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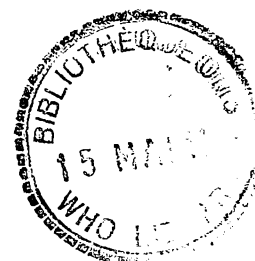
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(avec résumé en français)

THE PROBLEM OF RESURGENT BED-BUG INFESTATION IN
MALARIA ERADICATION PROGRAMMES

by

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Introduction

It has been known for some time that bed-bug infestation in certain countries has adversely affected the attainment of a total spraying coverage for malaria eradication. A survey carried out during 1967 showed out of 32 countries which reported bed-bug infestation, 19 (63%) considered it a problem in their malaria eradication projects (Table 1).

It is often noticed that increased bed-bug infestation reappears after a few years of spraying with one of the chlorinated hydrocarbon insecticides. This reappearance or increase is believed to be due largely to the development of resistance or tolerance of the bed-bug to the insecticides used. Also, there have been indications that an irritable insecticide such as DDT can increase the mobility of the bed-bug, thereby giving the impression of an increased infestation. In a field study in a bed-bug infested area where refusal of spraying was experienced in Thailand, however, no increased bed-bug infestation was observed after DDT spraying.

Once an increase in bed-bug infestation or its mobility has taken place in an area freed from infestation for a few years, the inhabitants begin to complain and oppose the antimalaria spraying as being useless and sometimes because they consider it to be the cause of what they believe to be an increase in the bed-bug population. Refusals have resulted in up to 80% of houses being left unsprayed in certain areas in malaria eradication projects and special measures were needed to complete the spraying. These, however, caused delays in the implementation of spraying and necessitated a considerable increase in the man-days needed for spraying.

In some areas the inhabitants replastered their houses soon after spraying to avoid an increase in bed-bug population. In Mexico, persistent transmission in Zone X (Morelia) was largely attributed to the high bed-bug infestation in as much as many householders were washing or replastering their walls or sleeping outdoors to avoid bed-bug attack (Pletsch, 1961). In Mozambique, bed-bug infestation is reported to have caused inhabitants to sleep outdoors. In at least one country, inhabitants in areas never sprayed before refused spraying on the grounds that it might increase the bed-bug infestation. The population's resistance to spraying sometimes took the form of their refusing to co-operate with spraymen to empty houses or even to provide water for spraying. Similar lack of co-operation

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was ascribed to increase of the bed-bug population in Zanzibar; Gratz (1961) investigating this found the bed-bug population of the island highly resistant to both dieldrin and DDT but since practically the entire island had been sprayed there was no way of comparing the bed-bug population with the presprayed one.

Measures to ensure the effective application of attack measures in malaria eradication projects where the bed-bug problem exists

For those areas where refusals to permit spraying on account of bed-bugs have seriously affected the total coverage necessary, a review has been made of the steps to be undertaken to overcome the problem.

Reports indicate that the following measures have been used with varying degrees of success in malaria eradication projects to counter the bed-bug problem:

1. Health education
2. Legal enforcement
3. Use of insecticides

1. Health education

Most programmes have reported that health education alone has little effectiveness where people see only an increase in bed-bugs. On the other hand, it is well recognized that health education is an essential part in any attempt at tackling this problem. Health education should include encouraging inhabitants to use their own simple means of controlling bed-bugs, e.g.:

- filling the fissures and cracks in walls;
- dipping bedding in hot water;
- applying kerosene to surfaces where the bugs rest, such as beds, window-frames, cracks in walls, poles, beams and furniture;
- general cleanliness of the house, etc.

Extensive use should be made of spraymen, surveillance agents and field supervisors to explain to the public not only the methods of controlling bed-bugs but also the fact that even though the collateral benefits of destruction of other insect pests in houses may not last beyond the first year or two, despite the continued spraying the effectiveness of DDT against malaria-carrying mosquitos usually continues.

2. Legal enforcement

The legal enforcement of residual spraying has been reported successful in one programme as the sole measure to counter refusal of spraying. Most programmes have rated it as being moderately effective and one programme called it undesirable.

In view of the adverse effect that such a measure may have on the population's attitude towards the malaria eradication project, its use is not generally recommended, although judicious use can be made of it in special circumstances.

3. Use of insecticides

A number of insecticides, such as DDT (higher dosages than 2 g/m^2), dieldrin, HCH, chlordane, malathion, diazinon, Sevin-85, have been used in malaria eradication projects for control of bed-bugs with varying results. These have been applied in liquid spray form together with the general spraying operation. Only one programme had used a dust formulation of malathion and reported satisfactory control of bed-bugs.

However, in general, chlorinated hydrocarbon insecticides other than those already used in the malaria eradication project, should not be utilized for control of bed-bugs.

Reports show that bed-bugs develop resistance to chlorinated hydrocarbon insecticides quite quickly and, in addition, dieldrin has the disadvantage of higher mammalian toxicity. On the other hand, malathion and diazinon have proved to be effective at low dosages. Malathion would be especially advantageous due to its very low mammalian toxicity.

Malathion has been applied with success at dosages ranging from 50 mg to 1 g/m^2 . Some projects have reported up to five months' effectiveness when it was applied at $100/200 \text{ mg/m}^2$, mainly on wood or similar organic surfaces. Malathion is quite safe for use under normal field conditions and has been used with no special safety measure in the spraying operation of the malaria eradication programme.

Diazinon at dosages between 75 mg and 200 mg has also been used with success in malaria eradication projects. At 200 mg/m^2 effective control extending to about nine months has been reported. Due to what has been reported as a synergistic effect, an increased effectiveness was obtained in one area when diazinon was applied together with DDT but this has not been confirmed. Diazinon has a high oral and relatively high dermal toxicity and, therefore, should be used under strict precautionary measures (WHO, 1967). Spraying of bedding should be avoided.

Sumithion (fenitrothion) 0.25% emulsion applied to beds, kit boxes and mosquito nets in army barracks in India has also been reported to have given effective control of bed-bugs for over eight months (Shetty et al., 1965). Sumithion has a low dermal toxicity and therefore can be handled safely in the field provided it is used under strict control to avoid ingestion or any undue dermal contact.

Synergized pyrethrum sprays (0.2% pyrethrum and 2% synergist) have also been recommended in the report of the Expert Committee on Insecticides for the control of bed-bugs. However, repeated application at intervals of one or two weeks may be required as the formulation has no residual activity (WHO, 1963). The advantage of this combination is its high degree of safety and that its application requires no special safety measure.

There are also a number of newer organo-phosphorus or carbamate insecticides, e.g. arprocarb (Baygon), Ronnel, carboryl (Sevin), etc., which might be considered for control of bed-bugs should those listed above prove, for some reason, to be unsuitable or unavailable.

Application - So far, additional insecticides for the control of bed-bugs in malaria eradication projects have usually been applied as an integral part of the general spraying. In view of the fact that the areas within dwellings which need to be sprayed for bed-bug control are comparatively limited and sometimes different from those treated for malaria eradication purposes, it may be wasteful to apply a spray combination of insecticides, particularly as the insecticides added for bed-bug control are expensive.

In general, it would appear that spraying for bed-bug control would be more economical and more effective if done separately from malaria eradication spraying. Combined spraying for both malaria eradication and bed-bug control may, however, be advantageous where operational costs are high, the cost of the additional insecticide is low or in those instances where large proportions of the areas to be sprayed for each purpose are identical.

Even when a separate application programme is planned for bed-bugs, maximum use should be made of the available facilities and the logistic organization of the malaria eradication project in order to reduce costs. Depending upon the extent of spraying to be done for bed-bugs, sufficient numbers of additional spraymen can be trained and attached to the spraying squads operating in the infested areas.

Insecticides should be applied directly to hiding places of bed-bugs. These may include clothing, frameworks and mattresses of beds, furniture, crevices in bedsteads, behind base boards, window and door frames, pictures and picture mouldings, loosened wall-paper, cracks in walls, ceilings, poles and beams.

Of all the insecticidal formulations, liquid sprays are preferable. Dusts do not cling to vertical surfaces and may be more difficult to apply to cracks and crevices.

Thorough application is important for effectiveness. All the hiding places should be treated adequately. Special care should be taken when treating crevices and cracks. When liquid sprays are used on beds, sufficient spray should be used to wet the slats, springs and frame. For spraying mattresses, a light mist should be applied to all surfaces to penetrate the seams, tufts and folds. The bedding should be allowed to dry for a few hours before being used.

As a measure of safety, the bedding should only be sprayed lightly, but not at all when a toxic material is used. Under no circumstances should the treated material be soaked with spray. The bedding of infants should not be sprayed (WHO, 1963). If necessary, walls should also be sprayed to a height of several feet above the floor.

It should be noted that while fumigation is also effective, it usually has no residual effect, unless fumigants with residual properties are used, and reinfestation may quickly occur. For fumigants with high mammalian toxicity, the strictest safety precautions are required and under no circumstances should such highly toxic fumigants be used by staff not specially trained for this work.

Conclusion

Malaria eradication projects faced with the problem of resurgent bed-bug infestation may use the following measures to counteract it:

1. A survey to identify and delimit areas where bed-bug resistance to insecticides leads to refusal of spraying.
2. Health education emphasizing the effectiveness of residual insecticides against malaria vectors even after some of the collateral benefits such as the destruction of bed-bugs and other domestic pests have been lost, and including also instruction on practical measures that can be taken by the householders themselves against bed-bugs.

3. Insecticides

- Use of insecticides if required.
- Chlorinated hydrocarbons other than those already used in the malaria eradication project in the country are not recommended for this purpose.
- Malathion would be the insecticide of choice, being safer and less expensive than other newer insecticides.
- Any additional insecticides to be used for the control of bed-bugs should first be tried on a small scale at the lower limit of the recommended dosages before general application.
- Normally application should be done separately, using the facilities of the general malaria eradication spraying and its logistic organization. Combined application can be done when this is economically and technically preferable.
- Application of insecticides to beds and mattresses should be light and in the form of mist. Application to these items should be avoided completely when insecticides of higher toxicity are used. Under no circumstances, should the bedding of infants be sprayed.

4. Judicious legal enforcement measures may be indicated in certain situations provided they are tolerated by the inhabitants without being prejudiced to the malaria eradication programme.

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TABLE 1(a). BED-BUG INFESTATION PROBLEM IN THE AFRICAN REGION

Project	Problem extent Degree as affecting spraying coverage	Extent infested areas Degree infestation	Refusal of spraying proportion	Health education legal enforcement effectiveness	Insecticide resistance ^a rounds applied before resistance discovered			Insecticides used for control of bed-bugs dosage applied alone or with other insecticides - results obtained (degree effectiveness)						
					DDT	Dieldrin	HCH	Dieldrin	HCH	Malathion	Diazinon	Sevin-85		
Mauritius	None	? ?	-	-	? ?	-	-	-	-	-	-	-	-	-
Mozambique	Pilot area ?	? ?	?	?	?	-	-	-	-	-	-	-	-	0.26 R/m ² with DDT ^c not satis.
Nigeria	No problem Pilot area 210 villages	-	-	-	-	-	-	-	-	-	-	-	-	-
Tanzania (Zanzibar)	Some areas most inhabi- tants complain	? ?	Some areas ?	Partially	Inter- mediate	Marked	?	-	-	-	1 g/m ^{2b} with 5% DDT	Unsatis- factory	-	-
Togo	Where spraying carried out significant	Riverine localities ?	?	Fully effective ^d No	T 10 rounds	? Used for 4 years	?	-	-	-	-	-	-	-

^a R = Resistant; T = Tolerant; S = Susceptible.

^b Was replaced soon by dust due to odour with satisfactory results.

^c Dosage inadequate on mud walls.

^d Filling fissures in wall by mud, cleaning houses, spraying bed frames with kerosene, dipping bedding in hot water.

? = Not known.

TABLE 1(b). BED-BUG INFESTATION PROBLEM IN THE AMERICAN REGION

Project	Problem extent Degree as affecting spraying coverage	Extent infested areas Degree infestation	Refusal of spraying Proportion	Health education legal enforcement effectiveness	Insecticide resistance ^a rounds applied before resistance discovered			Insecticides used for control of bed-bugs dosage applied alone or with other insecticides - results obtained (degree effectiveness)					
					DDT	Dieldrin	HCH	Dieldrin	HCH	Malathion	Diazinon	Sevin-85	
Colombia	Magdalena Valley ?	? ?	Yes ?	-	-	-	-	-	100 mg/m ² DDT 5% 2-3 months	-	-	-	-
Mexico	Zones 5, 6, 10 94 896 houses ?	23 800 houses High-Zone 10	Yes ?	Extensive HE - Little	R	S	S	-	40 mg/m ^{2b} DDT 5% Satis.	-	-	-	-

^a R = Resistant; T = Tolerant, S = Susceptible.

^b Applied once every year during the first semestral cycle.

? = Not known.

TABLE 1(c). BED-BUG INFESTATION PROBLEM IN THE SOUTH-EAST ASIA REGION

Project	Problem extent Degree as affecting spraying coverage	Extent infested areas Degree infestation	Refusal of spraying Proportion	Health education legal enforcement effectiveness	Insecticide resistance ^a rounds applied before resistance discovered			Insecticides used for control of bed-bugs dosage applied alone or with other insecticides - results obtained (degree effectiveness)					
					DDT	Dieldrin	HCH	Dieldrin	HCH	Malathion	Diazinon	Sovin-85	
Afghanistan	None	? ?	-	-	-	-	-	-	-	-	-	-	-
Ceylon	None	?	-	-	-	-	-	-	-	-	-	-	-
India	variable	variable	Considerable in certain areas Up to 70-80% of houses	effective certain areas	-	-	-	?	?	transient nature	0.13 g/m ² DDT 5% Excellent Spectacular	-	-
Indonesia	None	-	None	-	-	-	-	-	-	-	-	-	-
Nepal	where sprayed serious	widespread heavy (Zone B)	country-wide ?	Partly effective	-	-	-	-	-	-	-	-	-
Thailand	where sprayed for ME not serious	countrywide ?	Exist ?	Little effect	Country-wide ?	?	?	-	-	-	0.5 g/m ² DDT 5% 6 months	-	-

^a R = Resistant; T = Tolerant; S = Susceptible.

^b Coastal belts of Orissa, parts of Maharashtra and Gujarat. Also tracts in Madras, Bihar and Mysore.

? = Not known.

TABLE 1(d). BED-BUG INFESTATION PROBLEM IN THE EUROPEAN REGION

Project	Problem extent Degree as affecting spraying coverage	Extent infested areas Degree infestation	Refusal of spraying Proportion	Health education legal enforcement effectiveness	Insecticide resistance rounds applied before resistance discovered			Insecticides used for control of bed-bugs dosage applied alone or with other insecticides - results obtained (degree effectiveness)						
					DDT	Dieldrin	HCH	Dieldrin	HCH	Malathion	Diazinon	Sevin-85		
Algeria	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Morocco	None	Rabat town ?	?	?	?	?	?	?	?	?	?	?	?	?
Turkey	None None	?	?	?	Yes ?	Yes ?	?	?	?	?	?	?	?	?

? = Not known.

TABLE 1(e). BED-BUG INFESTATION PROBLEM IN THE EASTERN MEDITERRANEAN REGION

Project	Problem extent Degree as affecting spraying coverage	Extent infested areas Degree infestation	Refusal of spraying proportion	Health education legal enforcement effectiveness	Insecticide resistance ^a rounds applied before resistance discovered			Insecticides used for control of bed-bugs dosage applied alone or with other insecticides - results obtained (degree effectiveness)						
					DDT	Dieldrin	HCH	Dieldrin	HCH	Malathion	Diazinon	Sevin-85		
Ethiopia	wherever DDT spraying done significant	? variable	^b -consi-derable 3-38% unsprayed houses	-	-	-	-	-	-	-	-	-	-	-
Gaza Strip	-	20-90% houses	-	-	T	R	-	0.25 g/m ² alone satisf.	0.29 g/m ² sometimes with DDT satisf.	1 g/m ² x 2 rounds 7-8 day interval satisf.	0.2 g/m ² alone	2d	-	-
Iran	Teh. Province insignificant	Dezful Prov. Teh. Province Mild to heavy	-	-	High tolerance ?	R	-	1 g/m ² alone satisf.	-	-	-	-	-	-
Iraq	Some areas insignificant	Restricted geographically ?	-	-	-	-	-	-	-	-	-	-	-	-
Israel	-	-	-	-	R 1951	-	-	0.45 g/m ² alone satisf.	-	-	-	-	-	-
Jordan	No problem	? ?	Yes Not due to bed-bug but to increase of other insects e.g. house-fly	-	-	-	-	-	-	-	-	-	-	-
Libya	No problem	Fezzan Prov.	None	-	? ?	? ?	-	-	-	-	-	-	-	-
Pakistan (E)	Some areas insignificant	? mild	-	-	R 2nd & 3rd year of attack	-	-	-	-	-	-	-	-	-
Pakistan (W)	No problem	? No increase reported	? ?	-	? ?	? ?	-	-	-	-	-	-	-	-

^a R = Resistant; T = Tolerant; S = Susceptible.

^b Inhabitants plastered or washed sprayed surfaces soon after spraying.

^c Chlordane was also used at the rate of 1.6 g/m² in 1952 with satisfactory results.

^d No resistance observed after three years' use (1962).

? = Not known.

TABLE 1(e). BED-BUG INFESTATION PROBLEM IN THE EASTERN MEDITERRANEAN REGION (continued)

Project	Problem extent Degree as affecting spraying coverage	Extent infested areas Degree infestation	Refusal of spraying Proportion	Health education legal enforcement effectiveness	Insecticide resistance ^a rounds applied before resistance discovered			Insecticides used for control of bed-bugs dosage applied alone or with other insecticides - results obtained (degree effectiveness)						
					DDT	Dieldrin	HCH	Dieldrin	HCH	Malathion	Diazinon	Sevin-85		
Saudi Arabia	Some areas insignificant	? mild	-	-	-	-	-	-	-	-	-	-	-	-
Somalia	Widespread significant	Widespread Heavy-mild	Serious up to 60%	-	R	S	-	-	-	-	0.05 g/m ² 0.1 g/m ² w.d.p. with DDT 5% satisf.	-	-	-
Syria	Idleb Prov. ?	Idleb, Hamma, Homs provs., Heavy	? ?	-	R	S	-	?	?	-	-	-	-	-
Sudan	Some areas ?	North of 20°N mild												

^a R = Resistant; T = Tolerant; S = Susceptible.

? = Not known.

TABLE 1(f). BED-BUG INFESTATION PROBLEM IN THE WESTERN PACIFIC REGION

Project	Problem extent Degree as affecting spraying coverage	Extent of infested areas Degree of infestation	Refusal of spraying Proportion	Health education legal enforcement effectiveness	Insecticide resistance ^a rounds applied before resistance discovered		Insecticides used for control of bed-bugs dosage applied alone or with other insecticides - results obtained (degree of effectiveness)					
					DDT	Dieldrin	HCH	Dieldrin	HCH	Malathion	Diazinon	Sevin-85
British Solomon Islands	? very low	? -	-	Moderate Moderate	R 1961	-	-	-	-	-	0.75 g/m ² (60% EC) with and without DDT 5% more effective with DDT	-
Malaysia (West)	? variable	23 000 houses 5000 houses with serious infestation	22.6% house-holders complained 0.18% refused	Partly Undesirable	5th round	-	-	-	-	0.1 - 2 0.2 g/m ² with DDT EC 5% 5 months control	-	-
Malaysia (East - Sabah)	? very low	? Low	? -	Low Moderate	R 4-8	S -	-	-	-	-	-	-

^a R = Resistant; T = Tolerant; S = Susceptible.

? = Not known.

RESUME

En 1967, une enquête a été faite sur divers projets d'éradication du paludisme où une couverture totale par les insecticides s'est révélée impossible du fait de l'opposition de la population, qui attribuait aux pulvérisations une infestation par les punaises des lits. Celle-ci s'est produite dans 32 pays et elle a été considérée comme un problème dans 19 projets d'éradication du paludisme.

Les services antipaludiques qui se heurtent à ce problème peuvent prendre les mesures suivantes :

1. Une enquête destinée à identifier et à délimiter les zones où la résistance des punaises aux insecticides pose un problème pour les opérations de pulvérisation.
2. L'éducation sanitaire, dans laquelle on insistera sur le fait que les insecticides à effet rémanent demeurent efficaces contre le vecteur du paludisme, même s'ils ne le sont plus à l'égard des punaises et d'autres insectes nuisibles qui infestent les maisons. On indiquera également aux habitants comment ils peuvent se débarrasser des punaises.
3. L'emploi d'insecticides, si c'est nécessaire.
 - Les hydrocarbures chlorés, autres que ceux que l'on utilise déjà dans le pays pour l'éradication du paludisme ne sont pas recommandés, à moins qu'il ne soit prouvé qu'ils ne risquent pas de compromettre le succès du projet.
 - Le malathion est l'insecticide de choix, car il est plus sûr et moins coûteux que les autres insecticides plus récents.
 - Tous les autres insecticides que l'on envisage d'utiliser dans la lutte contre les punaises feront l'objet d'un essai à petite échelle à la plus faible des doses recommandées, avant que leur emploi ne soit généralisé.
 - Normalement, les applications d'insecticide destinées à éliminer les punaises se feront séparément, mais on utilisera à cet effet le matériel et la main d'oeuvre du service d'éradication du paludisme et son organisation logistique. On peut associer les deux insecticides si cette solution présente des avantages économiques et techniques.
 - On évitera de traiter les lits et les matelas, ou on ne pulvérisera que de petites quantités d'insecticide, sous forme de brouillard. Il ne faut en aucun cas pulvériser des insecticides sur la literie des nourrissons.
4. L'adoption de mesures judicieuses, ayant force exécutoire peut être indiquée dans certains cas, pourvu que les habitants les acceptent et qu'elles ne portent pas préjudice au programme d'éradication du paludisme.

The purpose of the WHO/mal series of documents is threefold:

- (a) to acquaint WHO staff, national institutes and individual research or public health workers with the changing trends of malaria research and the progress of malaria eradication by means of summaries of some relevant problems;
- (b) to distribute to the groups mentioned above those field reports and other communications which are of particular interest but which would not normally be printed in any WHO publications;
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