out with chemicals. Application of DDT suspension to the walls of houses is the method most commonly employed in malaria control programmes, although the multiple resistance of *A. albimanus* to many organochlorines, organophosphorus compounds and carbamates in Central America has led to a search for alternative insecticides and methods. *A.*

aegypti is controlled by addition of temephos to potable water, perifocal treatment with fenthion and malathion suspensions, and ultra-low-volume and thermal fog applications of malathion. Limited use has been made of biological control agents, such as larvivorous fish, bacteria, and fungi. Field trials are under way with nematodes and predatory mosquito larvae.

Examples of environmental management are the draining and filling of anopheline breeding habitats in some countries, the elimination of refuse containers to reduce *Aedes* larval sources, and house modification to reduce the habitats of triatomine bugs.

In most countries, control programmes against *Aedes aegypti*, anophelines and triatomines are implemented by the national government and were highly effective in reducing both vector and disease levels during the 1950s and 1960s. However, because of financial constraints, there is a tendency to decentralize these costly programmes, and to assign greater responsibility to the general health services. Fly and rodent problems are usually the responsibility of the municipal or county governments, while general pest control is left to private operators. Community participation has been notably successful in the control of *A. aegypti* in this Region.

There is a serious deficiency of trained staff at all levels of vector control. The WHO Regional Office for the Americas is helping to remedy this situation by organizing national and international courses for field operators, entomology staff, and management personnel, and by supporting a master's degree programme in medical entomology. Unfortunately, career structures and salaries for vector-control personnel are not such as to attract qualified people.

4.1.3 Eastern Mediterranean Region

In this Region, rapid urbanization has resulted in the growth of slums around big cities and the creation of favourable breeding conditions for insect vectors, pests, rodents and other reservoirs of disease, which have therefore proliferated.

The most significant anopheline is *Anopheles stephensi*, which is considered a truly urban mosquito and is responsible for urban malaria in some of the countries of the Region. The species is resistant to a number of organochlorine and organophosphorus insecticides. Control of anopheline vectors, both in rural and urban

areas, is still mainly dependent on insecticides. Some countries are still using DDT effectively, and malathion, fenitrothion and propoxur are being used either alone or in combination in a number of countries. Temephos is being used by the majority of countries for larval control. The control methods, other than the use of insecticides, employed by a number of countries include source reduction and biological control.

Culex quinquefasciatus and *C. pipiens* are prevalent in the urban areas of the majority of countries. They are the most important biting mosquitos of the Region, occurring in high densities in nearly all residential areas of cities. Resistance to chlorinated hydrocarbons, organophosphorus compounds and carbamates has been reported from a number of countries. Control methods involve source reduction by improving the sewage system, as well as chemical larviciding using chlorpyrifos or fenthion in polluted waters and temephos in less polluted or clean water. In Egypt, source reduction, larviciding against *C. pipiens* with temephos and adulticiding with malathion have reduced the number of reported cases of bancroftian filariasis. *Bacillus thuringiensis* H-14 and *Bacillus sphaericus* have been used on a limited scale in field trials in some countries.

The common housefly, *Musca domestica*, is present in the rural and urban areas of all the countries. The efficacy of the agencies responsible for fly control in urban areas varies markedly among the countries of the Region, but such agencies are far from satisfactory in most countries. In general, fly-control methods involve garbage collection and disposal, and cleaning of markets. Chemical control, in general, is effected using malathion, fenitrothion, dimethoate, and deltamethrin on garbage and refuse dumps. Adulticiding is effected by residual spraying with different insecticides around dairies, cattle sheds, poultry farms, slaughterhouses, and railway stations. Thermal fogging or ultra-low-volume spraying is carried out in the urban areas of a number of countries, using pyrethroids and malathion.

Cockroaches are widely distributed in the countries of the Eastern Mediterranean Region. No country has carried out organized cockroach control, which is left to individual householders, who generally employ commercially available pyrethrum aerosols, and residual sprays and baits, most of which contain an organophosphorus compound.

Cutaneous and visceral leishmaniasis occur in almost all countries in the Region, and an increase in the incidence of these diseases has

recently been noticed in many countries. Cutaneous leishmaniasis is the most important form in the Region and serious epidemics have occurred in the last decade in Afghanistan, the Islamic Republic of Iran, Iraq, Pakistan, the Sudan, the Syrian Arab Republic and Tunisia. Anthroponotic cutaneous leishmaniasis is present in the urban areas, where *P. sergenti* is the only vector of this disease.

Rodents have special significance in this Region, particularly with reference to plague. The most important are *Rattus rattus*, *R. norvegicus* and *Mus musculus*. In two countries of the Region, the Libyan Arab Jamahiriya and Yemen, outbreaks of plague are still considered to be possible. A number of countries carry out organized rodent control.

Other insect vectors and pests, such as fleas, bedbugs, ticks, mites, and head and body lice, are present in many countries of the Region.

4.1.4 South-East Asia Region

In the South-East Asia Region the number of cities with a population of 500 000 has tripled from 18 to 54 during the past 20 years. In 1955, the urban population of the 11 countries of the Region accounted for an average of 24% of the total population; by the year 2025 this figure is expected to reach 47%.

As the human population increases beyond the capacity of municipal services to dispose of wastes, more and more bodies of water become suitable for the breeding of *C. quinquefasciatus*, with a consequent increase in filariasis transmission. However, because of the shortage of systematic surveillance systems, the magnitude and extent of the problem is not known in most places.

The numbers of cases of dengue/dengue haemorrhagic fever continue to increase in most of the urban areas of the endemic countries of the South-East Asia Region, and particularly in Burma, Indonesia and Thailand. In Indonesia, the disease affects not only the younger age group, but also adults, thereby causing considerable economic losses. The vector, *A. aegypti*, breeds in man-made containers, such as the large clay jars used for storage of drinking-water, discarded tin cans, bottles, old tyres, and other receptacles. As the food habits of the human populations change and more containers are used and carelessly discarded, the problem of *A. aegypti* in urban areas continues to grow, as does the threat of disease transmission.

The problem of urban malaria in the South-East Asia Region is mainly confined to India. Over 15% of all malaria cases in the country occur in urban areas. *A. stephensi* is the principal vector of urban malaria; it breeds in wells, cisterns, overhead tanks and, in some cases, even in ponds and pools. Many of the immigrants from rural areas carry plasmodia with them, forming a new reservoir of infection accessible to the urban malaria vector. The problem is compounded by rapid developmental activities, including new constructions, which provide additional breeding grounds for the disease vector, thereby leading to conditions favourable to malaria transmission.

Rodent-borne diseases, including plague, typhus fever due to *Rickettsia typhi*, haemorrhagic fever with renal syndrome, salmonellosis and leptospirosis, are also a problem in urban areas, particularly in Burma.

Practically all cities and towns suffer from a number of pest problems. Infestation by fleas, bedbugs, ticks, mites, headlice and pubic lice cause great discomfort. Among non-blood-sucking insects, synanthropic flies and cockroaches are annoying pests in most of the urban areas.

With increased urbanization, it appears that the problem will become even greater in the future, if not properly tackled. There is therefore a need for effective and well organized vector control with adequate epidemiological, entomological and logistic support in most urban areas. However, few urban vector control activities are being carried out in an organized manner in the Region. In metropolitan cities throughout India, the vector control programme is a part of either the malaria or the filariasis control programme. In the major cities of other countries in the Region, vector control operations are the responsibility of the public health department of the municipal council. In the context of primary health care, efforts are being made to involve the community in urban vector control activities, e.g., in parts of Indonesia, larviciding for *A. aegypti* control is carried out by volunteers under the guidance of health officers.

4.1.5 *Western Pacific Region*

Only a few large-scale programmes specifically designed for the control of urban pest insects and mosquitos of public health

importance exist in the Western Pacific Region. In many big cities, the control of *Aedes* vectors of arboviruses, as well as *Culex* mosquitos, flies, fleas, bedbugs and cockroaches would be desirable, but it is not easy to implement an effective plan owing to lack of funds and the high costs of insecticide, spray equipment, and salaries of local personnel. Kuala Lumpur, Penang, Seoul and Singapore are among the cities with relatively advanced programmes, and where increasing emphasis is being given to environmental management and the provision of adequate water supplies. Environmental management is also widely applied in China, with considerable success.

The vector-borne diseases requiring the greatest attention are malaria, dengue haemorrhagic fever, filariasis, and Japanese encephalitis. Despite nearly three decades of extensive control efforts, malaria remains a major health problem in several countries. The mosquito-borne disease affecting the largest number of people is filariasis, which is endemic in many countries and areas. Japanese encephalitis continues to be an important public health problem in several countries, and seasonal epidemics occur in China and Viet Nam. In recent years, outbreaks of arboviral diseases have been a common occurrence in the South Pacific. The most important disease has been dengue fever/dengue haemorrhagic fever, but Ross River disease (epidemic polyarthritis) has also become of public health importance since the outbreaks in Fiji in 1979.

Many countries did not have adequate supplies of insecticides and spray equipment to deal with such outbreaks. To overcome this difficulty, a project on preparedness against outbreaks of arboviral diseases was approved by WHO, UNDP and 12 participating countries or areas in 1980, aimed at discovering and reporting such outbreaks as early as possible and at keeping vehicle-mounted and portable spraying machines as well as insecticides in all participating countries and areas. Ultra-low-volume malathion was the main adulticide used and temephos 10 g/kg (1%) sand granules the larvicide.

Basic vector control courses and national workshops are held regularly in several countries of the Region; these courses also cover surveillance and the control of arboviral disease outbreaks. In addition, intercountry training activities on vector biology and control are held in selected localities. The importance of health education is stressed in all these activities. Research is also being carried out, aimed at the development of appropriate technology

and simple vector control techniques that can be effectively used by communities.

While the broad objectives of the vector control programme are gradually being achieved, more emphasis needs to be placed on greater community participation in vector control and the use of simple environmental measures to prevent vector breeding. Although some simple control activities have been identified, more efforts are needed to inform the general population of their existence. The impact of community activities in decreasing and preventing vector-borne diseases in many countries is not, however, easy to evaluate, because such programmes are long-term in nature and progress can be slow.

4.2 Methods for control of vectors and pests in urban areas

4.2.1 Chemical methods

Chemical methods should play a secondary role as compared with environmental management in urban vector and pest control. However, with few exceptions, chemical control still remains the principal method in use in urban areas. This is because many governments and municipalities are unable or unwilling to provide the substantially larger funds required initially for long-term environmental management, although this would be cost-effective in the long run.

In tropical and subtropical areas, chemical control is mainly directed against vectors of important human diseases, e.g., malaria and arboviral diseases, whereas in temperate areas the emphasis is more on the control of pests such as cockroaches, rodents, flies and nuisance mosquitos. The differences in the characteristics of urban areas around the world and the wide variety of habitats within and around them, contribute in turn to the wide variety of arthropod vectors and pests, and of the chemical methods required for vector control.

A WHO survey of municipal vector control services carried out in 1982-83¹ showed that, in 25 cities in developing countries,

¹ SMITH, A. & GRATZ, N.G. *Urban vector and rodent control services*. Unpublished WHO document, VBC/84.4.

demand for insecticides and formulations was largely for those used in larviciding and space spraying. The greatest demand was for organophosphorus compounds.

When chemical methods of vector control are being considered for use in urban situations, the following aspects should be taken into consideration:

- (a) the susceptibility of the target species to the pesticides available for use;
- (b) the acceptability of the pesticide and method of application to local communities;
- (c) the safety of the pesticide formulation for human and non-target organisms;
- (d) the stability and residual activity of the pesticide;
- (e) the skill and competence of the personnel applying the pesticides.

Pesticides can be applied in various ways, as discussed below.

Residual applications. In general, indoor residual spraying is inappropriate in most urban situations. However, this can be the most economical, effective and relatively safe method for use against endophilic vectors, especially in periurban or slum situations with low-cost rural-type dwellings. It may not be cost-effective elsewhere in the city because too great a surface area may have to be treated or because it is not acceptable to house owners.

Paints containing insecticides have been in use for a long time, their popularity having increased recently following a substantial improvement in their effectiveness.

Space spraying. This is better adapted to use in the built-up areas of the city. It is also speedier in its impact, which is desirable under epidemic conditions. City inhabitants are, on their own initiative, increasingly using hand-operated space-spray pumps and aerosols.

Larviciding. In urban situations, vector breeding habitats are relatively discrete and restricted and larviciding may prove more cost-effective than routine measures against adults. A number of different classes of chemical pesticide are used as larvicides, but only temephos and methoprene have been found suitable for potable water. Crude mineral oils and their derivatives are also used as larvicides, but are of limited application.

Repellents. Repellents such as DEET and DEPA, applied to skin and clothing, give protection against man-biting pests for 4–8 hours. They are useful under specific conditions, e.g., during visits to highly infested areas.

Mosquito coils, mats and canisters. Mosquito coils are widely used even in underprivileged urban communities. The active ingredient is often a synthetic pyrethroid. The vapours released by the coil act simultaneously through their pyrethroid knock-down effect, their repellent effect, and their inhibition of biting, which is partly the result of the disorientating effect on insects.

Vaporizing mats placed in 5–6-watt electric heaters contain the same active ingredient as the coils and have a similar mode of action. The use of mats is limited by the availability of electric current and by price.

Aerosol canisters, containing freon propellant and a variety of synergistic combinations of active ingredients, are used in the urban areas of many countries for controlling household pests.

4.2.2 *Biological control methods*

Biological control (3) could be a cost-effective component in an integrated approach to vector and pest control in urban areas. The relative safety of biological control agents for non-target organisms renders them suitable for use by the community with minimal supervision as a self-help vector control method. The agents currently available are effective against the immature stages of some vectors that breed in close association with human habitations in urban areas. These breeding sites can be easily located and treated by the urban community. Some of the most promising biological control agents are discussed below.

Among the bacteria pathogenic to arthropods, much attention has been paid to the spore-forming toxin-producing species. Strains of *Bacillus thuringiensis* H-14 and *Bacillus sphaericus* have shown good activity against a broad spectrum of mosquito species. Methods have been developed for their local production and large-scale commercial fermentation. Laboratory and field tests of their activity against mosquito and blackfly larvae have been carried out and *B. thuringiensis* H-14 has been used in mosquito and blackfly control programmes for five or six years now. *B. sphaericus* is on the verge of being used in mosquito control.

B. thuringiensis H-14 can be used in urban areas for the control of mosquitos which act as vectors of diseases or constitute a nuisance. *B. sphaericus* has been shown to have high activity and good persistence against *Culex* larvae in polluted habitats. A new trend in mosquito control is the use of bacterial agents in combination with naturally occurring predatory insects and fish.

Among the fungi, several species have been shown to be pathogenic to larvae of mosquitos and other disease vectors. Among these pathogens, *Lagenidium giganteum* has attracted the most attention and this fungus shows some promise for the control of mosquito larvae in clear water. The fungus also recycles when inoculated into breeding sites.

The mermithid nematodes, *Romanomermis culicivorax* and *R. iyengari*, have been shown to recyle in the field in suitable mosquito habitats and to be useful in periurban situations. Larvae of the predatory mosquito *Toxorhynchites* have been released in field situations, where they have shown some effectiveness in controlling mosquitos that breed in tree-holes or containers. Some predatory copepods, including *Mesocyclops aspericornis*, have also shown promise in some areas. Parasitic wasps have been tested with some success against the vector of American trypanosomiasis (Chagas' disease), *Rhodnius prolixus*, in Venezuela and against houseflies in Chile.

Among the larvivorous fishes, *Poecilia reticulata* has a relatively high tolerance of pollution and could be used to control *C. quinquefasciatus* and some other mosquitos in urban areas. *Gambusia affinis* also has tolerance to pollution and has proved to be effective in urban situations, including breeding sites in underground storm drains. Larvivorous fish are used in many American and European countries.

Indigenous species of fish are being evaluated in developing countries and some have shown good potential, together with additional advantages, e.g., they are better adapted to the local conditions, have a smaller adverse impact on other fauna, and are more amenable to stocking as well as collection and distribution by the community from natural breeding sites.

Cats and specially trained dogs are very effective in controlling rodents under urban conditions, in harbours, warehouses, etc. It has been found that where cats are present, the density of house mice is very low.

4.2.3 *Environmental management measures*

Since the problem of urban vectors and pests results from the deterioration of the environment and its mismanagement, environmental management practices can best provide a permanent solution. Such practices are capable of reducing or eliminating vectors and pests, and are more efficient, more economical in the long-term and more ecologically sound than chemical control methods.

Environmental management for vector control covers a wide range of tasks and operations which have been aptly defined and classified by a WHO Expert Committee (4) and discussed in detail in a WHO publication (5). Table 4 shows the environmental management measures applicable for the control of vectors in different habitats in urban areas. In implementing the recommended vector control measures, biologists and engineers should work together on all aspects of the project.

Environmental management sometimes requires large capital investments while the results often become apparent only after a long time. In urban situations, environmental methods are economical, as the costs and benefits are distributed among a large group of people.

Some of the measures will need to be implemented by development agencies in order to prevent the creation of breeding habitats for mosquitos and other vectors and pests. However, there are also many simple measures aimed at source reduction which the community could undertake on its own. To keep costs low, the activities of the various departments should be coordinated. Proper maintenance is essential for the long-term effectiveness of environmental management measures and, if not done, may lead to a substantial increase in breeding sites of vectors and pests.

4.2.4 *Other methods*

A film of *petroleum hydrocarbons* on the surface of a body of water will prevent mosquito larvae from breathing, while the volatile compounds present lead to anoxia and narcosis.

More than 800 petroleum derivatives were tested between 1964 and 1968 and a formulation 35 times more active than fuel oil was

Table 4. Environmental management measures for vector control in different habitats of urban areas

Type of habitat or condition	Environmental modification		Environmental manipulation		Modification or manipulation of human habitation or behaviour																						
	Deepening and filling	Land grading	Velocity alteration	Impoundment	Cleaning and clearing	Design modification	Clearing of quarries	Recycling of water	Shoreline improvement	Moving outside city limits	Providing water supply	Providing sewerage	Refuse collection and disposal	Improving sanitation	Improving housing	Screening	Sealing	Installing pump	Installing syphon	Regular emptying and drying of water containers	Providing cover	Repairing fixtures	Good housekeeping	Collection and recycling	Health education	Legislation	
Canals																											
Storm-water canals																											
Cement water tanks																											
Roottop water tanks																											
Domestic water containers																											
Water wells																											
Step wells																											
Springs and ponds																											
Ornamental and recreational pools																											
Refuse water receptacles																											
Flower vases																											
Manholes																											
Distribution boxes																											
Water collections or pipe leakages																											
Construction sites																											
Open drains																											
Sewage systems																											

found, namely Flit MLO, which can be used in concentrations of 10–20 litres/ha. This is the most widely used domestic insecticide in the urban areas in many tropical countries.

Monolayers are formed by long-chain aliphatic alcohols, which spread across the surface of water in monomolecular films, reduce the surface tension and thus prevent mosquito larvae and pupae from surfacing to breathe and cause adults to drown as they emerge. They are non-toxic biodegradable products that can be used in dosages of 0.2–1 ml/m². A number of commercial products are currently employed in mosquito control programmes.

The effect of these films is short-lasting, as they are degraded after 24–48 hours by the bacteria in the breeding sites or by mechanical action. Mosquito breeding sites have therefore to be treated at weekly intervals.

Attempts have also been made to reinforce the activity of monolayers by incorporating into them insecticides such as temephos or biological control agents such as *Bacillus thuringiensis* H-14 or *B. sphaericus*. These formulations have proved very effective against *Culex quinquefasciatus* in killing the larvae as well as the pupae. The effectiveness is increased by incorporating the active material into slow-release pellets. However, the cost-effectiveness of the formulations is at present too low for them to be used other than in certain specific situations.

With *polystyrene beads*, the method of control is to cover the breeding sites with a continuous floating layer of these very light beads. This makes it difficult for mosquitos, especially the *Culex* species, to lay their eggs and prevents the larvae from coming to the surface to breathe.

The beads remain on the surface regardless of fluctuations in water level in the breeding sites. In field tests they remained in place for more than two years in pit latrines and brought about a marked reduction in the numbers of *C. quinquefasciatus*, which would seem *a priori* to be an excellent target in urban areas.

Excellent results have been obtained against *C. quinquefasciatus* in cesspits in West Africa, and against *A. stephensi* in disused wells and water tanks in Asia. Being non-toxic, the polystyrene beads can also be used in drinking-water storage tanks.

The use of *fly swatters* to control flies in screened houses, offices, hospitals, and other public places is a well tested and proven method. The famous Chinese fly eradication campaign, in which a similar method was used, is the best recorded example. Physical *hitting and*

clubbing of rodents in low-density areas is another practice reported to be successful.

Mosquito nets provide excellent protection if they are properly used. Similarly, *house screening*, supplemented by health education on the maintenance of screens and the timely opening and closing of doors, reduces the numbers of flying insects invading houses.

In several trials, the impregnation of bed nets, screens and curtains in houses with pyrethroids such as deltamethrin and permethrin has considerably reduced the numbers of nuisance pests and vectors, and also the transmission of vector-borne diseases.

The use of *traps* is the most widely used and recommended method for capturing and killing rodents. Various types of trap are available and have proved quite effective in different countries. A good example of the use of snap traps was in the port of Dalian, China, a city of 4.5 million inhabitants. Traps baited with raw peanuts were used initially to control rodents, and in 1986 the city was the first in China to be reported free of rodents. Traps are recommended where the use of rodenticides is forbidden (kindergartens, restaurants, food establishments, etc.), and where poisoned animals, after dying, could cause unpleasant odours. Their efficiency depends to a great extent on the attraction of the baits used in them.

Considerable progress has been made in developing certain sticky substances for use in traps; these are harmless to people and at the same time help in reducing the number of rodents, cockroaches, flies, etc.

The spectacular results obtained by the trapping of tsetse flies of the *Glossina palpalis* group must be emphasized. The biconical traps recently developed combine the colours white, blue and black, and attract the tsetse fly optically. Originally designed as a sampling device, such traps were soon found to be suitable for control purposes. When they were impregnated with deltamethrin, it was possible to achieve a reduction of more than 98% in the numbers of *G. palpalis* in the gallery forests of Côte d'Ivoire in less than one month.

Attractants such as pheromones or foods included in the composition of baits or in traps have been employed in the control of a number of pest and vector species. The inclusion of tricosene Z has found wide acceptance in toxic baits used against houseflies. Attractants for certain eye gnat species (*Hippelates* spp) in the western hemisphere have been identified and are now used in toxic

bait formulations employed in area-wide control programmes. Food baits attractive to cockroaches are effective in controlling these insects in domestic premises. The use of baits, attractants and traps is highly desirable in urban areas, where complete treatment of infested areas is not required. Baits and attractants can also be used in spot treatments.

Soap repellents containing 20% DEET and 0.5–1% permethrin have produced a striking, if not total, reduction in the number of bites received on areas of skin covered with it, the effect persisting for at least four hours. However, the presence of soap on the skin for a protracted length of time was perceived as uncomfortable by some people.

Recent publicity for *electromagnetic and ultrasound devices* of a variety of makes has claimed that they deter host-seeking or fertilized females of biting insects by producing sounds similar to those emitted by males. This effect has not been corroborated by scientific experiments, and some of these gadgets would appear to attract rather than to repel.

Low-voltage electrocution is suitable for fly and rodent control in large enterprises for the processing and storage of foodstuffs, where toxic agents cannot be applied.

4.2.5 *Integrated vector control strategies*

The subject of integrated vector control was reviewed at the meeting in December 1982 of the WHO Expert Committee on Vector Biology and Control (6) which reported that:

Integrated vector control can be considered as the utilization of all appropriate technological and management techniques to bring about an effective degree of vector suppression in a cost-effective manner. In this sense, integrated vector control is not a new concept in the field of vector control for the suppression of diseases. During the latter part of the nineteenth century and the early part of the twentieth century, when the role of vectors in the transmission of diseases was conclusively demonstrated and accepted, recommendations for vector management and control included: (1) personal protection, i.e., screening and use of repellents; (2) habitat management and source reduction, i.e., draining water-sources and getting rid of artificial breeding-sites; (3) the use of insecticides both as larvicides and adulticides; (4) an appreciation of the possibilities of biological control by recognizing the role of fish in reducing [mosquito] larval numbers; and (5) training and education.

The design and implementation of integrated vector control strategies will vary with the type of programme for which they are intended. The approaches adopted will vary with the disease, the

vector, the geographical location, and with the type of human habitation. Integrated vector control can be used in a variety of implementation schemes—for example, through community participation in a planned programme for the control of vector-borne diseases. It can also be used in programmes dealing with larger population segments, e.g., large urban centres where several vectors and more than one disease are involved. Finally it can be applied as part of large programmes that are, of necessity, designed for the control or elimination of a single disease. It is important that the selection of control methodologies should be based on ecological, environmental, safety and cost-benefit considerations.

4.3 Constraints

The implementation of urban vector and pest control measures currently encounters a number of difficulties, of which the most fundamental is the inability of the urban authorities to cope with the ever-increasing demand for basic environmental services resulting from unplanned urbanization. This difficulty is still further increased by a number of other factors, discussed below.

(1) Lack of political will and of vigorous and enlightened leadership leads to a low priority being given to investment in basic services, including vector and pest control, which do not generate revenue.

(2) Inadequate financial resources prevent investment in environmental measures and the funding of vector and pest control services, resulting in insufficient and inappropriate pesticides and equipment, and lack of transport and trained personnel.

(3) Current urban vector and pest control programmes often lack the entomological units needed if they are to be properly implemented because sufficient numbers of qualified vector control personnel are not available. This is the consequence of the failure to attract and motivate entomologists by providing attractive career prospects in vector control services.

(4) Inadequate technical knowledge and guidance at both the ministerial and operational levels are often responsible for failure to implement vector control programmes successfully. Thus wrong decisions with regard to pesticide formulations and active ingredients and failure to consider the insecticide resistance

spectrum of vectors lead to programme failure and wastage of resources. Failure to monitor and evaluate vector and pest control programmes effectively means that information on performance and cost-effectiveness is not obtained.

(5) Inadequate legal guidelines and support for the prevention of vector and pest breeding in and around urban areas impedes the implementation of control programmes. If field officers responsible for compliance with the law fail to receive adequate legal training, their effectiveness in enforcing health regulations is reduced.

(6) Inadequate intersectoral coordination between the ministry of health, the municipal and other urban authorities, those responsible for urban planning, departments of the environment and tourism, the transportation and telecommunications authorities and the private sector adversely affects the efficient implementation of urban vector and pest control programmes.

(7) Lack of health education and information on insect vectors, pests and rodents, the diseases that they transmit and the appropriate control measures, prevents the community from actively participating in the management of its own environment.

5. TYPES OF URBAN VECTOR AND PEST CONTROL PROGRAMMES

Urban vector and pest control programmes differ markedly in organization and management not only between developed and developing countries but also within them. Within developed countries, the differences are largely in respect of administration, whereas within developing countries they generally relate to the prevalence of vector-borne diseases and the availability of manpower and financial resources. In temperate areas, control programmes are concerned mainly with pests, whereas in tropical areas control of vectors receives priority. The population and size of the urban areas involved are also important factors influencing vector and pest control programmes.

5.1 Countries in temperate areas

In general, vector and pest control programmes in developed countries employ smaller numbers of personnel than those in

developing countries since it is more cost-effective to use equipment, such as aircraft, power-sprayers and tractors than manpower, and at the same time greater reliance can be placed on the legal enforcement of health regulations. In the USA for example, the relevant services are either provided by local health departments or by a wide variety of other agencies. The vector and pest control programme may be a separate division, responsible to the health director within the local health department, but is more commonly a part of the division of sanitation or environmental health. In some states, mosquito abatement districts have been formed in response to demands by taxpayers; these are discussed in greater detail on p. 46. Private organizations, e.g., power companies, as well as government agencies, e.g., agricultural services, parks, recreation and public works departments, also work closely with local health departments and thus contribute towards effective urban vector control. In the greater part of the USA, the existing organization and management, supported by good public health services (piped water supply and waste disposal and treatment), ensures satisfactory control of urban vectors and pests.

In the United Kingdom, vector-borne diseases are virtually absent and the emphasis is mainly on pest control. This is achieved through the local authorities, which are responsible for implementing the Prevention of Damage by Pests Act, 1949. The local authorities, in response to complaints by the public, detect and destroy rodents and other pests of public health importance free of charge in all domestic premises. The necessary funding is obtained through the general rates levied annually on ratepayers by the local authority, which is also responsible for the control of sewer rats. In the case of commercial premises, a charge is made by the local authorities for the control of pests; alternatively, the work may be carried out by private pest control contractors.

In a number of socialist countries, pest control measures come within the purview of the ministry of health. Control is the responsibility of special services attached to the hygiene-epidemiological inspectorates. An inspectorate is located in every district or principal town; and includes departments of disinfection, vector control (disinsection) and rodent control (deratting). The departments are funded through annual agreements with state and economic enterprises, factories, and private individuals who request services.

5.2 Countries in tropical areas

Most countries in tropical areas have sufficient resources to tackle outbreaks of disease as they occur, but not the means of providing efficient day-to-day vector and pest control in urban areas. Case studies of 26 cities (7)¹ indicated that vector-borne diseases were still present in 85% of them. Among tropical countries, however, Singapore provides an outstanding example of the successful control of urban vectors and pests. The vector control programme in Singapore is an integrated one, emphasis being placed on the permanent elimination of vector breeding sites through environmental measures, source reduction, public health education and law enforcement. Pesticides are used only in situations where it is necessary to destroy vectors rapidly, e.g., during epidemics. All vectors and pests of public health importance are systematically controlled under the programme. Effective management of the programme, strong legal enforcement of health regulations and emphasis on environmental management and health education, as well as appropriate levels of government funding, contribute significantly towards the effective control of vectors and pests in the country.

5.3 Single-disease control programmes

In most developing countries, vector control in urban areas is undertaken as part of a vertical disease-control programme, often directed against a single disease in an isolated approach. Such a programme consists of two parts: (1) case detection and chemotherapy; and (2) interruption of transmission through reduction of man-vector contact. The method of vector control is usually that of routine chemical control, without regard to long-term solutions. These programmes, because of their isolation, lead to wastage of resources, including manpower and equipment. Moreover, environmental management aspects are not generally taken into account in these single-disease control programmes. Since such vertical programmes do not take account of local ecological conditions and the priorities of the community, they tend to discourage community participation and intersectoral collaboration.

¹ SMITH, A. & GRATZ, N.G. *Urban vector and rodent control services*. Unpublished WHO document, VBC/84.4.

Two examples of such programmes are the malaria and filariasis control programmes carried out in many countries. Such programmes are invariably carried out by the ministry of health, have a high degree of autonomy, independent budgets, and also receive support from international organizations. With the existing structures, the funds voted for such programmes cannot be used for any other activities, so that there is duplication of technical staff, entomological and laboratory facilities and equipment. In addition, each programme carries out its own case detection and chemotherapy activities for parasite control purposes.

In the case of mosquito-borne diseases, particularly in urban areas, such programmes are not in a position to undertake activities contributing to permanent solutions, such as the elimination of breeding sites, as such activities fall within the competence of the local authority.

5.4 Mosquito abatement districts

Mosquito abatement districts in the United States of America are pest or vector control agencies, established at the request of the community and financed by taxes. The enabling legislation allowing them to be set up, outlines their powers and duties, which include the selection and implementation of vector control procedures and methods. Each has an appointed or elected board of directors that advises on policy, goals and objectives, and is staffed by qualified management, technical and operational personnel, including entomologists and biologists. These agencies have been successful in reducing mosquito numbers and cases of disease over the years. For reasons of efficiency, considerable reliance is placed on specialized equipment, so that there is a high degree of mechanization. All mosquito abatement districts carry out integrated vector control, to which public education and land-use planning to prevent the formation of vector breeding sites in new developments are being increasingly added. Intersectoral collaboration is an essential feature of the activities of these agencies, because many of the large mosquito breeding sites are located on facilities operated by other government bodies. Some applied research is also carried out by the mosquito abatement districts to deal with specific problems. Reporting and programme evaluation are important elements in ensuring that goals and objectives are achieved. A yearly summary of operations is prepared for the board of directors and other

groups. Training of personnel at all levels is becoming of increasing importance and may be made mandatory by the Federal Government. Managers are the key to organizational effectiveness and ensure that vector control is an integral part of community health.

5.5 Role of municipalities in urban vector and pest control

The administration of large cities, urban areas, towns and villages through a system of local government is a well established practice in most parts of the world. Under this system, the municipal council established by the Government in each municipality is charged with the regulation, control and administration of all matters relating to public health, utilities and thoroughfares, and generally with the protection and promotion of the comfort, convenience and welfare of the people, and the amenities of the municipality. Among the many powers and duties vested in the municipal council by law, some that have direct relevance to vector control and public health are discussed below.

5.5.1 General powers and duties of a municipal council

Municipal councils are required to:

- promote public health, welfare and convenience in general, and the development, sanitation and amenities of the municipality;
- abate all nuisances;
- establish and maintain a public water supply system;
- maintain and cleanse all public streets and open spaces vested in the council or committed to its management;
- enforce the proper maintenance, cleanliness and repair of all private streets;
- supervise and provide for the growth and development of the municipality by the planning and widening of streets, the preservation of open spaces, and the execution of public improvements;
- establish and maintain (to the extent possible with the resources available) any public utility which it is authorized to operate under the legislation governing municipal councils, and which is required for the welfare, comfort or convenience of the public.

5.5.2 Powers and duties in respect of public health

The municipal council is the general public health authority for the municipality. To enable it to carry out its duties in respect of public health, the legislation generally provides that, subject to the powers and responsibilities assigned by law to any other authority, the municipal council is the general authority responsible for promoting and maintaining public health within the municipality.

By virtue of the legal powers vested in the municipal council, it is responsible within the municipality for the following:

- the control of infectious diseases and epidemics;
- services for the proper sweeping and cleaning of streets, collection and removal of all household refuse, cleaning and emptying of all latrines and cesspits;
- the proper disposal of all street refuse, household refuse and night soil;
- latrines and toilets;
- the sanitation of buildings;
- surface and underground drainage systems for storm water and waste water;
- natural water courses, swamps and lakes.

Of the various departments of the council, those most directly concerned with vector control and public health are the public health and public works departments, whose health and engineering staff are technically qualified and able to direct and supervise a vector-control programme.

The municipality is generally divided into a number of wards or other units which are grouped together into districts for purposes of decentralization.

The municipal council has the power to promulgate by-laws to enable it to perform its statutory functions and duties within its area of authority and to ensure compliance with its legal requirements.

In addition to the powers vested in a municipal council by the legislation establishing it, power is also delegated to it under the legislation on public health to implement the provisions on public nuisances, quarantine and the prevention of diseases, food hygiene, the control of mosquito-borne diseases, housing and town planning, and the like.

6. PLANNING OF FUTURE URBAN VECTOR AND PEST CONTROL PROGRAMMES

In the planning of future urban vector control programmes, the following concepts need to be incorporated.

6.1 Comprehensive vector and pest control

The concept of primary health care implies a comprehensive health care system. Vector control in primary health care should take the form of an all-inclusive programme and not be fragmented into programmes for single diseases. Thus a comprehensive vector control programme should include all the control programmes for the individual diseases and cover all vectors and pests. The scope of such a programme will depend on local conditions and priorities, but in general will include:

- urban planning;
- environmental engineering, sanitation, and management;
- existing single and multiple disease-vector programmes, equipment and manpower;
- collaboration with nongovernmental organizations and the community;
- legislation;
- health education; and
- any other related activity that may be needed.

A comprehensive control strategy encompassing various vectors and pests will have the obvious advantage of making more rational use of resources. In addition, multipurpose health workers should be preferred so as to prevent visits to the same family, premises, or areas by a number of different specialist workers. A multipurpose health worker who is in a position to deal at the same time with many of the problems of a particular family will also be more acceptable to it. The team work required by such an integrated approach does not develop of its own accord however, particularly among workers with different backgrounds whose training has prepared them for working independently rather than as members of a team. A deliberate effort to create a properly functioning unified organization, together with a sense of collective responsibility and an appreciation of the value of good team work or partnership is indispensable, as well as the development of leadership training.

Vector control operations are labour intensive and therefore require sound organization and management. Daily supervision and technical guidance and support are also needed so as to ensure that the work assigned has actually been carried out and the correct procedures used. The problems of low standards and poor quality, resulting in inadequate performance and reduced effectiveness, need to be tackled vigorously. It is also sound practice in the management of vector control operations to keep the functions of inspectors and operators separate. To facilitate the operation and supervision of a vector control service, a multivalent technical core group (see p. 56) is necessary to support and collaborate with the vector control activities. Training of the workers, technical guidance, support and coordination are all essential. Within the primary health care system, the reorientation and retraining of personnel (*inter alia* in managerial skills), the reallocation of resources, intra- and inter-sectoral coordination, and the promotion of community development and participation should be emphasized. The understanding and cooperation of everyone concerned should be sought and their special interests given full consideration within a coordinated comprehensive vector and pest control programme.

6.2 Involvement of nongovernmental organizations and the private sector

Nongovernmental organizations can provide valuable support to environmental sanitation and vector control in the urban setting, and provide an essential link between government officials and the community.

Where the government's resources are limited and it is unable to provide the manpower required for work with the people at the grassroots level, the nongovernmental organizations can be invaluable in augmenting its efforts. These organizations can play a leading role in urban vector and pest control in areas such as health education, increasing public awareness and promoting community participation.

Nongovernmental organizations need the support and recognition of the government and of international agencies if they are to play a significant role in urban vector control. Such support may take the form of financial or technical assistance.

The private sector, in the form of private pest control undertakings, wherever they exist, can also be used to augment the government's vector and pest control activities.

6.3 Political will and legislation

The successful implementation of an urban vector and pest control programme depends chiefly on the determination of the government, which will depend in turn on its awareness of the economic and social benefits that such programmes can bring. In this connection, a strong political will is essential in ensuring that a long-term, viable and practical programme is implemented. Governments must also define their responsibilities in providing the necessary financial, technical, and administrative support for the programme. The ultimate objective will be to ensure that the vector and pest control programme becomes an essential part of the overall national environmental and public health programme.

Legislation can serve as an important tool in supporting, promoting and maintaining vector control activities at the community level, particularly in urban areas. Before legislation is introduced, governments should provide all the necessary infrastructure and machinery to control vector and pest breeding. A mass public health education campaign should also be undertaken in order to:

- (a) secure public acceptance of the proposed new legislation;
- (b) highlight the role of the public and the importance of their participation in the overall vector and pest control programme.

Legislation should satisfy the requirements of the vector control programme and, at the same time, be compatible with the political, cultural, social, and economic situation in the country. Enforcement of the legislation must be supported by health education. It should not be viewed as a means of generating revenue. Appropriate legislation will not only facilitate health education but will also promote the participation of those individuals who are reluctant or unwilling to comply with the recommended control measures.

6.4 Community participation

It is well known that health programmes can never succeed without the participation of the community. This applies

particularly to vector control programmes, especially in the urban areas of developing countries when the control measures have to be applied in and around the homes of individual families as well as factories, shops, institutions and public places.

Vector proliferation in urban areas is often associated with human activities. The inappropriate behaviour and life-style of urban dwellers usually aggravate the deterioration of environmental sanitation and thus increase vector proliferation. A change in human behaviour is therefore often needed if sanitary conditions are to be improved and breeding habitats reduced. This can be achieved if individuals, families and communities are made aware of the detrimental effect on their health of their careless behaviour. Moreover, the concentration of the population in urban and periurban areas offers abundant manpower resources which can be exploited for health development provided that people are motivated to assume greater responsibility for their own health and welfare.

Community participation is understood and interpreted in different ways in different countries, and is greatly influenced by the overall political structure and social and economic situation. Community members may be motivated to contribute in cash or kind, to support certain projects and, as a minimum, to take a positive attitude to vector and pest control. However, long-term participation can be achieved only if communities realize or are made to realize that a problem exists and that there are advantages to be gained by dealing with it.

By actively participating, individuals become agents in improving their own health and come to realize that, for the benefit of the community, they have to obey certain rules and regulations.

In addition to a sense of well-being, community participation brings about a favourable attitude towards change in the community. The community becomes aware that the unpleasant conditions from which it is suffering can be changed by its own efforts.

Once initiated, community participation requires continuous governmental and organizational support, otherwise it will not be long-lasting. The government's responsibility for developing health services and facilities is therefore not reduced. On the contrary, community participation needs the guidance and active interest of the government and can be sustained only through the constant motivation provided by the successful results of their joint efforts or by relevant organizations and agencies. In particular, municipalities

must provide clear advice to the public as to how refuse should be disposed of. The political will of the government is of vital importance in this connection and it is of prime importance that the government should adopt community participation as a national policy for promoting health development.

In some countries, community participation in health matters usually takes the form of occasional campaigns, during which the combined efforts of those concerned achieve certain objectives and produce a number of noticeable effects. These campaigns may need to be repeated in order to preserve what has been achieved. After each campaign, continued community participation is also indispensable for the consolidation of the gains made.

Health activists play an important role in encouraging people to keep the house and environment clean and to destroy pests. Routine sanitary and other health work may also be carried out by activists on a voluntary basis or by other workers subsidized by the community.

It is difficult to give an exhaustive list of control measures in which communities and individuals can participate, but such measures might include. The filling up of borrow pits and small ponds, the levelling of ground, the cleaning of drains and sewers by the removal of silt and refuse, the removal of aquatic weeds, the dumping of garbage and refuse on street corners for bulk collection and the clearing of vacant lots. Where urban and rural areas adjoin one another, dunghills may be removed, and nightsoil buckets or jars either moved away or covered.

A well informed community may also be involved in the control of pests by methods such as larviciding and residual and space spraying. They may also be educated to screen their houses, use mosquito nets and also impregnate them with insecticides, use traps and swatters for fly control, rear and use fish for mosquito control and apply household pesticides in a cost-effective way.

It is essential for governments and communities to be convinced that motivation, cooperation and participation in the fight against the common enemy can be achieved only in a spirit of partnership among equals.

6.5 Intersectoral collaboration

Intersectoral collaboration implies the establishment and maintenance of cooperation among all agencies, including

ministries, government departments, statutory boards, nongovernmental organizations, the private sector, universities, international and regional organizations. It should be initiated at the highest level of the ministry concerned. The highest political authority, such as the office of the president, prime minister, or the ministry of planning, should coordinate the activities so as to ensure that collaboration is maintained.

Intersectoral collaboration in vector control within the primary health care system has been reviewed by the WHO Scientific Working Group on Vector Control in Primary Health Care (7).

The activities of many agencies, such as those concerned with telecommunications, water supply and drainage, highways, electricity, railways, ports, etc., are directly relevant to the breeding and spread of urban vectors and pests. In addition, the carrying out of such activities in collaboration with the vector control agency could help in controlling the breeding and spread of these vectors and pests.

In the development plans for all sectors of the economy, due consideration should be given to vector and pest control requirements within the area concerned.

Intersectoral collaboration should commence with an improvement in the exchange of information between sectors in order to determine priorities.

In any plan for implementing intersectoral collaboration, those responsible should:

- (a) Describe the kind of intersectoral collaboration envisaged;
- (b) Describe the programme goals, objectives, strategies, monitoring, evaluation and funding;
- (c) List and describe the roles of each sector to be involved in the programme;
- (d) Describe how each sector will perform its role;
- (e) Ensure that the different sectors recognize that their inputs are essential; and
- (f) Assess and analyse government policies that promote or hinder collaboration.

6.6 Primary health care strategy

Primary health care is a means of providing an acceptable standard of comprehensive care that is also economically practicable and constitutes a rational and equitable way of using the limited

resources available. It involves a large number of inter-related activities in the various sectors and is essentially programmatic in form. The operations of the primary health care system must be directed by a unified management, which is also a mechanism for supervising performance at the various operational levels and for avoiding duplication of effort.

6.6.1 *Primary health care in urban areas*

The rapid growth of urban centres and the continued and increasing rate of urbanization with their attendant socioeconomic and health problems impose severe stress on housing, the water-supply services and the services for the disposal of both liquid and solid wastes. In addition, increasing environmental pollution poses a growing threat to living conditions and aggravates the existing health problems associated with vector-borne diseases. The unplanned growth of adjoining periurban areas on the outer fringes of urban centres also poses similar problems. Primary health care in both urban and rural areas is an appropriate strategy for achieving universal coverage on an equitable basis¹ and is largely concerned with the unserved and underserved groups of urban populations living in poor environmental conditions which, particularly in developing countries, give rise to various serious health problems, including vector-borne diseases.

6.6.2 *Vector control within primary health care*

It is recognized that the nature and magnitude of vector control activities in primary health care differ from one country to another and even in different geographical regions of the same country, depending on the technical feasibility of control and the priority given to vector-borne diseases. The existing control strategy is different for the different vectors and requires a more generalized approach that may not be compatible with a primary health care system primarily centred in and around households. In most urban situations, the breeding foci inside and outside houses are man-made. Communities can help themselves and the vector control programme by eliminating such breeding places and using the inputs

¹ UNICEF/WHO *Interregional Consultation on Primary Health Care in Urban Areas, Manila, Philippines, 7-11 July 1986*. Unpublished WHO document SHS/IHS/86.1.

provided by the government whenever necessary. The success of community participation will, to a large extent, depend on the methodology adopted for the programme. The simpler the methodology, the greater will be the programme's success. Its acceptability will also be greater if the minimum demand is made on the time and resources of community.

6.6.3 *Vector control core group*

The WHO Expert Committee on Vector Biology and Control recommended in its seventh report (6) that:

1. As an integral part of community participation in activities to control vector-borne diseases, and to support the delivery of primary health care, a core group should be provided at ministry level (or at regional level in larger programmes) with the duties of planning, coordination, provision of technical support, and surveillance of integrated vector control programmes.
2. A further duty of the core group should be to communicate information to enable the community to determine priorities relative to vector control, as it is recognized that a community may perceive different priorities from those identified by technical experts.

The WHO Scientific Group on Vector Control in Primary Health Care (7) recommended that:

Every country with vector control programmes being implemented through primary health care programmes or every country planning such programmes should form a core group of professionals that is capable of providing all aspects of the necessary technical support to every level of the primary health care system.

In view of the importance of mosquitos as the vectors and pests of greatest concern in the urban situation, and of environmental sanitation as a control measure in dealing with urban vectors and pests, the core group should consist of a public health administrator or medical officer of health, an entomologist, a sanitary engineer or public works engineer, an urban planner, and a health educator. It should be strengthened as appropriate, in the light of the special problems or diseases in a particular urban situation, and should consist of members of the staff of the authority responsible for vector control in the urban area concerned. If this authority is independent of the ministry of health, it should establish links with that ministry as well as with any other agency or organization involved in dealing with vector and pest problems in the area.

6.7 Planned urbanization

The planning of urbanization can help to enhance the quality of life, health and general well-being of urban populations and of migrants from the rural areas who come to live in the cities. Planning should be undertaken by a multidisciplinary group that can provide guidance and establish guidelines for consistent and adequate policy decision-making.

It is also necessary to consider very carefully the most important aspects of planning associated with vector and pest proliferation. Three distinct situations exist: (1) the construction of a new city; (2) the expansion of a neighbourhood or of an existing part of a city; and (3) the growth of small pockets in different parts of the city. These three situations vary considerably in complexity. Thus it is easier to plan for a completely new city, it is moderately difficult to forecast the needs of a new neighbourhood or a sector of a city, but it is extremely difficult to foresee what preventive or corrective measures will be needed for small areas.

Close attention must be given to the technology to be used and to scientific norms and standards, in order to avoid creating or worsening the problems associated with disease vectors, insects, arthropods, pests, etc., as this could seriously affect the well-being of the population or cause major health problems.

The multidisciplinary group in charge of urban planning or of studies to serve as the input for urban planning activities must include physicians, public health personnel, and vector control specialists, particularly biologists trained and experienced in medical entomology, together with sanitary engineers and architects specialized in urban planning.

In existing cities, it is essential to have a data bank containing information obtained from surveys and studies carried out in areas that either have foci of infestation or are capable of generating them. The data bank should also contain information on the underlying causes of such foci, vector density per residential unit, block or hectare, seasonal fluctuations and oscillations, and the relationship between indicators and the incidence of diseases associated with, transmitted, or borne by such vectors. Similar information is also necessary when new cities or boroughs in virgin areas or reclaimed lands are being planned.

6.8 Conclusions

The Committee noted that a municipal council possesses an infrastructure for carrying out its statutory functions and duties and has certain legal powers, many of which relate to environmental sanitation and vector control. It is therefore the ideal body to take responsibility for environmental engineering and management inputs, and the chemical and biological activities required to carry out urban vector and pest control effectively within its area of authority. It is also well placed to motivate residents to help in performing these functions.

However, a municipality cannot carry out an effective vector control programme in isolation from the local authorities of adjacent areas. These are also urban areas, although they do not have the same status as a municipality, and must also carry out a programme of equal effectiveness. Under these circumstances, operational activities covering the entire urban area, with the municipality forming the nucleus and all the local authorities pooling their resources, seems a feasible approach to urban vector control. Such districts could be coordinated through the ministry of local government, which has direct control over all local authorities, and could adopt all the approaches described above.

7. TRAINING OF VECTOR CONTROL STAFF AND PERSONNEL

With the growing complexity of vector control programmes, it is now even more imperative than before that the staff of local and national programmes should be properly educated and trained and possess the necessary technical expertise. The field of vector control is a dynamic one, and changes in philosophy, implementation, and selection of methods are continually taking place. This dynamic situation calls for regular updating and training and continuing education of vector control personnel. This should be carried out at three tiers or levels, corresponding to the different groups of personnel employed by a given agency or programme.

The three levels of training should be adapted to meet the needs and functions of the various personnel groups and the type of programme. For example, personnel and staff having overall managerial and operational responsibility should receive updated information in the general area of vector-borne diseases and vector

control programmes. Since their duties are those of running the general operations and administering and directing the programmes, they should be provided with up-to-date knowledge and information on the effective use of personnel, materials, and facilities. They should have the ability to introduce measures (improvements in administration, introduction of incentives, better communications, etc.) that will ensure that full use is made of the capabilities of their subordinates and technical staff.

The technical staff, who have undergone specialized training in the broad areas of epidemiology, ecology, sanitation, vector-borne diseases, and vector control principles, constitute the second group of personnel. Most of them will have had a university-level education and hold a degree in a relevant discipline, such as biology, entomology, zoology, botany, laboratory science, sanitary engineering, or other fields of specialization in the biological, natural, or biomedical sciences.

The training and education of personnel involved in the conduct of specific vector control programmes are also important. These staff, commonly referred to as technicians, inspectors, and community workers, may have had limited formal education, yet it is they who are directly involved in the application and routine assessment of vector control programmes. Since these activities constitute one of the most important segments of such programmes, it is most important that they should receive timely and appropriate training on new trends and problems in vector control operations.

7.1 Training of administrators and managerial staff

The managerial staff of vector control units, departments or organizations should be familiar with the nature and scope of vector-borne diseases and have a general knowledge of vector biology and ecology and of the major tools employed in vector and pest control programmes. They should receive regular training in interpersonal relationships, administration, budgeting procedures and new management techniques, and should be kept up to date on new developments in vector biology and control. Training should be provided in the form of workshops, seminars, and attendance at meetings of scientific and professional organizations at the local, national, regional, or international level.

7.2 Training of technical staff

The initiation and implementation of vector control programmes, in addition to requiring financial resources, administrative skills, and government support, also require a high level of technical competence and a basic understanding of vector biology and control, and of the epidemiology of vector-borne disease. The technical staff should have the competence and ability to assess the performance of vector control programmes and to be able to detect failures if and when these occur. They will therefore need additional training appropriate to their duties and functions. Such training is essential for all technical staff, but especially for those who have not had specialized training or education in medical entomology, medical zoology, vector biology and control, and the epidemiology of vector-borne disease. Training in the disciplines and subdisciplines considered below will be necessary to enable technical staff to discharge their duties effectively and to supervise, direct and interact with operational personnel, such as inspectors, vector control operators and other nontechnical staff. The training and education should be provided by means of courses, workshops, seminars, and field demonstration sessions, and by participation in and attendance at scientific and professional meetings.

7.2.1 Vector biology and ecology

Technical staff should be familiar with the life history, population dynamics, seasonal fluctuations and spatial distribution of important disease vectors in various climatic and geographical zones. A good understanding of vector feeding, resting and dispersal patterns will dictate the selection, timing and scope of vector control methodologies. Technical staff should be familiar with the most recent knowledge and information on the biology and ecology of vectors.

7.2.2 Recognition and identification of vectors

For epidemiological purposes, it is important to be able to recognize and identify the species involved in the transmission of a given disease agent. Training should be provided in the criteria and characteristics used in identification, and the development and use of identification keys. The technical staff should be given instruction on

how to prepare brochures and leaflets on the recognition and identification of vectors.

7.2.3 Biological control methods

Biological control agents are coming into use in certain vector control programmes; their full potential has not yet been realized, however, and it is probable that efforts to make use of such agents will be intensified. Vector control personnel should therefore receive adequate training in the recognition, uses and assessment of efficacy of biological control agents. Since these agents include a large number of different animals and plants, and since knowledge about them is being accumulated at a rapid rate, practical laboratory and field training courses should be made available at appropriate intervals.

7.2.4 Chemical control methods

Chemical agents for vector control continue to be important, and new materials and formulations are continually being investigated. The technical staff of vector control programmes should be aware of new trends in chemical control technology. They should be trained to test and evaluate compounds and formulations under actual field conditions and be able to gather reproducible data on their efficacy. They should possess an adequate knowledge of the chemistry, safety, side-effects and mode of action of various groups of compounds. Some information on environmental implications and effects on non-target organisms should also be included in training courses and sessions.

7.2.5 Techniques

The technical staff of vector control units should be adequately trained in up-to-date vector control techniques and assessment, and in the epidemiology of diseases. They should be familiar with the sampling techniques used in monitoring populations of both vectors and reservoir hosts. They should also be trained in the evaluation and assessment of biological and chemical control agents, under both laboratory and field conditions. Training in the use of equipment and in application techniques and on the design of experiments should also be provided.

The training necessary to detect acquired resistance, to monitor levels of resistance in various populations of vectors, and to interpret the data should be provided. Such monitoring skills will facilitate the detection of resistance at an early stage, and the information obtained will enable those in charge of the vector control programme to change the method of control accordingly.

7.2.6 Data gathering, analysis and interpretation

Technical staff should be trained in, and be capable of gathering scientific data from laboratory and field experiments and operational vector control programmes. The experiments undertaken should have a sound scientific basis. Training in the procedures involved in gathering, compiling and analysing data, and in keeping detailed records should be provided. Technical staff should have the knowledge and ability to analyse the data with the aid of suitable statistical methods.

7.3 Training of inspectors and field and community workers

Personnel involved in the day-to-day operation and implementation of vector control programmes should receive training aimed at updating their understanding and knowledge of vector control programmes. The training should be provided in the form of laboratory and field workshops in which demonstrations are given of vectors, vector control agents, equipment and operational methods. They should be trained by the national staff at such times and places as may be convenient. The areas discussed below should be the subject of local or national training programmes.

7.3.1 Practical aspects of vector biology and control

Staff should be trained and educated in the general principles of vector biology and the administration of different control methodologies in specific situations.

7.3.2 Surveillance and geographical reconnaissance

Field workers should be familiar with sampling techniques for monitoring vector populations (dipping techniques, trapping and collecting procedures). The reading and preparation of maps

showing infested and treated areas, or areas being monitored or evaluated, should be part of the training of field workers.

7.3.3 Use and maintenance of equipment

Operators should receive practical training in the use and maintenance of equipment. They should be instructed in the performance of minor repairs, especially in the field, where workshop facilities may not be available.

7.3.4 Pesticides, formulations, and safe use

Field workers and operators should be given adequate training in the use of the various pesticides and their formulations employed in vector control. They should be informed about the risks and the safety procedures to be adopted in storage, mixing, and application in the field.

7.3.5 Biological control agents

Field workers should receive practical training in the recognition of biological control agents as well as the application and use of such agents in vector control programmes. They should be informed about the proper use of these agents in controlling specific vectors in specific habitats.

8. HEALTH EDUCATION OF THE PUBLIC

Health education of the public is of fundamental importance in launching any health programme and should not be neglected. This is particularly true with regard to vector control in urban areas.

The community health problems, including vector proliferation and vector-borne diseases, resulting from the coming together of large numbers of people during rapid urbanization may either be aggravated or improved, depending on how the population behaves and whether communities participate in the necessary activities. In order to secure community participation, it is necessary to mobilize public opinion and to develop health education programmes geared to the public at large.

8.1 Types of health education

With regard to community participation in vector control in urban areas, the following three distinct yet interrelated types of health education are important:

(a) regular health education aimed at propagating and popularizing scientific knowledge about vectors and their relationship to disease transmission;

(b) health education aimed at disseminating and popularizing knowledge regarding the techniques and control measures that could be implemented by the community;

(c) health education designed to make people understand and become aware of the existing problems, to provide valid information on the ways of solving them, and to motivate people to take part in the abatement of vectors and pests.

8.1.1 *Regular health education*

Regular health education is so important that it cannot be overemphasized. It exerts a subtle influence on ways of thinking, and in the long-term provides people with up-to-date scientific knowledge about the health and well-being of the community. It covers all aspects of health, among which knowledge about vectors and vector-borne disease is particularly important. In most developing countries, regular health education may be carried out through the mass media, such as newspapers, magazines, radio, television, films, plays, posters, community bulletin boards, etc. It should be presented in easily understandable language and in a form acceptable to the people. The information should be both interesting and scientifically sound. The subjects selected should vary with the seasonal variation in vector prevalence.

The health education of schoolchildren is particularly important, not only because children need this type of education but also because, once informed, they often become intensely interested in propagating their knowledge both at home and in the community. Talks and demonstrations should therefore be given regularly to schoolchildren by professional health workers.

8.1.2 *Health education to popularize control measures*

Experience everywhere shows that a community's perception of the situation and the action that it takes, or does not take, determine

the degree of success of a vector control programme. When a community is mobilized and ready to take action, it is necessary to teach it how to act, why particular actions are taken, and what the benefits will be.

Information should be provided by specialists in, for example, the disinfection/disinsection services, vector control units, health departments or municipal vector control and health authorities, so that when a large-scale campaign is launched, people will apply the appropriate methods correctly.

By acquiring technical know-how and participating in campaigns, community members will become skilled in vector control techniques and enthusiastic about such activities. Appropriate technology adapted to the local situation will often be developed and solutions found to hitherto unsolved problems.

8.1.3 *Health education to motivate and sustain community participation*

The carrying out of a health campaign is in itself a form of practical health education of the people. By participating in the campaign, they see what can be achieved and enjoy the benefits gained thanks to their own contributions. However, behaviour and life-styles not conducive to good sanitation and hygienic practices cannot be expected to change rapidly. A constant dialogue between the community and the community health worker and the launching of repeated health campaigns are therefore necessary to maintain people's motivation. Areas achieving the best performance during the campaign can be used as models and representatives from other communities invited to visit such model areas and thereby be made aware of the deficiencies in their own programmes and performance. The personal participation of community leaders in eliminating vectors, e.g., in dredging open ditches and removing refuse dumped on street corners, will also encourage people.

9. APPLIED RESEARCH

Urban vector and pest control is a complex matter, requiring specialized and multiple approaches. To achieve the desired results, a thorough knowledge of the biology, ecology and behaviour of the vector/pest complex is needed. A thorough knowledge of the

epidemiology of the prevailing vector-borne diseases is also necessary if effective and sustained vector control programmes are to be conducted. It goes without saying that all the strategies available should be developed and employed wherever possible in a systematic, appropriate and orderly manner. These strategies include, but are not limited to, environmental management, sanitation, habitat management, biological control, chemical control, the use of attractants, repellents and protectants, etc. In order to improve and implement these and other control methods, operational and applied research programmes are needed, with special reference to the urban ecosystem.

Operational research is concerned with the operational aspects of service delivery, and with ways and means of improving organization and management so as to increase efficiency. The areas covered include staffing patterns and their hierarchical arrangements, logistics and supply, supervision, monitoring and the flow of information, the keeping of records and, for that matter, any other matters involving management. The method of solving the particular problem that emerges from the research must be applied pragmatically; it must also be feasible with the resources available to the organization.

Since vector control programmes are operational in character, their success will depend to a great extent on efficient management. Operational research has a major role in assessing the efficiency of the methods used and in improving them or introducing more effective ones.

9.1 Environmental management

Although environmental management techniques (see section 4.2.3) for a variety of programmes involving water management, solid waste management and crop production are available, additional strategies need to be developed to improve the efficiency of vector control operations. In this context, the role, efficacy and desirability of various environmental techniques should be investigated. Methods within the means of infested communities should be demonstrated and put to use if and when practical.

9.2 Biological control

Biological control methods (see section 4.2.2) will play an important role in the suppression of vectors in urban communities. Microbial larvicides, such as spore-forming bacteria and their formulations, offer good possibilities for the control of domestic and peridomestic mosquitos. Micro- and macroinvertebrate predators are also potentially useful for the control of mosquito vectors. The role of these agents in regulating vector populations remains to be clearly demonstrated, however, in endemic disease areas.

Larvivorious fish adapted to clear-water situations are available for use in water storage containers, wells and standing water. The prolific breeding of urban mosquitos in polluted waters is best controlled by means of a combination of methods such as environmental management, larvivorious fish and chemical control agents. Methods that will be compatible with each other should be investigated and developed and their usefulness in operational programmes documented.

9.3 Chemical control methods

These have been discussed in detail in section 4.2.1.

9.3.1 *Adulticides*

The spraying of dwellings with residual adulticides for the control of vectors, especially mosquitos, is costly and will not be accepted by many urban communities. However, the use of residual applications, space sprays and aerosols both indoors and outdoors may be valuable for the control of other vectors and pests in urban areas. Such approaches may be employed on an area-wide basis if emergency vector control schemes become necessary. However, the efficacy of the equipment and materials used for the control of specific vectors in specific areas should be demonstrated before such measures are adopted.

9.3.2 *Larvicides*

Since mosquitos constitute a very important group of vector/pest organisms, greater attention should be given to the use of new larvicides and larvicidal formulations. Larvicides belonging to the organophosphorus and synthetic pyrethroid groups are highly

effective mosquito control agents. When these compounds are used, however, information should be provided on environmental risks and hazards to non-target organisms. It is also important to investigate and develop the operational use of these compounds and their formulations in such a way that the emergence of acquired resistance is minimized or precluded. The efficacy of new larvicides and their formulations should be demonstrated in operational control programmes.

9.3.3 *Insect growth regulators*

A fairly large number of compounds with novel modes of action have become available in the past few years, some of which have shown exceptional activity against a variety of pests and vectors, such as cockroaches, fleas, biting flies, and mosquitos. The further development of these highly active compounds will provide useful methods of expanding vector control operations; however, their effectiveness needs to be demonstrated in area-wide control programmes.

9.4 **Bioecological research**

A detailed knowledge of the biology and ecology of vectors and their role in disease transmission is necessary if effective vector control programmes are to be initiated and maintained. Such information will make it possible to discover the vulnerable points in the vectors' life processes at which they can be attacked by some appropriate means. Seasonal population trends, density parameters, vector competence, biting behaviour, developmental rates, etc., are some of the variables that need to be investigated in urban areas.

9.5 **Behaviour-modifying factors**

Many vectors, especially those belonging to the phylum Arthropoda, are affected by intraspecific and trans-specific regulating factors. These factors, if identified, could perhaps enable highly specific and effective measures to be developed for the control and management of particular vectors. These factors will probably provide the basis for techniques that can be used in an integrated approach to the control of many vectors. The factors on which further research is needed include pheromones, kairomones,

attractants, repellents, etc., which regulate the reproductive, feeding, resting, aggregation and dispersal behaviour of many disease vectors and human pest species.

The development of traps, baits and other formulations making use of these behaviour-modifying factors should be investigated with a view to controlling specific vectors. Some of these factors, once identified, could facilitate the development of the improved sampling methods needed in the management and control of many vector-borne diseases.

9.6 Protectants and exclusion measures

New measures involving the development and use of agents giving protection from the bites of haematophagous and non-haematophagous vectors and pests are needed. For example, the use of impregnated netting could provide protection from a number of vectors, such as mosquitos, chiggers and ticks. Additional protectants and exclusion measures should be developed so as to provide reasonable protection for individuals in urban and suburban areas at a cost that communities in developing countries can afford.

9.7 Integrated vector control

Research is needed to determine the effectiveness, implementation and timing of different control strategies used as part of an integrated approach. The management of vector organisms and the methodologies selected should be based on entomological, epidemiological, and economic considerations. The use of various techniques in combination will increase the complexity of the control programme; it will nevertheless produce a more effective technology for long-term vector and pest control programmes in urban areas.

10. RECOMMENDATIONS

10.1 Urbanization

The Committee, recognizing the fundamental importance of rapid unplanned urbanization as a result of migration and natural population growth in causing the degradation of the human urban environment, and concerned by the resulting spread of conditions

suitable for the transmission of vector-borne diseases, recommended that greater emphasis should be given to the essential contribution that can be made by appropriate urban and demographic planning in preventing the deterioration of urban and periurban health conditions.

10.2 Environmental management

The Expert Committee agreed that urban vector and pest problems are linked to the mismanagement of the environment. The implementation of environmental management measures will therefore be the most appropriate and cost-effective course of action for eliminating and controlling vectors and pests in urban areas. The Committee therefore recommended that:

(a) An efficient service should be provided for the storage of refuse from each individual residence, as well as both adequate refuse collection and final disposal of wastes. Guidelines and regulations for the operation of sanitary landfills for garbage disposal should be drawn up and enforced.

(b) Efficient services should be provided for the thorough and continuous cleaning of areas where common services are available, such as public markets, slaughterhouses and meat packing-houses, meat and fish markets, and shops selling dairy products.

(c) Industrial undertakings, especially food-processing plants, should be encouraged or compelled to plan and implement the proper disposal of industrial wastes, by-products, and waste-water from their operations.

(d) Permanent breeding sites, such as canals, drainage channels, and public water-storage facilities, should be properly maintained, while semipermanent and temporary breeding sites, such as blocked drains, borrow pits and discarded containers, should be expeditiously repaired or eliminated.

(e) Measures should be taken to prevent dumps, wrecked cars, used tyre disposal sites, etc., from becoming breeding sources for vectors and reservoirs of disease.

(f) In urban areas, the presence of individual water supplies and waste water, e.g., cisterns, containers for storing water, septic tanks, cesspools, etc., creates favourable conditions for the proliferation of vectors and pests. Measures must therefore be taken to prevent them from becoming a source of vectors.

(g) Building codes and standards relating to construction procedures should take into account vector and pest problems that may arise during and after construction, e.g., in construction sites, elevator shafts, ducts in garages, tanks, etc. During the course of urban planning and development, engineers and planners should seek information from biologists and entomologists with a view to preventing the proliferation of vectors.

10.3 Biological control

Among the currently available vector control methods, biological control measures could provide a cost-effective component of an integrated approach to vector and pest control in urban areas. The relative safety of biological control agents for non-target aquatic fauna and higher organisms render them suitable for use by communities as a self-help method requiring minimal supervision. Currently available agents are effective against the immature stages of mosquitos, and this is an advantage in that the breeding habitats of many mosquito vectors in urban areas are closely associated with human habitations and are easily located and treated by the community. The Committee therefore assigned special significance to the use of biological control agents in urban areas and made the following recommendations:

(a) Procedures should be developed to breed larvivorous fish at the local level so that they can be distributed to communities for introduction into mosquito breeding sites.

(b) Emphasis should be placed on the use of indigenous fish, if possible, for the control of urban and periurban mosquitos.

(c) Microbial control agents, such as bacteria, should be employed in preference to chemical control agents because of their proven activity against pests and vectors, safety, and persistence.

(d) Biological control agents should be used as a component of larviciding programmes in urban areas, emphasis being placed on the use of microbial agents in conjunction with naturally occurring predator organisms.

10.4 Future organization of vector control

Having critically examined the existing organizational patterns of urban vector control programmes, such as single-disease oriented programmes, mosquito abatement districts, and activities under

municipal administration, the Committee came to the conclusion that a comprehensive approach to the control of vectors, pests and vector-borne diseases would be cost-effective, especially in economizing in manpower and other resources.

The Committee also recognized that primary health care is an appropriate strategy that is just as applicable in urban as in rural areas for achieving universal coverage on an equitable basis. The basic elements of primary health care, including equity, intersectoral collaboration, community participation and appropriate technology, are all relevant to urban vector control. The Committee therefore recommended that:

(a) Single-disease vector control programmes should be integrated into a unified management system so as to avoid an isolated and fragmented approach and to permit rational utilization of limited resources.

(b) As vector problems in urban areas are intimately related to sanitary conditions, the vector control programme should work in close collaboration with the urban sanitary programme.

(c) The strategy to be adopted for vector control should be selected at the local level in the light of the ecology of the area and the available resources. Local bodies should seek the advice of professionals in developing the strategy.

(d) The assistance given to local bodies should be in proportion to the actual need. Professional bodies should clearly spell out the appropriate method of choice for a particular area.

(e) The local authorities in urban areas, since they obtain their revenue from taxes and are responsible statutory bodies, should be entrusted with both sanitation and vector control. The vector control programme should be routinely reviewed and be held accountable for its operation and finances.

(f) The change from a single-disease to a comprehensive vector control programme will call for the training of multipurpose/polyvalent workers. The use of such broadly trained workers will reduce the duplication of services, ensure optimum use of manpower, and increase rapport with the community.

(g) Since vector control operations are labour-intensive, sound organization, efficient management, adequate in-depth supervision and technical guidance must be provided.

(h) Since collective responsibility and good teamwork are indispensable for effective urban vector control, the understanding

and cooperation of all concerned should be fostered through the coordinated activities of a multidisciplinary core group.

(i) Municipalities should be recognized as the focal points for the commencement of urban vector control programmes, and should be provided with adequate finance, receive the support of the central government, and have an elected council and a district management system. The role of the ministry of health should be essentially that of technical adviser and provider of administrative support and collaboration in all fields, particularly research.

(j) The valuable support of nongovernmental organizations and other appropriate agencies, having good organizational and management capabilities and links with the community, should be harnessed.

10.5 Vector control core group

Appreciating the need for a well trained and informed core group, including vector control specialists, to provide expertise when needed and to promote or carry out any research that may be required to improve technology or to solve specific problems, the Committee recommended that:

(a) A suitable career structure should be established for entomologists and other vector control specialists at both municipality and ministry of health levels.

(b) Core groups should be established at national, regional and district levels.

(c) A core group should consist of a public health administrator, entomologist, sanitary engineer, medical officer, urban planner and health educator.

(d) Core groups should have the authority to approach other sectors on their own initiative in order to establish intersectoral collaboration.

10.6 Training

Having thoroughly discussed manpower needs for urban vector and pest control, the Committee concluded that there was a serious shortage of trained personnel at both the professional and subprofessional levels. In order to overcome this shortage, the Committee recommended that:

(a) Appropriate training of managerial and administrative staff should be provided at the national, regional, or international level. Managerial staff should receive training in management techniques, the planning of operations, personnel use, and budget management.

(b) The training of professional and technical staff in vector-borne disease epidemiology, including surveillance and vector control strategies, should be undertaken at the local and national levels. The professional and technical staff should be permitted and encouraged to attend and participate in meetings on vector control and vector-borne diseases.

(c) Practical training should be provided for vector control operators carrying out day-to-day vector and pest control operations.

(d) Since vector proliferation can be prevented by the proper design and planning of housing, streets, and waste management systems, courses on vector control and vector-borne disease should form part of the curricula in the training of engineers and planners.

10.7 Research

The Committee considered the present status of vector control programmes and concluded that many safe and effective vector control strategies were available for use. However, lack of adequate information on the field efficacy at the local level precluded the incorporation of alternative methods in vector control. Recognizing this fact and the need for a multistrategy approach, the Committee strongly supported additional research at the field level and recommended that:

(a) Relevant applied and operational research should be carried out on the cost-effectiveness of single or multiple vector control strategies and the integration of various methods in the control programme, including large-scale field trials on promising chemicals, and on biological and physical control measures.

(b) Promising biological control measures should be tested and used in all situations.

(c) The most effective and practical formulations should be selected, based on the results of field research on the operational aspects of their use.

(d) Methods of protection from vectors should be tested in the field.

(e) Further studies should be carried out aimed at developing spraying equipment more suitable for operational use in urban vector control.

10.8 Community participation

It became evident to the Committee that action by governments alone was insufficient to control urban vectors and pests and that communities should set their own priorities, be more self-reliant and participate actively in their own protection. Many vector control operations are labour-intensive and would benefit from the manpower resources available within the community. The Committee therefore recommended that:

(a) Steps should be taken to ensure the involvement and active participation of communities in the planning, execution and, where possible, the evaluation of vector control activities, including the involvement and participation of various social organizations.

(b) The usual welfare approach, in which government provides all public services including vector control, should give way to a developmental approach, in which government collaborates with the community in self-help activities in accordance with the community's own priorities, and only provides services of a general nature and large-scale control programmes beyond the capability of the community.

(c) An income-generating approach, such as pisciculture or the use of refuse to generate biogas, should be promoted so as to obtain the ready cooperation and sustained involvement of the community.

10.9 Health education

Realizing that health cannot be thrust on people and must be achieved by their own efforts and with their cooperation, the Committee stressed that health educational activities must be promoted and carried out by all health workers in order to win the confidence of the community and through a continued and sustained dialogue bring about a change in its attitude towards healthy living. The Committee therefore recommended that:

(a) Training should be provided to vector control personnel on appropriate health education approaches and techniques relevant to seeking and motivating community participation.

(b) The mass media and special educational materials should be used to inform, educate and increase awareness of vector-borne diseases.

(c) School curricula should include material on basic measures for avoiding, preventing, and combating vectors and pests. Information on preventive and control measures should also be made available to individual families and to community or neighbourhood associations.

10.10 Legislation

In the course of its deliberations, the Committee recognized that the most successful urban vector and pest control programmes derive great strength from the support of adequate legislation and its enforcement, as well as from community interest and participation. The Committee therefore recommended that authorities wishing to implement successful urban vector and pest control should review relevant existing legislation and, where necessary, adapt it to the current socioeconomic and cultural situation, with suitable provision for its effective implementation.

ACKNOWLEDGEMENTS

The Expert Committee wishes to record its appreciation of the considerable contribution made by Dr C.P. Pant, Chief, Ecology and Control of Vectors, WHO, Geneva, to the planning and organization of the meeting, and to express its regrets that he was unable to attend for health reasons. The Committee acknowledges the assistance in its work provided by the following who made valuable written and oral contributions during its deliberations: Mr R. Bahar, Planning, Management and Operations, WHO, Geneva, Switzerland; Dr I.A.H. Ismail, Ecology and Control of Vectors, WHO, Geneva, Switzerland; Dr D.A. Muir, Malaria Action Programme, WHO, Geneva, Switzerland; Dr M. Nelson, WHO Regional Office for the Americas, Washington, DC, USA; Dr G. Quélenec, Ecology and Control of Vectors, WHO, Geneva, Switzerland; Dr H.R. Rathor, WHO Regional Office for the Eastern Mediterranean, Alexandria, Egypt; Dr C. Ravaonjanahary, WHO Regional Office for Africa, Brazzaville, Congo; Mr G.R. Shidrawi, Ecology and Control of Vectors, WHO, Geneva, Switzerland; Dr I. Tabibzadeh, National Health Systems and Policies, WHO, Geneva, Switzerland.

It also acknowledges the valuable written contributions from: Dr Jun Akiyama, WHO Regional Office for South-East Asia, New Delhi, India; Dr J. Mouchet, Office de la Recherche Scientifique et Technique d'Outre-Mer (ORSTOM), Paris, France; Dr A. Nadim, WHO Regional Office for the Eastern Mediterranean, Alexandria, Egypt; Dr L.S. Self, Disease Vector Control, WHO Regional Office for the Western Pacific, Manila, Philippines.

The Committee also wishes to thank the following WHO staff members who participated in some of the plenary sessions: Dr R. Bos, Division of Vector Biology and Control; Dr J.F. Copplestone, Pesticide Development and Safe Use; Dr P. de Raadt, Parasitic Diseases Programme; Dr B. Dobrokhotov, Ecology and Control of Vectors; Dr R. Le Berre, Ecology and Control of Vectors; Mr R. Novick, Responsible Officer, Environmental Health in Rural and Urban Development and Housing; Dr R. Plestina, Pesticide Development and Safe Use; Dr A. Prost, Epidemiologist, Division of Environmental Health.

REFERENCES

1. *Sixth report on the world health situation. Part I: Global analysis.* Geneva, World Health Organization, 1980.
2. WHO Technical Report Series, No. 718, 1985 (*Environmental pollution control in relation to development: report of a WHO Expert Committee*).
3. WHO Technical Report Series, No. 679, 1982 (*Biological control of vectors of diseases: sixth report of the WHO Expert Committee on Vector Biology and Control*).
4. WHO Technical Report Series, No. 649, 1980 (*Environmental management for vector control: fourth report of the WHO Expert Committee on Vector Biology and Control*).
5. *Manual on environmental management for mosquito control with special emphasis on malaria vectors.* Geneva, World Health Organization, 1982 (WHO Offset Publication, No. 66).
6. WHO Technical Report Series, No. 688, 1983 (*Integrated vector control: seventh report of the WHO Expert Committee on Vector Biology and Control*).
7. WHO Technical Report Series, No. 755, 1985 (*Vector control in primary health care: report of a WHO Scientific Group*).

**WORLD HEALTH ORGANIZATION
TECHNICAL REPORT SERIES**

Recent reports:

No.		Sw. fr.
706	(1984) The uses of epidemiology in the study of the elderly Report of a WHO Scientific Group on the Epidemiology of Aging (84 pages).....	8.—
707	(1984) Recommended health-based occupational exposure limits for respiratory irritants Report of a WHO Study Group (154 pages).....	14.—
708	(1984) Education and training of nurse teachers and managers with special regard to primary health care Report of a WHO Expert Committee (54 pages).....	6.—
709	(1984) WHO Expert Committee on Rabies Seventh report (104 pages).....	9.—
710	(1984) Evaluation of certain food additives and contaminants Twenty-eighth report of the Joint FAO/WHO Expert Committee on Food Additives (44 pages).....	5.—
711	(1984) Advances in malaria chemotherapy Report of a WHO Scientific Group (218 pages).....	20.—
712	(1984) Malaria control as part of primary health care Report of a WHO Study Group (73 pages).....	8.—
713	(1984) Prevention methods and programmes for oral diseases Report of a WHO Expert Committee (46 pages).....	5.—
714	(1985) Identification and control of work-related diseases Report of a WHO Expert Committee (71 pages).....	7.—
715	(1985) Blood pressure studies in children Report of a WHO Study Group (36 pages).....	5.—
716	(1985) Epidemiology of leprosy in relation to control Report of a WHO Study Group (60 pages).....	6.—
717	(1985) Health manpower requirements for the achievement of health for all by the year 2000 through primary health care Report of a WHO Expert Committee (92 pages).....	8.—
718	(1985) Environmental pollution control in relation to development Report of a WHO Expert Committee (63 pages).....	6.—
719	(1985) Arthropod-borne and rodent-borne viral diseases Report of a WHO Scientific Group (116 pages).....	10.—
720	(1985) Safe use of pesticides Ninth report of the WHO Expert Committee on Vector Biology and Control (60 pages).....	6.—
721	(1985) Viral haemorrhagic fevers Report of a WHO Expert Committee (126 pages).....	10.—
722	(1985) The use of essential drugs Second report of the WHO Expert Committee on the Use of Essential Drugs (50 pages).....	6.—
723	(1985) Future use of new imaging technologies in developing countries Report of a WHO Scientific Group (67 pages).....	7.—

724	(1985) Energy and protein requirements Report of a Joint FAO/WHO/UNO Expert Consultation (206 pages)	17.—
725	(1985) WHO Expert Committee on Biological Standardization Thirty-fifth report (140 pages)	11.—
726	(1985) Sudden cardiac death Report of a WHO Scientific Group (25 pages)	4.—
727	(1985) Diabetes mellitus Report of a WHO Study Group (113 pages)	9.—
728	(1985) The control of schistosomiasis Report of a WHO Expert Committee (113 pages)	10.—
729	(1985) WHO Expert Committee on Drug Dependence Twenty-second report (31 pages)	4.—
730	(1986) Dementia in later life: research and action Report of a WHO Scientific Group (74 pages)	10.—
731	(1986) Young people's health—a challenge for society Report of a WHO Study Group on Young People's Health and "Health for All by the Year 2000" (117 pages)	16.—
732	(1986) Community prevention and control of cardiovascular diseases Report of a WHO Expert Committee (62 pages)	9.—
733	(1986) Evaluation of certain food additives and contaminants Twenty-ninth report of the Joint FAO/WHO Expert Committee on Food Additives (59 pages)	9.—
734	(1986) Recommended health-based limits in occupational exposure to selected mineral dusts (silica, coal) Report of a WHO Study Group (82 pages)	12.—
735	(1986) WHO Expert Committee on Malaria Eighteenth report (104 pages)	14.—
736	(1986) WHO Expert Committee on Venereal Diseases and Trepo- nematoses Sixth report (141 pages)	18.—
737	(1986) Resistance of vectors and reservoirs of disease to pesticides Tenth report of the WHO Expert Committee on Vector Biology and Control (87 pages)	12.—
738	(1986) Regulatory mechanisms for nursing training and practice: meeting primary health care needs Report of a WHO Study Group (71 pages)	10.—
739	(1986) Epidemiology and control of African trypanosomiasis Report of a WHO Expert Committee (127 pages)	16.—
740	(1986) Joint FAO/WHO Expert Committee on Brucellosis Sixth report (132 pages)	18.—
741	(1987) WHO Expert Committee on Drug Dependence Twenty-third report (64 pages)	9.—
742	(1987) Technology for water supply and sanitation in developing coun- tries Report of a WHO Study Group (38 pages)	7.—
743	(1987) The biology of malaria parasites Report of a WHO Scientific Group (229 pages)	32.—
744	(1987) Hospitals and health for all Report of a WHO Expert Committee on the Role of Hospitals at the First Referral Level (82 pages)	12.—

745	(1987) WHO Expert Committee on Biological Standardization	
	Thirty-sixth report (149 pages).....	20.—
746	(1987) Community-based education for health personnel	
	Report of a WHO Study Group (89 pages).....	12.—
747	(1987) Acceptability of cell substrates for production of biologicals	
	Report of a WHO Study Group (29 pages).....	5.—
748	(1987) WHO Expert Committee on Specifications for Pharmaceutical Preparations	
	Thirtieth report (50 pages).....	9.—
749	(1987) Prevention and control of intestinal parasitic infections	
	Report of a WHO Expert Committee (86 pages).....	12.—
750	(1987) Alternative systems of oral care delivery	
	Report of a WHO Expert Committee (58 pages).....	9.—
751	(1987) Evaluation of certain food additives and contaminants	
	Thirtieth report of the Joint FAO/WHO Expert Committee on Food Additives (57 pages).....	9.—
752	(1987) WHO Expert Committee on Onchocerciasis	
	Third report (167 pages).....	24.—
753	(1987) Mechanism of action, safety and efficacy of intrauterine devices	
	Report of a WHO Scientific Group (91 pages).....	12.—
754	(1987) Progress in the development and use of antiviral drugs and interferon	
	Report of a WHO Scientific Group (25 pages).....	5.—
755	(1987) Vector control in primary health care	
	Report of a WHO Scientific Group (61 pages).....	9.—
756	(1987) Children at work: special health risks	
	Report of a WHO Study Group (49 pages).....	9.—
757	(1987) Rational use of diagnostic imaging in paediatrics	
	Report of a WHO Study Group (102 pages).....	14.—
758	(1987) The hypertensive disorders of pregnancy	
	Report of a WHO Study Group (114 pages).....	16.—
759	(1987) Evaluation of certain food additives and contaminants	
	Thirty-first report of the Joint FAO/WHO Expert Committee on Food Additives (53 pages).....	9.—
760	(1987) WHO Expert Committee on Biological Standardization	
	Thirty-seventh report (203 pages).....	28.—
761	(1988) WHO Expert Committee on Drug Dependence	
	Twenty-fourth report (34 pages).....	6.—
762	(1988) Training and education in occupational health	
	Report of a WHO Study Group (47 pages).....	6.—
763	(1988) Evaluation of certain veterinary drug residues in food	
	Thirty-second report of the Joint FAO/WHO Expert Committee on Food Additives (40 pages).....	6.—
764	(1988) Rheumatic fever and rheumatic heart disease	
	Report of a WHO Study Group (58 pages).....	8.—
765	(1988) Health promotion for working populations	
	Report of a WHO Expert Committee (49 pages).....	8.—
766	(1988) Strengthening ministries of health for primary health care	
	Report of a WHO Expert Committee (110 pages).....	12.—