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VECTOR CONTROL MEASURES APPLIED IN THE
EASTERN MEDITERRANEAN REGION

by

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1 INTRODUCTION

In the Eastern Mediterranean Region, vector-borne diseases are among the most important communicable diseases in terms of morbidity and mortality. Most of the important vector-borne diseases are prevalent in nearly all the countries of the Region. More than two hundred million people are at risk. Table I attached shows the distribution of vector-borne diseases in the Region. Vector control still remains either the major or an essential component of an integrated approach for the prevention and control of vector-borne diseases. As such, the regional programme of work has stressed the importance of vector control and given priority to it in the prevention and control of vector-borne diseases. In addition, pesticide hazards to human health and environment constitute another problem dealt with in the vector biology and control programme

2. VECTOR CONTROL MEASURES APPLIED IN THE REGION

The strategy for vector control in the Eastern Mediterranean Region is oriented towards an integrated approach, calling for a selective combination of methods of control. Efficiency, safety and economy are determining factors in such a selection.

The main vector control measures applied in this Region, either singly or in combination, are: chemical control, biological control and environmental management.

2.1 Chemical Control

The main vector control measure still remains chemical control. The insecticides used in large quantities for this purpose are:

- adulticides: DDT, DLD, Malathion, Fenitrothion and Propoxur
- larvicides : larvicidal oil, Temephos and Fenthion

Some other insecticides have been used in small quantities, either for field trials or by municipalities for vector pest control. These are Dimethoate, Chlorpyrifos, synthetic pyrethroids, Trichlorfon, Phenothoate, Pirimiphos-methyl, Diazenon, Naled, Iodofenphos, and Dichlorovos.

The formulations used have been mainly water-dispersible powder in the case of adulticides and emulsion concentration or granules in that of larvicides. Limited amounts of solution formulations have been used for residual spraying and for ULV and fogging. Aerial spraying has been carried out for the vector control of Rift Valley Fever in Egypt.

Molluscicides have been applied for schistosomiasis control programmes in the Region; these are: Niclosamide, copper sulfate and Trifenmorph. Small amounts of tributyltin fluoride have been used in field trials.

Rodenticides used in the Region are mainly of the anti-coagulant group, namely coumatetralyl and chlorophacinone.

As most malaria vectors in the Region at present are resistant to the organochlorine group of insecticides, and a few of them exhibit varying degrees of resistance to the organophosphorous group of insecticides as well, application of alternative or supplementary vector control measures has been necessary. Table 2 (attached) illustrates the status of malaria vector resistance to insecticides in Eastern Mediterranean countries at mid-1982.

Moreover, certain factors, such as (i) the high cost of alternative insecticides, (ii) toxicity to humans, animals and the environment and (iii) the increase of minimum wages for workers, have limited the use of insecticides in vector control.

On the other hand, population increase and consequent greater demands for foods have necessitated the expansion of water development schemes for irrigation.

Production of energy and satisfaction of the water demands of fast-growing urban areas have added a new dimension to existing problems by aggravating malaria and schistosomiasis transmission, even in those countries where some advances in control had been achieved. The establishment of these schemes has led to great changes in the environment, which have caused the spread and multiplication both of the snail intermediate host of schistosomiasis and of the vectors of malaria, thus producing an increase in the prevalence of these diseases.

To confront the situation, attempts have been made to·

- develop and promote alternative methods of vector control,
- develop new strategies and approaches for vector control;
- promote engineering methods and environmental management wherever feasible,
- carry out field trials of new insecticides to assess their efficacy and cost effectiveness,
- develop skilled manpower and improve managerial skills in the field of vector control at country level for better planning, evaluation and implementation of the programme.

2.2 Biological Control

2.2 1 Larvivorous fish have been used in the Eastern Mediterranean Region since the turn of the century as a mosquito control measure. However, it is only since the mid-sixties, when resistance of malaria vectors to residual insecticides loomed as a very serious problem, that highly organized attention has been paid to the promotion and utilization of larvivorous fish as a control agent

Currently, different species of larvivorous fish of local or exotic origins are being utilized for larval control in several countries of the Region For details see Table 3 attached.

Of particular importance and deserving special mention is a trial carried out during 1980 - 1982 by the Government of Somalia in cooperation with the World Bank and TDR/EMRO, to evaluate the effectiveness of Oerochromis spilurus spilurus (Tilapia) in malaria control in man-made water reservoirs in the semi-desertic areas of Somalia. The trial started in May 1980⁽¹⁾ in Burao district, Togdheer Region, Northern Somalia covering an area of about 4000 square kilometers. The area is characterized by a semi-desertic climate, rains are scant and irregular, with the main spring rains occurring from about April to June.

As soon as the rains fall the villagers make every effort to conserve the run-off surface water in cement tanks called "birkits", which constitute the only water resources throughout the entire dry season.

Based on the malarionogenic potential of the villages and on previous records, the following two areas were selected:

Areas	No. of villages	No of Birkits	No. of population
Experimental areas (A)	16	600	6216
Control area (B)	10	551	6024

After collecting the necessary baseline data during the last week of July 1980, a total of 13 380 fish were released in all the birkits of area (A) at the rate of 2 fish per square meter. After each check, the necessary number of fish were replenished. Up to end January 1982, a total of 31 963 fish were seeded in the birkits of area (A). The epidemiological evaluation of the trial up to January 1982 is presented as follows.

(1) The data here presented are reported with the kind permission of the principal investigator, Dr A.Y Alio, Director of Anti-malaria Services, Mogadishu. This investigation received financial support from the Applied Field Research Component of Special Programme for Research and Training in Tropical Diseases.

YEAR	AREA	NO. OF VILLAGES SURVEYED	LARVAL DENSITY PER 10 DIPS	ANOPHELINE DENSITY ROOM SPRAY CATCH	VECTOR/HUMAN CONTACT NIGHT COLLECTION INDOORS NO. PER PERSON PER NIGHT	SLIDE POSITIVITY RATE %	REMARKS
July 1980	A	14	194.0	4.5	123	14.24	Baseline data before introduction of fish
	B	8	201.9	2.8	78	13.61	
July 1981	A	14	0.1	0.06	0	0.40	
	B	8	43.7	3.30	21	15.87	
Jan. 1982	A	14	0.02	0.14	0	0.09	
	B	8	12.54	2.30	8	8.18	

In addition to the above data, a field visit to the trial area, to all birkits where the fish were present, was carried out. The following observations were made:

- Mosquito larvae were practically absent,
- No aquatic insects were detected;
- Algae growth was minimal,
- The water in general was clearer than in those birkits where fish did not exist,
- Cooperation of the residents had improved and villagers expressed thanks for the lack of mosquitoes at night and the improvement of quality of the water.

A detailed final report on the result of this trial is being prepared by Dr Alio. On the whole, the results are encouraging. It is expected that, as from 1982, biological control with O. spilurus spilurus will be extended to other semi-desertic areas of Somalia, with community participation.

The outcome of this trial will be of importance to all countries in semi-desertic parts of the world.

Studies with the assistance of ichthyologists have shown that in Somalia, in addition to O. spilurus spilurus there are other potential larvivorous fish such as the annual fish Nothobranchius sp. which may be effective for mosquito control under specific ecological conditions. A large-scale trial on the effectiveness of Nothobranchius sp. is being carried out in Baidoa district where "whars", i.e. large ponds, are suspected to be the main breeding places for the malaria vector A. arabiensis. The interesting advantage of this fish is the survival of its eggs during the dry season.

2.2.2 Limited field trial with Bacillus thuringiensis H-14 has been carried out in Egypt, Iran and Sudan. The results are not yet available.

2.3 Control of disease vectors through environmental management

The application of environmental modifications, i.e. source reduction through drainage and filling, introduction of better water management systems, provision of efficient and adequate sewerage systems, is mostly carried out by governmental agencies other than those in the health sector. In the Eastern Mediterranean Region, attempts have been made to involve the Ministry of Agriculture, the Ministry of Irrigation, Water Authorities and the Municipalities, in taking part in environmental management projects. Provision for health components in development projects are being solicited in order to prevent the health hazards which may occur as a result of changes and modifications in the environment.

Promotion of environmental sanitation through the improvement of sewerage systems, provision of drainage for storm water and small-scale drainage and filling along the banks of rivers are being implemented in collaboration with municipalities in Basrah (Iraq), Khartoum (Sudan), Karachi (Pakistan) and Kabul (Afghanistan). At present, a study is under way in Lahore, Pakistan, with the collaboration of a WHO Sanitary Engineer

to prepare a model plan of operation for an integrated (multi-directional) approach for urban vector/pest control. Based on the experience gained in the Lahore project, a general guideline for vector/pest control operations in urban areas will be prepared.

2.4 Genetic Manipulation for Control of Vectors

Due to shortage of manpower specialized in this field and suitable laboratories for carrying out research, so far no genetic control measure has been applied. However, the potential for carrying out this type of research in several countries of the Region exists and could be activated in future.

2.5 Integrated Vector Control

A good example of an integrated vector control project in the Region is the Blue Nile Health Project in the Sudan. The overall objective of this project is to control and prevent major water-associated diseases, primarily malaria, schistosomiasis and diarrhoeal diseases, through a comprehensive integrated approach, and to assess the impact of measures taken on the health and socioeconomic conditions of the populations concerned. The total project population is about 2 million.

The main approach towards the prevention and control of the above diseases in the project area is through the application of permanent and long-term vector control measures. Out of a total budget of US\$ 155 million, to be spent over ten years (1979 to 1989) an amount of US\$ 98 million, representing 63% of the total, is earmarked primarily for the provision of water supply systems in the villages, environmental management, improvement of the irrigation system through clearing, cleaning and maintenance of the canals and the modification of irrigation practices. All these measures will help to reduce the density of malaria vectors' larvae and the snail hosts of schistosomiasis.

As the objectives set for the project, attempts are being made to prevent and control water-associated diseases through an integrated approach. The most prevalent water-associated diseases in the project area are malaria, schistosomiasis and diarrhoeal diseases. The first two diseases are transmitted respectively through the mosquito vector and the snail intermediate host, both of which require water for breeding and habitat.

The integrated control measures planned to be implemented for prevention and control of these diseases comprise:

- a) extensive community education
- b) chemotherapy for schistosomiasis
- c) treatment of diarrhoeal diseases with oral rehydration salts (ORS) therapy
- d) malaria treatment based on laboratory diagnosis only
- e) suppression of snails and mosquitoes by chemical, biological and environmental methods
- f) extensive improvement in domestic water supply to reduce man/water contact
- g) construction of pit latrines
- h) community action regarding drainage and sanitation

As may be understood from the above, four measures being implemented for the control of water-associated diseases are aimed directly against the vector or the intermediate host of the disease. The vector control measures are also based on an integrated approach, with regard both to methods and to their application, this results in considerable saving in staff, equipment, supplies, management services and facilities and consequently in total project cost. Moreover, some of the control

methods used against the vector of one disease are also effective against the vector/intermediate host of the other disease. In fact, the vector control measures thus adopted are being developed and will be implemented, combining efforts in one programme within the framework of existing and planned health services and the development of Primary Health Care. The project is therefore multi-disciplinary, utilizing expertise in medicine, biology, engineering agronomy, sociology, economics and public education.

The important feature of this integrated approach is intersectoral cooperation for the implementation of all the control measures adopted. For example, in order to clean and clear irrigation canals, the Ministry of Irrigation is the executive agency, therefore funding and technical services will be provided through this agency. The same applies in the case of improvement of water supplies in villages. The agency responsible for this activity is the Rural Water Supply Authorities. All the national ministries and agencies involved in this project will form a National Coordination Board to meet once a year to discuss the direction and policy of the Blue Nile Health Project. The National Coordination Board has met twice since the initiation of the project.

Coordination of work and cooperation for implementation of the project is also functioning at international levels, in addition to WHO, FAO, UNEP and WFP, the World Bank, JICA and USAID are contributing to the projects. The representatives of donor agencies participate in the Scientific Advisory Group (SAG) meeting held periodically to review and discuss technical aspects of the project and make recommendations for future plans. In the SAG meeting, in addition to the representatives of the above agencies and the donor governments, prominent scientists and experts in the fields of water-associated diseases and vector control are invited to attend and contribute in discussions and recommendations. So far two SAG meetings have been held and their reports are available.

3. SAFE USE OF PESTICIDES

The promotion of the safe use of pesticides in the Region is one of the priorities of the VBC programme. Activities in this programme area aim mainly:

- a) to promote public awareness of the health hazards represented by pesticides and to disseminate information on their safe use, especially for those persons who, due to the nature of their jobs or professions, come in close contact with pesticides;
- b) to establish a mechanism for quality control of pesticides within the Region in order to facilitate and speed the transmission of analysis results to interested governments or agencies

With regard to (a) above, in three countries of the Region namely Egypt, Pakistan and Sudan, a series of training courses on the safe use of pesticides has already been organized.

It is planned that in each calendar year, such multi-level courses on the safe use of pesticides be initiated in two countries of the Region

As for the quality of pesticides, the Hussein Ebrahim Jamal Research Institute of Chemistry, University of Karachi, has been designated as a Collaborating Centre for this purpose. It is expected that this collaboration will be operative during 1983.

Attempts are being made to organize, at country level, a Board which would be responsible for supervising the manufacture, licensing and registration of pesticides with a view to their safety regarding humans, domestic animals and the environment. Such a Board already exists in some countries of the Region, namely Egypt, Iran, Pakistan, Sudan and Syria.

All the above activities on the safe use of pesticides are being implemented with the collaboration of the Ministries of Agriculture and FAO.

4. TRAINING AND RESEARCH IN VECTOR BIOLOGY AND CONTROL (VBC) IN THE EMR

4.1 Training

The shortage of manpower in the field of vector control and medical entomology is one of the major problems in most of the countries of the Region. Serious attempts have been made to develop sufficient manpower in order to fill the gap of technical expertise within the Region.

In collaboration with the Member States, so far three Regional Training Centres have been established. These are:

4.1.1 The Regional Training Centre for Malaria and Vector Biology and Control, Baghdad, which has been established in collaboration with the Government of Iraq and the Secretariat of Health of the Arab States of the Gulf Area. This Training Centre offers courses on malaria and vector biology and control, both for junior and senior participants. The language of the course for junior participants is Arabic and for senior English. Since 1980, two junior courses have been offered on vector biology and control and five courses on malaria control, of which two have been for senior staff.

4.1.2 The Research and Training Centre on Vectors of Diseases, Ain Shams University, Cairo, which has been designated as a WHO Collaborating Centre and will be, in the near future, in a position to accept trainees in different fields of vector biology and control.

4.1.3 The University of Khartoum, which is organizing, in collaboration with WHO, a course on vector biology and control leading to a Master's degree. It is expected that the first course can be announced for the scholastic year 1982/1983.

In addition to the above training centres, fellowships have been offered to vector biology and control staff in Member States for advanced studies and observation tours abroad. During 1981/1982 seven fellowships in the field of VBC have been offered by EMRO.

It is expected that, after the above training centres become fully operational, the Region will be self-sufficient in the training of manpower in the field of VBC.

4.2 Research and Field trials

Due to the shortage of manpower and research institutes in the field of VBC in the Eastern Mediterranean Region, research projects have been limited. Nevertheless, attempts are being made to promote field trials and strengthen some of the institutes in the Region to enable them to carry out research work.

4.2.1 Field trials

Promotion and implementation of field trials of new insecticides and dispersing equipment, and the development of alternative measures for vector control, are among the continuous activities of field projects. Field trials of major relevance can be listed as follows:

4.2.1.1 Field trial of insecticides

Residual effect of Malathion E.C. 500 on adult mosquitoes in Syria (completed)

Residual effect of Decamethrin on adult mosquitoes, Blue Nile Health Project (BNHP), Sudan (completed).

Effectiveness of Monoxi for control of mosquito larvae, BNHP, Sudan (completed).

Snail control by the focal application of Bayluscide 70% w.d.p., BNHP, Sudan
(ongoing)

Slow release Organotin TBTO and TBTF Tributyltin oxide and Tributyltin fluoride
for snail control in Somalia (completed).

4.2.1.2 Field trial of bio-insecticides

Efficacy and cost effectiveness of Bacillus thuringiensis serotype H-14
on mosquito larvae in Egypt, Iran, Pakistan and Sudan (ongoing).

4.2.1.3 Field trial of biological control

Effectiveness of Oerochromis spilurus spilurus in "birkits" for mosquito larvae
control, Somalia (completed)

Community participation in distribution and maintenance of fish in birkits
for larval control, Burao, Somalia (ongoing)

Effectiveness of Nothobranchius sp. in "whars" for mosquito larvae control,
Baidoa, Somalia (ongoing)

Effectiveness of Gambusia affinis Holbrookii in canals for mosquito larvae
control, BNHP, Sudan (ongoing)

Effectiveness of Aphanius dispar for larval control in canals, BNHP, Sudan
(ongoing)

Trials on the survival of larvivorous fish in Gezira canals, BNHP, Sudan
(ongoing)

Country survey for identification of Nothobranchius sp. in Somalia and Sudan (ongoing)

Effectiveness of herbivorous fish e.g. Ctenopharingodon idella (Chinese grass carp) and local grass carp Sarotherodon niloticus for control of the snail host of schistosomiasis and mosquito larvae, BNHP, Sudan (ongoing)

Effectiveness of Protopterus annecteus (lung fish) in control of the snail host of schistosomiasis, BNHP, Sudan (ongoing)

Effectiveness of Lanistes carinatus, a local ampullarid, for the control of the host of schistosomiasis, BNHP, Sudan (ongoing)

Effectiveness of Marisa cornuarietis, a mollusc imported from Puerto Rico, for the control of the snail host of schistosomiasis, BNHP, Sudan (ongoing).

4.2.1.4 Field trial of herbal molluscicides

Effectiveness of Ambrosia maritima, locally known as "damssisa", on the snail host of schistosomiasis, High Institute of Public Health, Alexandria, Egypt (completed)

Studies on the identification of further plants with toxic effects on the snail host of schistosomiasis, BNHP, Sudan (ongoing)

4.2.1.5 Field trial of vector control through environmental management

Village level integrated vector control, Egypt and Saudi Arabia (planning phase)

Effect of cleaning and clearing of irrigation canals on larval and snail density, BNHP, Sudan (ongoing)

Effect of improved sanitation at village level on vector breeding and transmission of malaria and schistosomiasis, BNHP, Sudan (ongoing) (in collaboration with UNEP, WFP).

Study on weeds favourable for habitat of the snail host of schistosomiasis in canals, BNHP, Sudan (ongoing)

Study on utilization of solar energy for heating water for control of the snail host of schistosomiasis and mosquito larvae, Somalia (ongoing).

4.2.1.6 Studies on socio-economic aspects of vector-borne diseases

To determine the economic benefits of disease control activities, BNHP, Sudan (ongoing)

Effect of human behavioural patterns in relation to water contact on transmission dynamics of schistosomiasis, BNHP, Sudan (ongoing)

4.3 Strengthening of Research Institutes in the Region

Apart from the Institutes already mentioned in this paper, namely the Regional Training Centre for Malaria and Vector Biology and Control, Baghdad, and the Research and Training Centre for Vectors of Diseases, Ain Shams University, Cairo, the following institutes have the potential to be further developed for research work in vector biology and control:

The University of Khartoum. In the near future this Institution, by utilizing post-graduate students attending the M.Sc course in VBC, will be in a position to carry out research on different aspects of vector biology and control.

The Department of Environmental Health, School of Public Health, University of Teheran, which has been engaged for a long time in research on vectors of diseases

their control This Institution will be further strengthened for a more advanced type of studies, especially on cytogenetics.

The Research Institute of Medical Entomology, Dokki, Cairo, which is already cooperating in training personnel, could be further strengthened for research on different aspects of vector biology and control.

With regard to studies on rodents as a reservoir of disease, the Vertebrate Pest Control Centre in Karachi, Pakistan, which has been established by the Government of Pakistan in collaboration with FAO and WHO and is actively engaged in studies on¹ rodents and disease transmitted to man through them in Pakistan, could in future assist in a similar kind of studies in other countries of the Region.

5. EXISTING PROBLEMS IN THE REGIONAL VECTOR CONTROL PROGRAMME

The difficulties encountered in vector biology and control programmes are either of a technical or of an administrative nature:

5.1 Technical difficulties

- Development of resistance in vectors to most of the available insecticides, intensified by the extensive use of pesticides in agricultural sectors,
- Rapid development of irrigation schemes, resulting in man-made breeding places for vectors and thus further aggravating the problems,
- Mishandling and improper use of pesticides which have in the long run toxicological hazards for man, animals and environment;
- Lack of adequate numbers of personnel properly trained in VBC in most of the countries of the Region;

- Shortage of research facilities and research activities in the field of VBC in the Region.

5.2 Administrative difficulties

- High cost of alternative insecticides and limited financial resources for vector control inhibit the application of insecticides in most of the countries of the Region,
- Lack of emphasis on organized VBC activities within the public health service structure,
- Shortage of managerial skills at all levels to plan and implement VBC activities effectively and efficiently within available resources,
- Inadequate reliable information for formulation and evaluation of VBC programmes;
- Inadequate coordination, interdepartmental and intersectoral, at national level as well as interagency at international level,

Subsequently the regional VBC programme has been directed and planned in a way so as to collaborate with the Member States to overcome the above difficulties.

To promote alternative vector control measures in the Region, a series of seminars were held, either in collaboration with VBC, WHO Central Office, or at regional level.

Since 1972, six seminars were held for this purpose:

- Inter-Regional Seminar on Larval Control, Alexandria/Cairo/Aswan, 2 - 21 July 1972;
- Public Health and Economic Aspects of Rodent Control, Alexandria, December 1974,

- Seminar on the Prevention and Control of Vector-Borne Diseases in Water Resources Development Projects, Alexandria/Khartoum, 21 March - 6 April 1978,
- Travelling Seminar on the Use of Larvivorous Fish for Mosquito Control in Anti-malaria Campaigns, Bulgaria/USSR, 27 August - 15 September 1979,
- Inter-Regional Seminar on Integrated Control of Mosquito Vectors, Adana, Turkey, 2 - 14 November 1981,
- Seminar on the Role of Health Services and Training Institutes in Control of Vectors and Reservoirs of Diseases, Baltchik, Bulgaria, 4 - 11 October 1982.

In these seminars attempts have been made to discuss all the alternative vector control measures which could be applied at present, and also to prepare guidelines for future planning and organization of control operations. As a result of these seminars, research and field trials in the area of vector control have been encouraged, training of personnel has been revised to meet demands in relation to vector control methods other than chemical control, a manual on larval control was published by Malaria and Other Parasitic Diseases, WHO Geneva and a manual on source reduction and environmental management for vector control also published by VBC/Geneva during 1982.

6. CONCLUSIONS AND RECOMMENDATIONS

In this paper, attempts have been made to explain the problems which the countries of the Region are facing in the prevention and control of vector-borne diseases and the role and importance of vector control in campaigns organized against these diseases. The strategy of vector control programmes in the Region has also been discussed.

Several examples have been given of alternative measures applied for the control of malaria vectors and the snail host of schistosomiasis in the countries of

the Eastern Mediterranean Region, with special reference to environmental management and biological control. The application of integrated vector control measures, which is expected to be carried out by governmental agencies other than those in the health sector, gives permanent results and is economical in the long term. Ministries of Health, although not in a position to undertake large-scale integrated vector control measures in irrigation and other water resource development projects, nevertheless can stimulate intersectoral involvement in such activities. In this connection, on WHO initiation, several international organizations have recognized the importance of the component of the water resource development projects and have allocated sufficient funds for studying the probable health hazards which may arise as a result of implementation of this type of project; rendering advice for incorporating designs and measures for prevention of such hazards, IBRD, FAO, UNEP and the African Development Bank are some of the organizations which are involved in this procedure.

For the application of biological control methods such as the use of larvivorous fish, the active participation of the community is required for a successful programme. The role of Ministries of Health is to promote community action for this purpose. Primary health care departments could play a major role in the implementation of this activity.

To improve the technology used for vector control, at the regional level, there is a great need for studies and research. From the 1940s onwards residual insecticides have been extensively used and relied upon for vector control in anti-malaria campaigns all over the world; there has been a halt in further research for the control of mosquitoes through environmental management, i.e. minimizing of breeding places by applying appropriate engineering methods and utilizing predators and competitors for biological control of vectors. One of the major roles of WHO is to promote research and participate in research projects, in conjunction with other international agencies, i.e. FAO and UNEP, and national research institutes, for the development of better design and water management in irrigation systems and other forms of water resource development. Development of effective and economical

material for lining canals and ponds, precision syphons for level management for distribution boxes (which help in minimizing the possibilities of breeding of mosquitoes in irrigation systems), are examples. Development of an irrigation system for rice growing which eliminates impondments of water for a long period also can be studied.

Urban pest vector control is given special attention in the countries of the Region. Preparation of a guideline for integrated vector/pest control for urban areas will be of great help to municipal authorities and will save a substantial amount of funds which currently are spent on chemical control of pests with only short-term impact on vector/pest density.

Studies and investigations for the identification of local larvivorous fish which should be introduced into major breeding sites would be another contribution towards vector control in anti-malaria campaigns.

In order to achieve self-sufficiency in respect of manpower in the field of vector biology and control in the Region, priority is given to training of personnel. Substantial progress has been made. However, further strengthening of training institutes is required.

Finally, emphasis should be placed on the development of organized vector biology activities within the national public health structure, in order to assist maximally in control of vector-borne disease in the country.

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Table 1

Distribution of Vector-Borne Diseases in EMRO

Country	Mosquitoes							Flies					Rodent-borne diseases (Reservoir)							
	An.	Cu.	Ae.	Ae.	Cu.	Cu.	Snail	Sand	Sand	Black	tse tse	Louse	Fleas	Mite	Ticks					
	Malaria	Filariasis (W.B.)	Yellow fever	Dengue fever	West Nile fever	Rift Valley "	Schistosomiasis	Leishmaniasis	Papa tacti fever	Onchocerciasis	Trypanosomiasis	Typhus	Relapsing fever	Plague	Murine Typhus	Scrub Typhus	Relapsing fever	Leptospirosis	Rat bite fever	
Afghanistan	+						-	+	+										+	
Bahrain	+			+																
Cyprus	-						-													
Dem. Yemen	+			+			+													
Djibouti	+			+			-													
Egypt	+	+		+	?	+	+	+					+	+	+				+	
Gaza	+						-													
Iran	+			+			+	+	+										+	
Iraq	+			+			+	+	+					+						
Israel	-						-													
Jordan	+						-												+	
Kuwait	-			+			-	+	+						+					
Lebanon	-																			
Libya	+			+			+	+	+				+	+	+	+				
Oman	+			+			-							+						
Pakistan	+						-								+	+	+			
Qatar	-			+			-													
S. Arabia	+			+			+	+	+					+		+				
Somalia	+	+		+				+	+	+										
Sudan	+	+	+	+	+	+	+	+	+	+	+									
Syria	+						+	+												
Tunisia	+						+													
UAE	+						-													
Yemen	-						+	+	+	+				+						

Table 2

Status of Malaria Vector Resistance to Insecticides in EMRO countries
at 31 December 1981

Country	Species																	
	A. arabiensis	A. claviger	A. coustani	A. culicifacies, cul.	A. d'thali	A. fluviatilis	A. funestus	A. gambiae	A. hyrcanus	A. labranchiae	A. maculipennis	A. multicolor	A. pharoensis	A. pulcherrimus	A. sacharovi	A. sergenti	A. stephensi	A. superpictus
Afghanistan		+		①②	+	+			1,2			+		1			①②	0
Bahrain				+					+			+		+		+	+	+
Cyprus		+										+						0
Democratic Yemen	0		+	+	+											+		
Djibouti	-				-		-						-					
Egypt		1 2 3 4*			+				+			11,12 13,14	1,2 3*4			2*	+	+
Iran		-		①	2	0			+		1	+		+	1		①②③④ 6 7 8 9	0
Iraq		-			+						+	+		1 1,2	+	①②③④ 7		0
Israel		-	+						+			+	2	+	+	+		0
Jordan		0	+		(5)							(5)	+			2(5)		0
Kuwait																	+	
Lebanon		0							+			+		①②④	+	+		0
Libya	-									+		+				+		+
Oman			+	1 2(5)	0							+				+	1 2	
Pakistan		+		①②③		+			1					2			①②③	+
Qatar												+						
Saudi Arabia	0		2	+	+	2						1 2	+	2		0	1 2	0
Somalia	0		+		+		0						+					
Sudan	①②③		+		+		0	+					1 2			+		
Syria		+			+				+			+	+	2 ①②④	+	+		0
Tunisia		+			+					1 2		+				+		+
U.A.E.				(1)(5) (11)	+							+				+	+	
Y.A.R.	0		+	+	+								+			+		

Table 2 (Footnotes)

- | | | | |
|----|---|-----|---|
| + | = Species present, no tests carried out | 4 | = Species resistant to Fenitrothion |
| 0 | = Species susceptible to all insecticides | 5 | = Species resistant to Temephos (Aba) |
| 1 | = Species resistant to DDT | - | = No information available |
| 2 | = Species resistant to Dieldrin/BHC | () | = Resistance suspected |
| 3 | = Species resistant to Malathion | ○ | = Resistance implication necessitates change of insecticides in area distribution |
| 6 | = Species resistant to Propoxur | * | = New records |
| 7 | = Species resistant to Actellic | | |
| 8 | = Species resistant to Chlorphoxim | | |
| 9 | = Species resistant to Phoxim | | |
| 10 | = Species resistant to Iodofenphos | | |
| 11 | = Species resistant to Durshan | | |
| 12 | = Species resistant to Fenthion | | |

Country	Are fish used now	Date of introduction	Species of fish	Local or foreign fish	Species of Mosquito	Usage > < stable	How fish obtained	Type of habitat and treatment	Are fish added to habitat	Efficiency	Ecological Changes	Possible Causes of ail oment	Evaluation	Remarks
Afghanistan *	Yes	1971	<u>Gambusia affinis</u> Holbrooki	Foreign imported from Tajikistan USSR 1971	<u>An. hyrcanus</u> <u>An. pulcherrimus</u> <u>An. superpictus</u>	>	Central and Regional hatcheries, natural swamps	Ditches 150 km Rice paddies 500 ha Small pools 30ha Large ponds 5ha Marshes 50ha	15 million in 1973 2-4/m ² in seeded areas	<u>An. pulcherrimus</u> and <u>An. hvr</u> well controlled when fish are 4-5/m ²	Not apparent	Large areas Lack of funds, personnel and transport	Gambusia alone not epidemiologically satisfactory. Better results in areas which are sprayed with DDT 75% wdp 1.5 g tech/m ² as well as fish introduction	
Cyprus	Yes	1946	<u>Gambusia</u> and goldfish	Foreign	<u>An. superpictus</u> <u>An. bifurcatus</u> and culicines	<	Tanks Pools	277 wells (415m ²) 3 ditches 300m ² 5 streams 24000 m ² 412 small pools 2 890 m ² 384 large ponds 13 360 m ² 3 natural lakes 10 000 m ² 36 man-made lakes 21 700 m ² 2 marshes 500 m ²	7 500/year	Fish important in areas such as dams ravines where cannot treat otherwise	Cyprinus eat grass on water surface		Fish have eliminated breeding sites which remained after other treatment	
Egypt *	Yes	1929	<u>Gambusia affinis</u>	Foreign	<u>An. Pharaonis</u> <u>An. sergenti</u> <u>An. multicolor</u>		Imported	Canals, ditches rice fields	Yes	?	?	Introduction of Chemicals	Results not available	
Iran *	Yes	1928	<u>Gambusia affinis</u> Holbrooki	Foreign	Anophelines	stable	Natural reg hatcheries		1-1/2-2 million/year	Cannot be evaluated since done in conjunction with spraying and larviciding	No studies	one	Certain reduction in Anophelines but no systematic studies	
Iraq	Yes	1954	<u>Gambusia affinis</u> <u>affinis</u> and holbrooki	Foreign	opheline and culicine	>	Natural habitats	Numerous ditches, streams, pools, few ponds lakes, marshes	Ad hoc additions density in habitat 3-20/m ²	Local lab. studies for demonstration	Not apparent	None	No evaluation	
Jordan *	Yes	1956	<u>Gambusia</u>	Foreign	<u>A. sacharovi</u>	>	Abroad	marshes and streams				Administrative	No evaluation	
Lebanon	Yes	1964	<u>Gambusia</u>	" "	<u>A. sacharovi</u>	>	Natural habitat	streams			None	None	No evaluation	

Table 3 cont'd

Country	Year of fish use	Species of Fish	Local or foreign fish	Species of Mosquito	Usage > < < > stable	How fish obtained	Type of habitat and treatment	Are fish added to habitat	Efficiency	Ecological Changes	Possible Causes of abandonment	Evaluation	Remarks
Pakistan *	1973	Local species called SADD (sent for identification) - <u>Aphanius dispar</u>	Local	<u>An. culicifacies</u> , <u>A. thalassini</u> , <u>Culex sp.</u>	>	Natural habitats and around man-made streams fed by underground streams	50 wells (200m ²) 3 streams (3km) 1 small pool 200 x 15 m 3 man-made lakes 15 x 10 x 1m	Density in habitat, 10-50 m ²	Exp in basins and in wells - 15 fish increased 10x in 10 months - significant increase in larvae	None	None	Remarkable decrease in larvae 3 days after fish introduced	
Pakistan *	1967	<u>Lilapia Mosambica</u> , <u>Poecilia reticulata</u>	Local	<u>An. stephensi</u>	>	Natural habitat	River	?	?	Not applicable	None	No evaluation carried out	
Saudi Arabia *	1975	<u>Aphanius dispar</u>	Local	<u>A. stephensi</u> , <u>A. culicifacies</u>	>	Natural habitat	Irrigation and drainage canals		Excellent Control	None	None	No evaluation	No specific program - measures were carried out
Somalia *	1972	<u>Oerochromis spilurum</u> , <u>Notobranchius paliqueti</u>	Local	<u>A. A-abiensis</u>	<	Natural habitat	Berkit	3-4m ²	Excellent Control	Reduction in weeds and algae	-	Trial is going on 1980/81/82	So far results encouraging
Syria *	1962	<u>Gambusia affinis</u>	Foreign	<u>A. sacherovi</u>	<	Central hatcheries natural habitats	1 streams (2km) 10 small pools Natural lake (2km ²)				Difficulty in handling fish and maintaining in new habitat	Formerly by larval density	
Sudan *	1978	<u>Gambusia affinis</u> , <u>Cteroptharygodon idelle</u>	Foreign China	<u>A. Arabiensis</u>		Imported or Natural habitat	canals	?	?		Introduction of chemicals		Under trial
	1976	<u>Sirotherodon niloticus</u>	local	" "			canals	-	-				
PRY (Zaire)	1980	<u>Gambusia affinis</u> , <u>Aphanius Dispar</u>	Foreign local	<u>Anopheles</u> , <u>A. Af. isis</u>	>	Not given Natural habitat stream	Streams Small pools man-made lakes	?	?	not applicable	None	No evaluation	
Yibouti	1977	<u>Gambusia affinis</u>	Foreign and Local	<u>An. aegypti</u>	>	Natural habitats	Ditches (6km) 1 large pond (800m x 300m) 170 man-made lakes	No	-	-	Lack of Personnel		A trial is planned

* Data provided by the participants of the Seminar on Integrated Control of Mosquito Vectors, Adana, Turkey, 2 - 14 November 1981 or reported from the field