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THE PRESENT STATUS OF AIRCRAFT DISINSECTION

By

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The need for measures to prevent the accidental transportation of dangerous insects from one part of the world to another has been accepted for many years. Nevertheless, a survey recently performed by WHO indicated that 1) many International Airports whilst satisfactory from the standpoint of yellow fever could not be so regarded as far as other mosquito vectors of diseases of man are concerned, and 2) disinsection of aircraft throughout the world is on the whole performed ineffectively or not at all.

The ever increasing volume of air traffic, the constantly increasing speed and range of aircraft, the development of insecticide resistant strains of disease - vector mosquitos, the world-wide activities in the eradication of A. aegypti and malaria have tended to aggravate the situation, and the danger of the importation of a non-indigenous or resistant species of mosquito cannot be excluded from the problems confronting many health authorities.

An example of what can happen has recently been described by Burnett. He reports that Aedes (Oechlerotatus) vigilex (Skuse) was almost certainly transported by air into Fiji in 1957. After establishing itself at Suva this mosquito spread along the coast of Vite Levu and soon became the worst post species where conditions favoured its breeding.

The implications of this in International Quarantine are self-evident. WHO has therefore sponsored and undertaken a series of studies and trials on aircraft disinsection, the main points ensuing from which are as follows:

1. In-the-air disinsection, with aerosols cannot be recognized as complying with the requirements of the International Sanitary Regulations.

2. DDVP is a compound well suited for in-the-air disinsection and a mechanical system has been developed for its dispersion during flight. The Expert Committee on Insecticides has consequently recommended its general use for this purpose when the toxicological studies on it now in progress have been completed.

3. Disinsection of aircraft with aerosols on the ground in the absence of passengers is effective but brings about operational delays.

4. "Blocks-away" disinsection, an operation performed after the doors have been locked after embarkation and before take-off, has proved to be biologically effective and acceptable to the airline operators. A report on trials performed by WHO with the "blocks-away" procedure has been published as WHO/Insecticides/128, a copy of which is attached.

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WHO STUDIES ON AIRCRAFT DISINSECTION AT "BLOCKS AWAY"

by

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INTRODUCTION

Studies carried out in the 1930s emphasized the need for disinsecting aircraft at certain points to prevent the accidental dissemination of insect pests and vectors of diseases of man. The use of aerosols for this purpose came into general use during World War II.[8] An extensive literature which has grown up about the subject has been reviewed in several post-war papers[1,2,4,6,7] dealing both with the extent to which aircraft are transporting insects from one area of the world to another and with the methods for disinsecting the aircraft.

Efforts to standardize disinsection procedures at the international level commenced with requirements for aircraft disinsecting recommendations embodied in the International Sanitary Convention for Aerial Navigation, 1933/44, Art. 54.[5] The World Health Organization's Expert Committee on Insecticides endeavoured to adjust these procedures to a rapidly changing air transportation situation at its first, second and seventh meetings in 1949, 1950 and 1956 (reports published in 1950,[11] 1951[12] and 1957[13]).

In its 1951 report,[12] the Expert Committee on Insecticides recommended that disinsection on departure should be undertaken before take-off with all luggage and/or freight loaded, but without passengers. The aircraft was to be kept

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tightly closed during the spraying and for a period of not less than five minutes following the operation. The Committee disapproved spraying during flight. This entire procedure was endorsed by the report of the seventh meeting.[13]

Meanwhile, there was growing concern that aircraft might reintroduce Aedes aegypti into areas where eradication projects had been completed, or resistant anophelines into areas actively conducting malaria eradication campaigns. At the same time the rapid growth of aviation, its increasing speed, and the operating costs of jet aircraft, brought new facilitation problems highlighting the necessity that aircraft disinsection cause the least possible interference with traffic. These facts rendered urgent early agreement on unambiguous and generally acceptable disinsection procedures.

As a result, the whole subject was again considered by the Expert Committee on Insecticides at its eleventh meeting in 1960 (report published in 1961[14]). This Committee recognized the inadequacies of present methods of in-the-air disinsection, and of the pre-departure treatment as currently practised, as well as the disadvantag associated with post-arrival treatment of passenger cabins. It recommended therefor that while aerosols continue to be used for disinsection, the passenger cabin and all other accessible interior spaces of aircraft, except the flight deck, should be treated after the doors have been locked following embarkation and before actual take-off, the operation to be referred to as "blocks away" disinsection. To avoid human error in estimating aerosol dosage, the Committee also advocated employing single-use hand-operated dispensers for this purpose. Since little information was available on aerosol formulations suitable for use in aircraft against resistant vectors, the Committee further recommended that WHO sponsor investigations on the problem.

This paper reports the results of trials of the disinsection principles set fortl by the Committee.

The primary objective of these tests was to determine whether disinsection by means of single-use disposable dispensers at "blocks away" would be effective against mosquitos in regular passenger flights. Secondary objectives were to obtain preliminary information on whether the passengers would react adversely to this metho and to demonstrate to the airlines its convenience compared with the methods presentl in use.

This study was a co-operative effort between the:

(a) Italian, Swiss and United Kingdom Governments;

(b) World Health Organization;

(c) International Air Transport Association;

(d) Entomology Research Division, Agricultural Research Service, USDA;

(e) London School of Hygiene and Tropical Medicine;

(f) Istituto di Malariologia, Stazione Sperimentale, Monticelli (Frosinone), Italy; and the following airlines:

(g) Alitalia; British European Airways; British Overseas Airways Corporation; Deutsche Lufthansa; Pan American Airways; and Swissair.

MATERIALS AND METHODS

Test Aircraft

To assure an adequate coverage of aircraft now in use, tests were made on passenger aircraft of piston, prop-jet, and turbo-jet types, as listed in Tables 1 and 2. During taxiing the circulation of air in the cabin varies in these aircraft and this is of concern in "blocks away" disinsection.

In general, the pressurized piston type aircraft in addition to the pressurization system have a built-in circulating system consisting of a blower and ducts for distributing the air in the cabin. Return ducts are provided to the recirculating blower. The prop-jet Viscount has a similar recirculating system.

In the Boeing 707 and Douglas DC-8 turbo-jets, the air is introduced into the aircraft from auxiliary turbo-compressors and is discharged into the main cabin area along the passenger service unit and overhead rack. The air leaves the cabin through a grill located at floor level and is discharged through outlet valves in the under side of the aircraft. It is a one-way flow without recirculation. In temperate areas the air is changed once in nine to ten minutes during taxiing; in the tropics once every six minutes. Air flow in the Caravelle is similar except that the ventilation system is shut off during take-off.

In the Comet the air comes in at floor level and is removed from the cabin fore and aft through grills; partial recirulation of the air is accomplished by a venturi system. The air is then allowed to escape through valves.

Experimental Aerosols

Two experimental aerosols were used in these tests. The first (given below) was the WHO standard reference aerosol (SRA) referred to in the eleventh report of the Expert Committee on Insecticides;[14] this aerosol has been widely used in Europe, Asia and the Western Pacific.

WHO Standard Reference Aerosol: (10 g aerosol per 1000 cubic feet, [35 g/100 m^3] as recommended by WHO Expert Committee on Insecticides[14])

	Percentage by weight
Pyrethrum extract (25 per cent. pyrethrins)	1.60
DDT technical	3.00
Xylene	7.50
Odourless petroleum distillate	2.90
Dichlorodifluoromethane	42.50
Trichlorofluoromethane	42.50

The formula and dosage of the second aerosol, G-1480, were selected to give three times the pyrethrins and two-thirds the DDT obtained with the recommended dosage of the SRA formula (see tabulation below). This formula was promising in the control of resistant mosquitos. G-1480 was a modification of the G-1029 aerosol referred to in the eleventh report of the Expert Committee on Insecticides[14] and had been in use for many years for disinsecting aircraft in the Americas. The formula was modified by increasing the propellant ratio so that a dosage of 18.8 g of G-1480 per 1000 cubic feet was equivalent to the 10-g dosage of G-1029 normally used. This modification was based on the concept that a more dilute aerosol of reduced particle size was necessary to cope with the large flow of non-recirculating air that is flushed through jet aircraft cabins under "blocks away" disinsection conditions in the tropics.

G-1480: (18.8 g aerosol per 1000 cubic feet (equivalent to 10 g of G-1029 per 1000 cubic feet [35 g/100 m^3] as recommended by the Expert Committee on Insecticides[14]

	Percentage by weight
Pyrethrum extract (20 per cent. pyrethrins)	3.40
DDT	1.17
Aromatic petroleum derivative solvents:	
Velsicol AR-60	3.40
Velsicol AR-50	1.10
Dichlorodifluoromethane	63.62
Trichlorofluoromethane	27.31

The amount of aerosol used in the tests for the various aircraft are given in the tables.

The SRA used in these tests was packaged in anodized aluminium cans 21 mm x 58 mm with 12 or 18 g of formulation and fitted with precision valves (spring mechanism removed) and dip-tubes (see Fig. 1). Once activated by pressing down on the button, the valve remained open and the full contents were delivered (at the approximate rate of a gram per second). The particle size produced is 13.5 microns m.m.d.

Plain aluminium containers, 35 mm x 64 mm (1-3/8" x 2-1/2"), were filled with 30 g of the G-1480 formulation and fitted with a break-off tip. The lower end of the tip, inside the container, was fitted with a siphon tube (0.51 mm x 51 mm = 0.020" x 2").

When these G-1480 containers are used, the tip is broken off, which allows the aerosol to flow rapidly through the capillary. The resistance of the capillary tubing to the flow produces a boiling effect when the solution touches the walls of the tubing. The formation of these bubbles provides a break-up of the solution before it reaches the end of the tubing. Since the solution changes to the aerosol form before it leaves the capillary, the size of the hole at break-off point is not critical. The particle size produced is 12.5 microns m.m.d.

Experimental Procedures

For convenience of operation and yet including some long-distance flights, tests were carried out on aircraft flights from London to Baltimore, London to Geneva, and Rome to Geneva. All flights were approximately one to two hours in duration except those to Baltimore, which lasted ten hours. Tests were made during August, Septembe and early October. The test mosquitos were allowed to emerge at room temperature fc acclimatization to the conditions to which they would be subjected during transportation.

Vigorous, adult mosquitos were placed in cylindrical cages (2-1/2" [6.4 cm] in diameter and 7-1/2" [16.2 cm] long) made of wire mesh, either 14 mesh x 18 mesh or 18 x 18 mesh (see Fig. 2). In the aircraft the cages were secured at test stations located at rack, seat and floor levels as shown in Tables 1 and 2. The control insects were sealed in a polyethylene bag (see Fig. 2) and placed in any convenient location in the aircraft.

The London School of Hygiene and Tropical Medicine supplied the susceptible _Aëdes aegypti_ and _Culex fatigans_ used in the tests from London to Baltimore and London to Geneva. They also furnished the DDT-resistant strain of _Aëdes aegypti_ from Trinidad used in two of the tests.

The Istituto di Malariologia Stazione Sperimentale, Monticelli (Frosinone) supplied the mosquitos used in the Rome-Geneva tests (Table 2). The test mosquitos were from four to eight days old and had received one to four blood meals, the last not more than five hours before the test. The presence of a few males in the cages was unintentional. The DDT resistance of the various colonies was as follows: (WHO standard test method for measuring resistance in adult mosquitos, one hour exposure)

Anopheles stephensi	LD_{50}	0.8-1.0 per cent. (DDT)	
A. gambiae	LD_{50}	1.6 per cent.	$LD_{100} < 4$ per cent
Aëdes aegypti	LD_{50}	2.0-2.5 per cent.	
Culex pipiens	$LD_{50} >$	4 per cent.	

This shows that the _Culex_ were distinctly resistant to DDT, while the strains of the other three species can be considered susceptible even if a moderate vigour-tolerance is indicated in _A. gambiae_ and _Ae. aegypti_.

Prior to the flight, the steward (or stewardess) of the airline was thoroughly briefed on the proper method for applying the aerosols in the aircraft as soon as the door was closed for departure, that is, at "blocks away". Aerosols were applied either by hand or by breaking off the tips of fixed units (see Fig. 3) mounted near the overhead racks of the aircraft. For hand application the steward applied the aerosol while slowly walking down the aisle, activating the indicated number of dispensers one at a time The aerosol was directed from a point above and away from the heads of the passengers and more than half a metre from ceilings and walls. The pilot's compartment was not treated.

The recommended dosages to be used in the various aircraft are given in Table 3; the actual dosages applied in the tests are given in Tables 1 and 2.

To assure a record of each test, a data questionnaire was given to the steward, who completed the aircraft flight section of this form. Particular attention was given to passenger reactions. The remainder of the form was completed by the entomologist conducting the test.

The aircraft were met on arrival by an entomologist who received the test mosquitos, the data questionnaire, and the empty aerosol containers. Observations were made immediately on the knockdown of the mosquitos during flight. The insects were then fed with sugar-water and held at room temperature (18-23°C). On the following day mortality counts were made and the insects sexed.

RESULTS AND DISCUSSION

Effect on Mosquitos

The knockdown during flight and the mortality in 24 hours for those mosquitos treated on the London-Baltimore and the London-Geneva flights are given in Table 1. The same information for the Rome-Geneva flights is given in Table 2. A close correlation exists between knockdown and kill. Consistent results indicated that the test procedure was satisfactory.

It was amply demonstrated by the almost total lack of mortality of the control insects used in these tests that mosquitos can be transported by jet aircraft for long distances at high altitudes and remain alive in pressurized and air-conditioned passenger compartments.

It is likewise clear that aircraft disinsection at "blocks away", as recommended by the WHO Expert Committee on Insecticides can be effective in practice. With G-1480 a 100 per cent. mortality of resistant and susceptible mosquitos occurred even at reduced dosages in all but two trials. In one of these (test 8) the non-affected mosquitos were placed directly in front of the air-inlet, in the other (test 16) the dosage was only three-fifths of the recommended.

The SRA aerosol gave 90-100 per cent. mortality against susceptible mosquitos in most trials. Lower mortalities occurring at certain test stations (particularly in the Comet) should be related to the fact that the mosquitos were in cages, which reduce the contact of the insects with the aerosol both initially and by restricting the movements of the mosquitos after they have been irritated by the pyrethrins. This is of particular importance where the ventilation causes uneven distribution of the aerosol. Work by Tew and others[9] has indicated that a 50 per cent. mortality for caged mosquitos in the presence of aerosols may be equivalent to a kill approaching 90-100 per cent. for free-flying insects.

It is therefore likely that there would have been a complete mortality of non-caged susceptible mosquitos in all tests.

The results show that the SRA aerosol fails to give an adequate kill of resistant mosquitos. This deficiency is probably due to the fact that not enough pyrethrins are included in the formula and the high DDT content is of little use against DDT-resistant mosquitos.

Reaction of Passengers

Based on crew reports, reactions from passengers were not always comparable, but certain factors became clear from analysis. In no test was there any unfavourable reaction to the SRA aerosol, whether or not passengers were informed of the treatment. An unfavourable reaction to G-1480 with a higher pyrethrum content and different solvents was marked in some instances and on all flights during which it was applied some objections were noted. Thus, the G-1480 formula, although highly satisfactory from a quarantine standpoint, unfortunately had an irritant effect on passengers.

General Discussion of Disinsection at "Blocks Away"

From these results based on experiments in non-tropical climates, the SRA aerosol is considered suitable for aircraft disinsection at "blocks away" except in areas where DDT-resistant mosquitos may be transported by aircraft. In such situations an aerosol such as G-1480 could be used, with passenger briefing to explain the need.

The single-use aerosol dispensers assured application of correct dosage. The break-off tip type presents less chance of malfunction because of its simplicity and absence of moving parts.

Over a period of years considerable time and money have been spent to develop equipment that would release aerosols from fixed positions in aircraft by means of automatic equipment activated by pressing a button.[3] In three of the trials recorded here, the aerosol units were discharged from holders in fixed positions located 20 feet apart on or near the overhead rack; in 11 tests the units were discharged by hand by a crew member walking slowly down the aisle. Although the insect kill was 100 per cent. in all tests in which the fixed dispensers were used, further effort should probably not be spent on this development for ae sols. This method is more expensive and complicated, and the fixed dispensers deliver too great an initial aerosol concentration in the area of release. This high aerosol concentration annoyed passengers, and in one test dripping on passengers occurred. In addition, passengers will accept procedures carried out by the crew, but a mechanically operated device is a little startling and thus may not be as easily accepted.

However, these objections to a built-in system with mechanical release from fixed points would not apply to odourless vapours that might eventually be introduced for aircraft disinsection.

In the present investigation the ventilation systems in operation at "blocks away" posed no problems and a sufficient time lapse occurred before the aircraft became airborne (4-28 minutes) to allow the aerosol to become effective. It is believed that the G-1480 and probably the SRA aerosol have sufficient reserve potency to be effective under tropical conditions when the air-conditioning may be used at full capacity, but this needs further investigation. Ventilation at "blocks away" has the advantage of creating air movement, which aids in bringing the aerosol to the resting mosquito. However, there are enough data to indicate that the effectiveness of aircraft disinsection may be related to the type of ventilation. In the Comet, 100 per cent. mortality was not obtained where the cages were located on the floor against the incoming air duct.

It is self-evident that disinsection at "blocks away" eliminates the 10-minute delay in aircraft operation caused by present practices. The method was also suitable from the standpoint of availability of the crew for disinsection work in relation to their flight duties during this interval.

Additional research is required to produce an aerosol formulation that would not only be effective against susceptible and resistant mosquitos but also acceptable to passengers. Development of such a formulation would undoubtedly further a joint disinsection procedure satisfactory for both agriculture and public health purposes.

SUMMARY AND CONCLUSIONS

Experiments on disinsection of passenger cabins at "blocks away" (i.e., after the doors have been closed following embarkation and before take-off) with single-use disposable aerosol dispensers have been carried out in six types of aircraft on flights from airports in non-tropical zones.

The following tentative conclusions are drawn:

1. The SRA formulation as used in these tests in single-use disposable dispensers at "blocks away" at a dosage of 10 g/1000 cubic feet (35 g/100 m^3) gives satisfactory control of non-resistant mosquitos in aircraft.

2. The G-1480 formulation applied similarly at "blocks away" at 14 to 19 g/1000 cubic feet (48 g - 64 g/100 m^3) is biologically effective for both resistant and non-resistant mosquitos in aircraft.

3. The SRA formulation creates no passenger reaction, whereas G-1480, containing a higher pyrethrum content and different auxiliary solvents, is markedly irritating to some passengers in aircraft.

4. More research should be carried out to develop a formulation effective against both resistant and non-resistant mosquitos and not offensive to aircraft passengers.

5. Disinsection at "blocks away" with hand-operated single-use aerosol dispensers is acceptable to the airlines and more convenient than aerosol treatments at other periods of the operation. Disinsection by crew members is to be preferred to release of aerosols from fixed stations.

6. "Blocks away" disinsection should be tried on a wide scale in tropical areas, to obtain practical experience with the procedure and ascertain its effectiveness under a greater variety of climatic conditions.

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3LOCKS AWAY" AIRCRAFT DISINSECTION BY MEANS OF SRA
TIONS OR BY HAND). THE MALE (M) AND FEMALE (F)
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e d	Insect stations	No. of insects		% knock-down during flight		% mortality in 24 hours					
						Aëdes aegypti			Culex fatigans		
		Aë.	Cul.	Aë.	Cul.	M	F	Total	M	F	Total
	Rack seat 1A			100	100	100	100	100	100	100	100
	Seat No. 4			100	100	100	100	100	100	100	100
	Floor No. 4			100	100	100	100	100	100	100	100
	Under seat 15			100	100	100	100	100	100	100	100
	Rack seat 3 rear	21	21	100	100	100	100	100	100	100	100
	Sealed in bag on rack	30	21	0	0	0	0	0	0	0	0
	L. rack, F.C.	18	13	72	62	100	100	100	100	100	100
	R. floor seat 3	36	48	100	100	100	100	100	100	100	100
	L. rack, row 16	14	18	100	44	100	100	100	100	100	100
	L. floor row 1	24	37	100	92	100	100	100	100	100	100
	Sealed in bag on rack	21	86	0	0	0	0	0	-	-	1
	L. rack seat 3	20	56	100	100	100	100	100	100	100	100
	R. rack seat 23	27	73	100	100	100	100	100	100	100	100
	L. rack seat 27	28	52	100	100	100	100	100	100	100	100
	L. on seat 10	79	60	100	100	100	100	100	100	100	100
	R. under seat 8	30	54	100	100	100	100	100	100	100	100
	R. rack seat 3	72	50	100	100	100	100	100	100	100	100
	L. under seat 7	24	41	100	100	100	100	100	100	100	100
	R. on seat 11	12	49	100	100	100	100	100	100	100	100
	R. rack seat 4	26	35	100	100	100	100	100	100	100	100
	L. rack seat 27	34	28	100	100	100	100	100	100	100	100
	Flight deck	-	42	-	90	-	-	-	100	89	95
	L. rack row 2	52	30	100	100	100	100	100	100	94	96
		42[b]	-	10[b]	-	44[b]	13[b]	33[b]	-	-	-
	R. rack under seat 5	37	52	100	70	100	100	100	100	54	81
		34[b]	-	10[b]	-	0[b]	0[b]	0[b]	-	-	-
	L. rack row 8	26	49	60	95	83	78	81	100	88	96
		32[b]	-	0[b]	-	0[b]	0[b]	0[b]	-	-	-
	R. under seat row 10	33	34	100	100	100	100	100	100	100	100
	L. rack, row 13	19	33	100	100	100	100	100	100	84	[illegible]
	In sealed bag on rack	67	47	0	0	0	0	0	0	[illegible]	[illegible]

TABLE 1. THE EFFECTIVENESS AGAINST CAGED MOSQUITOS OF "
AND G-1480 AEROSOL FORMULATIONS (APPLIED FROM FIXED STA'
MOSQUITOS USED IN THESE TESTS WERE SUPPLIED BY THE L

Test No.	Aircraft	Route of flight	Air conditioning while taxiing	Taxi time	Test aerosol	Amount of aerosol used	Active ingredients[a]	Release metho
				Min.		g per 1000 cu.ft	mg per 1000 cu.ft	
1	DC-8 (PAA)	London-Baltimore			G-1480 Control (not exposed)	18.8	T: 347 P: 128 D: 219	Fixed
2	DC-8 (PAA)	London-Baltimore	Off	20	G-1480 Control (not exposed	18.8	T: 347 P: 128 D: 219	Fixed
3	Boeing 707 (BOAC)	London-Geneva	50% capacity	10	SRA	9.8	T: 333 P: 39 D: 294	Hand
4	Boeing 707 (BOAC)	London-Geneva	50% capacity	6	G-1480	18.8	T: 347 P: 128 D: 219	Fixed
5	DC-6B (Swissair)	London-Geneva	On		SRA Control (not exposed	9.5	T: 323 P: 38 D: 285	Hand

TABLE 1 (c

Test No.	Aircraft	Route of flight	Air ditioning while taxiing	Taxi time	Test aerosol	Amount of aerosol used	Active ingre-dients[a]	l m
				Min.		g per 1000 cu.ft	mg per 1000 cu.ft	
6	DC-6B (Swissair)	London-Geneva	On	6	G-1480 Control (not ex-posed	13.6	T: 251 P: 92 D: 159	
7	Comet 4B (BEA)	London-Geneva	Fan system only	28	SRA	9.5	T: 323 P: 38 D: 285	
8	Comet 4B (BEA)	London-Geneva	Fan system only	4	G-1480 Control (not ex-posed)	18.9	T: 351 P: 130 D: 221	
9	Comet 4B (BEA)	London-Geneva	Fan system only	6	SRA Control (not ex-posed)	9.5	T: 323 P: 38 D: 285	

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Re-ease method	Insect stations	No. of insects		% knock-down during flight		% mortality in 24 hours					
						Aëdes aegypti			*Culex fatigans*		
		Aë.	Cul.	Aë.	Cul.	M	F	Total	M	F	Total
Hand	L. rack row 1	41	56	100	100	100	100	100	100	100	100
	R. under seat row 6	31	50	100	100	100	100	100	100	100	100
	L. rack row 7	28	37	100	100	100	100	100	100	100	100
	R. under seat R. 14	35	41	100	100	100	100	100	100	100	100
	L. rack row 15	28	64	100	100	100	100	100	100	100	100
	Control sealed in bag, coat rack	24	71	0	0	0	0	0	0	0	0
Hand	L. rack row 18[c]	31	55	100	100	100	100	100	100	100	100
	R. floor row 14[c]	28	59	90	90	100	100	[illegible]	100	96	99
	L. rack row 11[c]	21	72	50	50	56	42	49	83	47	72
	R. floor row 7[c]	28	61	80	100	100	89	93	100	94	98
	L. rack row 1[c]	24	44	10	10	[illegible]	0	0	69	17	55
Hand	L. rack row 18	31 51[b]	32 -	100 100[b]	100 -	100 100[b]	100 100[b]	100 100[b]	100 -	100 -	100 -
	R. floor row 14[d]	37 33[b]	34 -	0 0[b]	0 -	0 0[b]	0 0[b]	0 0[b]	[illegible] -	[illegible] -	0 -
	L. rack row 11	14	35	100	100	100	100	100	100	61	80
	R. floor row 7	51	39	100	100	100	100	100	100	95	98
	L. rack row 1	53 22[b]	34 -	100 100[b]	100 -	100 100[b]	100 100[b]	100 100[b]	100 -	100 -	100 -
	In sealed bag on rack	30	47	0	0	0	0	0	0	0	0
Hand	L. rack row 18	28	11	100	100	100	100	100	-	100	100
	R. floor row 14[d]	15	20	10	100	0	9	7	100	85	90
	L. rack row 11	28	20	80	100	14	19	18	100	100	100
	R. floor row 7	38	18	100	100	100	100	100	100	100	100
	L. rack row 1	30	23	75	100	93	87	90	100	100	100
	Sealed in bag on seat	33	20	0	0	0	0	0	0	0	0

nued)

Insect stations	No. of insects		% knock-down during flight		% mortality in 24 hours					
					Aëdes aegypti			Culex fatigans		
	Ae.	Cul.	Ae.	Cul.	M	F	Total	M	F	Total
In envelope in baggage rack	74	47	0	0	0	0	0	0	0	0
Front of FC compt.										
Behind last row TU seats, R. side	47	43	0	0	0	0	0	0	0	0
In envelope under seat			0	0	0	0	0	0	0	0
In envelope taped to wall			0	0	0	0	0	0	0	0
In envelope near luggage rack			0	0	0	0	0	0	0	0

tion.

TABLE 1 (Conti

Test No.	Aircraft	Route of flight	Air ditioning while taxiing	Taxi time	Test aerosol	Amount of aerosol used	Active ingre-dients[a]	Re-lease method
				Min.		g per 1000 cu.ft	mg per 1000 cu.ft	
10	DC-6B (Swissair)	London-Geneva			Control (not ex-posed)	-	-	-
11	DC-8 (PAA)	London-Baltimore			Control (not ex-posed)	-	-	-

[a] P: Pyrethrins; D: DDT; T: Total

[b] Trinidad strain DDT-resistant mosquitos

[c] The use of 1" Scotch tape (test 7) to secure the cages markedly restricted the air circula

[d] Cages this station were directly in front of air inlet duct.

TABLE 2. THE EFFECTIVENESS AGAINST CAGED MOSQUITOS OF "BLOCKS AW
(APPLIED BY HAND ONLY). FEMALE MOSQUITOS, SUPPLIED BY THE

Test	Aircraft[b]	Route of flight	Taxi time	Test aerosol	Amount aerosol used	Active ingredients[c]	Insect stat
			Min.		g per 1000 cu.ft	mg per 1000 cu.ft	
12	Caravelle (Swissair)	Rome-Geneva	6	SRA Control (not exposed)	11.0	T: 374 P: 44 D: 330	L. rack seat 3 Behind seat 4 R. rack seat 9 R. behind seat 1 L. rack seat 10 In sealed bag on
13	DC-6 (Swissair)	Rome-Geneva	12	SRA Control (not exposed)	9.5	T: 323 P: 38 D: 285	R. aft cabin und L. rack M. cabin L. rack Fr. M. c R. floor Fr. M. L. seat Fr. comp In sealed bag on Fr. compt.
14	DC-6 (Swissair)	Rome-Geneva	12	G-1480 Control (not exposed)	13.6	T: 251 P: 93 D: 158	L. rack rear F. L. under seat re compt. R. rack mid F. On rack forw. cc On front seat F. In sealed bag fc
15	Viscount (Alitalia)	Local training flight (3 hrs)	10	SRA Control (not exposed)	8.9	T: 303 P: 36 D: 267	Rack seat 12a Floor under seat On seats 6c and Rack seat 2c Floor under seat Sealed in bag or

AY" AIRCRAFT DISINSECTION BY MEANS OF SRA AND G-1480 FORMULATIONS
ISTITUTO DI MALARIOLOGIA, ROME, WERE USED IN THESE TESTS.[a]

ions	No. of insects				% knockdown during flight				% mortality in 24 hours			
	Aë.[d]	Cul.[e]	Steph.[f]	Gamb.	Aë.	Cul.	Steph.	Gamb.	Aë.	Cul.	Steph.	Gamb.[g]
	36	37	-	-	100	24	-	-	100	19	-	-
	38	34	-	-	100	6	-	-	100	0	-	-
	36	41	-	-	100	[illegible]	-	-	100	12	-	-
2	32	-	-	-	100	-	-	-	100	-	-	-
	37	39	-	-	100	100	-	-	100	100	-	-
rack	37	35	-	-	0	0	-	-	0	0	-	-
er seat	47	50	52	-	100	98	92	-	100	82	56	-
R.	50	55	51	-	100	71	76	-	100	58	76	-
abin	50	50	49	-	100	100	100	-	100	100	100	-
cabin	41	50	50	-	-	-	-	-	100	92	100	-
t.	51	50	50	-	100	100	100	-	100	98	100	-
seat,	48	56	46	-	-	-	-	-	4	2	0	-
compt.	50	51	45	-	100	100	100	-	100	100	100	-
ar F.	52	48	54	-	100	100	100	-	100	100	100	-
compt.	64	51	54	-	100	100	100	-	100	100	100	-
mpt.	53	50	50	-	100	100	100	-	100	100	100	-
compt.	58	50	53	-	100	100	100	-	100	100	100	-
rw. compt.	37	56	-	-	0	0	-	-	0	0	-	-
	49	49	46	27	100	71	100	100	100	69	100	100
10c	46	45	43	24	100	40	100	100	100	33	93	100
6d	49	46	43	25	100	89	100	100	100	87	100	100
	47	46	44	27	100	65	100	100	100	50	100	100
la	46	47	44	26	100	74	100	100	100	60	100	100
seat	43	46	42	20	0	0	0	0	2	0	0	0

nued)

No. of insects				% knockdown during flight				% mortality in 24 hours			
Ae.[d]	Cul.[e]	Steph.[f]	Gamb.	Ae.	Cul.	Steph.	Gamb.	Ae.	Cul.	Steph.	Gamb.[g]
47	45	42	21	91	42	95	100	94	29	93	96
45	44	48	25	93	43	91	84	89	27	90	88
46	42	44	24	100	74	100	100	100	65	100	100
46	41	39	24	100	61	100	100	100	54	100	100
43	42	42	-	91	64	100	-	88	52	100	-
41	32	34	-	0	0	0	-	5	0	3	-

to 5 males per station.

TABLE 2 (Cont

Test	Aircraft[b]	Route of flight	Taxi time	Test aerosol	Amount aerosol used	Active ingre-dients[c]	Insect stations
			Min.		g per 1000 cu.ft	mg per 1000 cu.ft	
16	Viscount (Alitalia)	Local training flight	15	G-1480	11.2	T: 207 P: 76 D: 131	On the rack On the floor On the seats On the rack On the floor
				Control (not exposed)			Sealed in bag o seat

[a] An effort was made to select only females; sexing after tests showed that there were 0

[b] The air-conditioning was on in tests 13 and 14; off in test 12.

[c] P: Pyrethrins; D: DDT; T: Total

[d] Aëdes aegypti (susceptible) cf. p. 6

[e] Culex pipiens (DDT resistant) cf. p. 6

[f] Anopheles stephensi (susceptible) cf. p. 6

[g] Anopheles gambiae (susceptible) cf. p. 6

TABLE 3. NUMBER AND TYPE OF DISPENSERS USED TO DISINSECT AIRCRAFT, WITH RECOMMENDED DOSAGES

Aircraft	Cabin volume cu.ft	Number of dispensers		
		SRA Aerosol		G-1480 Aerosol
Comet	3160	1 (12-g) + 1 (18-g)	or	2 (30-g)
DC-6	4400	2 (12-g) + 1 (18-g)	or	2 (30-g)
Boeing-707	8000	2 (12-g) + 3 (18-g)	or	5 (30-g)
DC-8	8000			5 (30-g)
Caravelle	3800	2 (12-g) + 1 (18-g)		
Viscount	2680	2 (12-g)	or	1 (30-g)

Figure 1

The single-use SRA and G-1480 aerosol dispensers, with holders for fixed-position mounting for G-1480, shown from left to right. Once activated, dispensers deliver a measured amount of aerosol to assure an adequate dosage.

Figure 2

Wire cages containing Aëdes, Culex, or Anopheles mosquitos placed in high, mid and low positions in aircraft to measure effectiveness of various aerosol treatments. Controls sealed in polyethylene bags and placed aboard the test aircraft.

Figure 3

Steward activating a fixed unit by breaking off tip of container.

Fig 1
WHO studies on aircraft disinsection at «Blocks away»

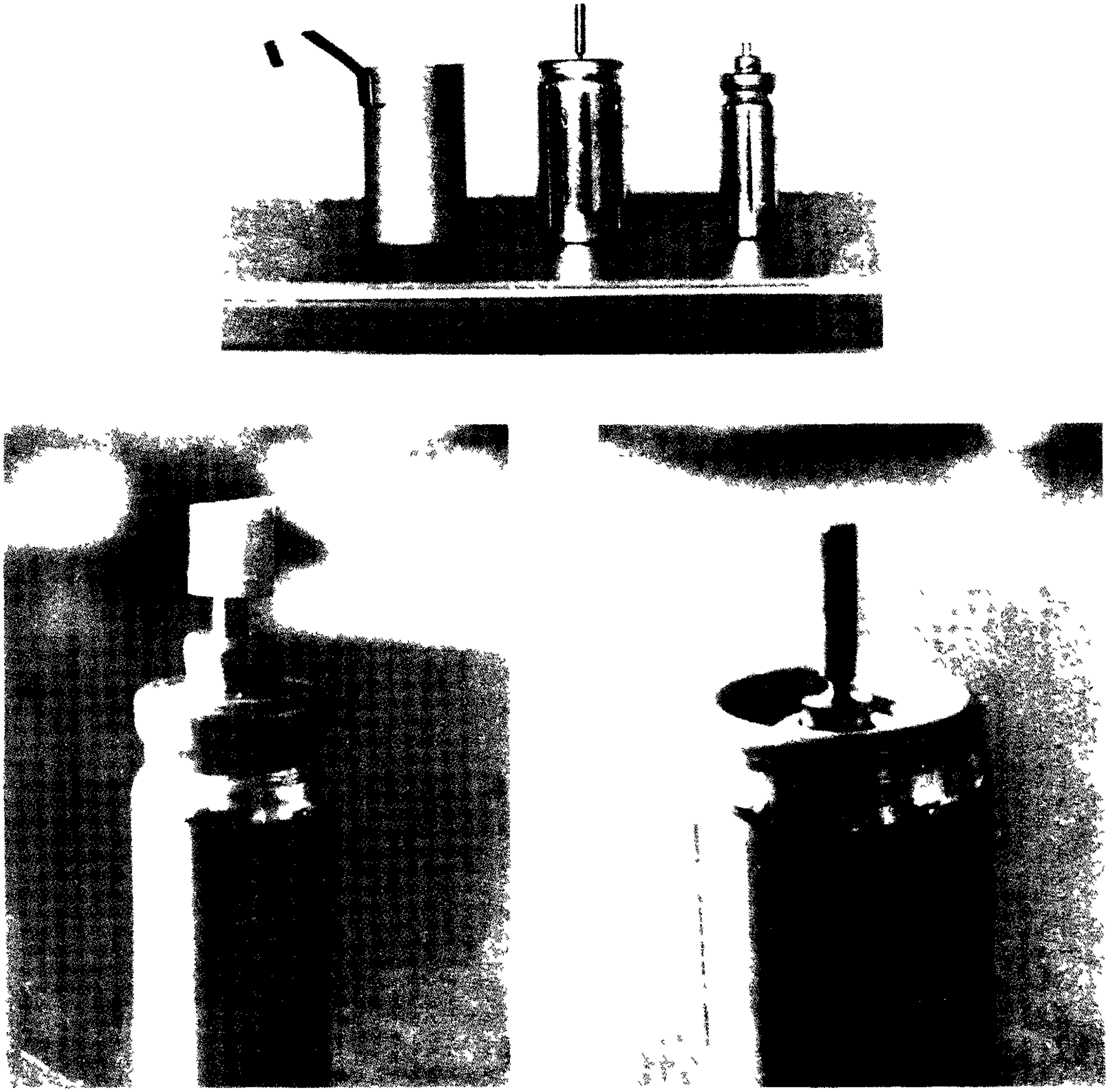

Fig 2
WHO studies on aircraft disinsection at «Blocks away»

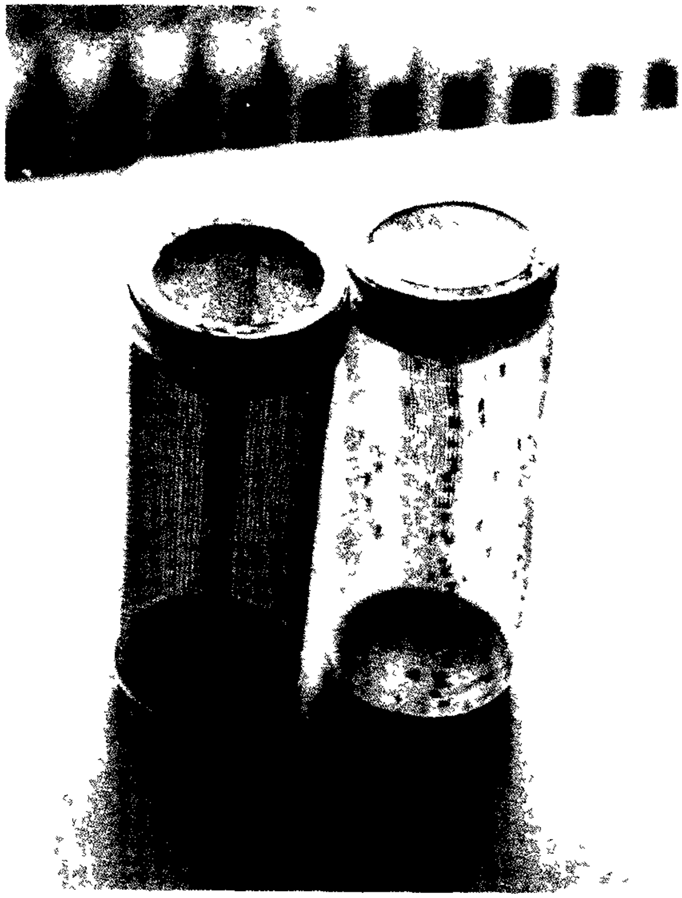

Fig 3
WHO studies on aircraft disinsection at «Blocks away»