CONFIDENTIAL

REPORT
of

THE ARMY AIR FORCES BOARD

ORLANDO, FLORIDA

TESTS CONDUCTED BY

AAF TACTICAL CENTER

ORLANDO, FLORIDA

SUBJECT

TEST TO DETERMINE THE MOST PRACTICABLE MEANS OF DISSEMINATING INSECTICIDES D.D.T. FROM AIRCRAFT

PROJECT No 3486B725 (m-5)212

DATE 14 October 1944

COPY No. 61

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THE ARMY AIR FORCES BOARD
Orlando, Florida VCH/TEE/dh-F

14 October 1944

ARMY AIR FORCES BOARD PROJECT 3486B725

TEST TO DETERMINE THE MOST PRACTICABLE MEANS OF DISSEMINATING INSECTICIDES D.D.T. FROM AIRCRAFT

1. Inclosed herewith is Final Report of the AAF Tactical Center, Orlando, Florida, dated 30 September 1944, subject as above.

2. The AAF Board concurs in the conclusions and recommendations contained in the Final Report of AAF Board Project No. F3486, submitted by the AAF Tactical Center.

3. The AAF Board recommends that action be expedited to initiate the recommendations contained in par. 4j. of subject report.

4. The AAF Board further recommends that a supplementary project, as recommended in par. 4k, subject report, be initiated without delay. Data contained in this report is of an immediate nature and no improvisations or development of equipment has been considered. Subsequent project should review all methods of dissemination to determine the optimum in such operations.

EVALUATED BY:
TED E. ENTER, Lt. Col., CWS, Bomb and Chemical Br., Armament Div., AAF Board.

CONCURRED IN BY:
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A. F. SHEA, Col., AC, Executive, AAF Board.

APPROVED:

For the Army Air Forces Board:

E. L. EUBANK
Brigadier General, U.S. Army
President

OFFICIAL: Robert H. Ueida
Capt AC
for GUSTAV A. NEUBERG
Lt. Colonel, A.G.D.
Recorder

DISTRIBUTION: "D"
S# 5617-1

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ARMY AIR FORCES BOARD PROJECT NO. 3486B725

TITLE: Test to Determine the Most Practicable Means of Disseminating Insecticides DDT from Aircraft.

30 September 1944

1. Object.

To determine the practicability of employing standard aircraft and equipment as a means of disseminating insecticide DDT for area insect control, especially mosquito control.

2. Introduction.

This test was requested by 1st Indorsement, Army Air Forces Board, Orlando, Florida, dated 27 April 1944, to Commanding General, Army Air Forces Tactical Center, Orlando, Florida, to letter from Headquarters, Army Air Forces, to Executive Director, Army Air Forces Board, Orlando, Florida, dated 20 April 1944, subject: Board Project on Dissemination of Insecticide DDT.

a. Description.

(1) DDT, a whitish, light powder, is a synthetic product with the following chemical formula: 2, 2-bis-(p-chlorophenyl) -1,1,1 - trichlorenthane. Previous experimental work has shown that this substance has a variety of insecticidal properties including a high toxicity for mosquito larvae and adults.

(2) DDT is nearly insoluble in water, moderately soluble in petroleum oils, and readily soluble in many common organic solvents. For test purposes the following solutions by weight were used:

(a) 5% DDT, 95% fuel oil.

(b) 5% DDT, 47½% #2 fuel oil, 47½% SAE #10 lubricating oil.

(c) 5% DDT, water emulsion.

(d) 10% DDT, 10% cyclohexanone, 80% #2 fuel oil.

(e) 10% DDT, 10% cyclohexanone, 40% #2 fuel oil, 40% SAE #10 lubricating oil.

(f) 10% DDT, 10% cyclohexanone, 80% kerosene.

(3) The DDT solutions were released from the air from tank, airplane, smoke, M-10 (32 gallon capacity) and tank, airplane, smoke, M-33 (70 gallon capacity), standard Chemical Warfare Service items of issue to the U. S. Army Air Corps.

(4) A-20G and B-25H airplanes were used, respectively, to carry the M-10 and M-33 chemical tanks.

(5) Test areas covered by a heavy jungle type canopy and containing a high adult mosquito population, were chosen. The predominant species were Aedes taeniorhynchus and Anopheles crucians.

b. Problems Presented.

(1) Practicability and suitability of standard aircraft and equipment to disperse DDT solutions from the air for area mosquito control.

(2) Optimum DDT concentration and solutions to obtain immediate and residual toxicity.

(3) Optimum time and frequency of application.

(4) Optimum altitudes and formations for release of spray.

(5) Effectiveness of penetration of jungle type foliage.

(6) Effectiveness of control of larval and adult, both free living and dwelling inhabiting, mosquitoes.

3. Conclusions.

a. An effective reduction of mosquito population, ninety percent (90%) and higher, can be accomplished by the dissemination of DDT from the air using standard aircraft and equipment. It can be assumed that there will be a corresponding reduction in the incidence of malaria and other mosquito-borne diseases in areas so treated. DDT is considered even more effective against flies than against mosquitoes, and it is suggested that the reduction of fly population may contribute to the control of dysentery.

b. Up to fifty percent (50%) reduction of adult mosquito population may be expected in four (4) hours. Maximum reduction is accomplished in twenty-four (24) to forty-eight (48) hours with a residual effectiveness of as much as eighty percent (80%) reduction after a period of five (5) to seven (7) days.

c. It is estimated that effective mosquito control can be accomplished over a normal beachhead area (.5 x 1.5 miles) in the Southwest Pacific, for instance, by nine (9) to twelve (12) A-20 airplanes, each equipped with four (4) M-10 chemical tanks and flying crosswind at minimum altitudes

d. Tank, airplane, smoke, M-10, and tank, airplane, smoke, M-33, unmodified, standard Chemical Warfare Service items of issue to the U. S. Army Air Corps, are equally adaptable for successful application of DDT insecticide solutions from the air.

e. Fighter, dive, light and medium bombardment, combat airplanes, capable of carrying chemical spray tanks and capable of selective release of the contents of these tanks, are functionally satisfactory for release of DDT solution from the air. No reduction in gun load and in the case of wing or belly tanks, no reduction in bomb load is necessary for this operation and these planes can, in addition, proceed to an offensive tactical mission.

f. Due to dependence upon the wind for lateral dispersion of insecticide, crosswind release of spray is most satisfactory. Downwind or upwind release is unsatisfactory due to limited distribution. For efficient dispersion release of spray should not be less than forty-five degrees (45°) quartering to the wind.

g. Steady winds from five (5) to ten (10) miles per hour are optimum. Winds below one (1) or above fifteen (15) miles per hour are unsatisfactory.

h. Treatment of areas is best accomplished in early evening or early morning, due to more favorable meterorological conditions at those times and due to inherent habits of most adult mosquitoes.

i. Applications of solutions of DDT in kerosene, #2 fuel oil, mixtures of half and half SAE #10 lubricating oil and the previous oils, and water emulsions of DDT apparently are not significantly different as concerns the reduction of mosquito population. Ten percent (10%) solutions or emulsions of DDT are necessary in jungle type terrain to achieve ninety (90%) to ninety-five percent (95%) reduction of adult mosquito population and to achieve a residual action for from five (5) to seven (7) days. Five percent (5%) solutions or emulaions of DDT will yield fifty percent (50%) to seventy-five percent (75%) reduction of adult mosquito population in jungle type terrain and a residual action for from two (2) to three (3) days. All of the above solutions will achieve larval control.

j. DDT is slowly soluble in petroleum oils. Amounts greater than five percent (5%) by weight ordinarily will not dissolve. In order to achieve ten percent (10%) solutions, an auxiliary solvent such as cyclohexanone, benzene, trichlorethylene, ethylene dichloride, xylene, acetylene tetrachloride, or carbon tetrachloride must be used

in sufficient proportions, ten percent (10%) to twenty percent (20%) of the solution by weight. Due to variances in purity and composition of various petroleum oils and organic solvents, specific proportions for complete solution of ten percent (10%) DDT must be determined in the field.

k. Animal experimentation has indicated that oily solutions of DDT can be absorbed through the skin in harmful quantities. In addition, liquid absorption of or vapor from many of the auxiliary solvents is harmful. Personnel engaged in mixing these oily solutions will take precautions to prevent repeated or prolonged contact of the solution with the skin or inhaling of the vapors. Contact with small amounts of solutions as from airplane spray has in no instance during the test proved harmful.

l. Approximate and similar reductions of both forest dwelling and house inhabiting adult mosquitoes can apparently be expected.

m. Release of spray from individual spray tanks can be expected to achieve partial reduction of adult mosquitoes over an approximately fifty percent (50%) wider area than that in which ninety percent (90%) or greater control results.

n. The average single tank spray pattern with ten percent (10%) DDT solution which will yield effective mosquito control is for minimum altitude crosswind release one hundred by six hundred (100 x 600) yards for the M-10 chemical tank, and two hundred by nine hundred (200 x 900) yards for the M-33 chemical tank; for two hundred foot altitude crosswind release is two hundred by six hundred (200 x 600) yards for the M-10 chemical tank, and three hundred and fifty by nine hundred (350 x 900) yards for the M-33 chemical tank.

o. The size of the area in which mosquito control is desired will determine the airplane and supply requirements. In order to obtain effective coverage, a spray formation should not consist of less than three airplanes, and for effective control in the air by one formation leader, should not consist of more than one squadron of airplanes. If the area to be treated is of such size as to require more than one squadron of airplnes, two or more independent spray formations will be used.

p. Nine A-20G airplanes, each carrying four M-10 chemical tanks of 10% DDT solution, discharging crosswind in train at minimum altitude are capable of effectively covering an area nine hundred (900) yards in width and twenty-four hundred (2400) yard in length; at two hundred feet altitude, an area eighteen hundred (1800) yards in width and twenty-four hundred (2400) yards in length.

q. Nine P-38 airplanes, each carrying two M-33 chemical tanks of 10% DDT solution, discharging crosswind in train at minimum altitude are capable of effectively covering an area eighteen hundred (1800) yards in width and in length; and at two hundred feet altitude, an area thirty-one hundred and fifty (3150) yard in width and eighteen hundred (1800) yards in length.

r. The entire area in which control is desired will best be treated simultaneously. If simultaneous treatment is not practicable and successive treatments must be made, reference points, in order to obtain concurrent coverage, must be provided. If distinctive terrain features are not present, it is suggested that a strip of target cloth, bunting, a roll of toilet tissue, or similar marker be dropped from the airplane furthermost downwind as a reference point for succeeding spray formations.

s. Table of pertinent facts as concerns dosages, lateral spacing between airplanes, and requirements to be used in jungle type terrain for control of adult and larval mosquito populations is attached as Inclosure No. 3.

4. Recommendations. It is recommended that:

a. The following solution by weight be standard for use in jungle type terrain:

(1) 10% DDT.

(2) 80% #2 fuel oil (principal solvent).

(3) 10% cyclohexanone (auxiliary solvent).

Depending upon availability, kerosene or other fule oils, Diesel oils, or light lubricating oils may be substituted for the principal solvent and trichloro-ethylene, ethylene dichloride, xylene, acetylene tetrachloride, or carbon tetrachloride may be substituted for the auxiliary solvent. The use of 10 to 20% benzene as an auxiliary solvent is not recommended, except as a last resort, because of its low flash point. Water emulsions of DDT may be substituted as emulsion concentrates become available.

b. Formations be flown no less than forty-five degrees (45°) quartering to the wind and chemical tanks be discharged in train to achieve concurrent coverage.

c. In situations where possible enemy action indicates minimum altitude flight, less than fifty feet above the tops of the trees, a formation line abreast, one hundred (100) yard intervals between airplanes carrying M-10 chemical tanks and two hundred (200) yard intervals between airplanes carrying M-33 chemical tanks be used.

d. In all other situations the following be used:

(1) Altitude of flight two hundred (200) feet above the tops of trees.

(2) Line abreast formation.

(3) Two hundred (200) yard intervals between airplanes carrying M-10 chemical tanks.

(4) Three hundred and fifty (350) yard intervals between airplanes carrying M-33 chemical tanks.

e. Treatment of an area include, if possible, at least one-quarter (¼) mile additional treatment on all land sides of the area in which control of mosquitoes is desired.

f. Application of insecticide be made in early evening or early morning.

g. Advantage be taken of chemical companies' air operations, which are present in the field, for the purpose of mixing insecticidal solutions, filling chemical spray tanks, and assisting in arming and hanging of spray tanks on airplanes.

h. Advantage be taken of malaria control units, which are present in the field, for the purpose of determining the necessity and time interval for retreatment of area.

i. Due to necessity for immediate dissemination of information to the field forces and due ot unforeseen decrease of suitable test populations of mosquitoes in this area, results of Events I and II of this project be made available to theatre commanders.

j. Event III, Overseas Application in Combat Areas, of this project be assigned to an air force in the South Pacific Area to determine the following:

(1) Tactical suitability of above recommendations.

(2) Practicability of treating required areas.

(3) Observation of disease incidence and/or control in treated areas.

(4) Intervals of application required to render area relatively free of mosquitoes.

k. A supplementary test be initiated at AAFTAC in which development of improved equipment and technique for distribution of DDT by air to determine and examine all of the best means available and render a complete and final study of such methods.

5. Discussion.

a. Distribution Patterns - Event I.

(1) Test Method.

(a) In order to determine approximate lineal and lateral dispersion, number of droplets per square inch, and range of droplet size, the following ground plan was used. Stations were arranged in three lines six hundred (600) yards in length and one hundred (100) yards apart at right angles to approximate crosswind line of flight. Stations in each line were twenty-five (25) yards apart and consisted of a round glass plate, five (5) inches in diameter, on which the spray was recorded. Line of flight was directed across the furthermost upwind stations, contents of tank being released one hundred (100) to one hundred and fifty (150) yards before reaching line number one.

(2) Thirty-three (33) missions using M-10 and M-33 chemical tanks were completed at varying altitudes and under verying wind conditions. Six (6) preliminary tests were run with a special tank designed for the L-4 airplane by C. N. Husman and O. M. Loncoy of The Orlando, Florida, Laboratory of the Bureau of Entomology and Plant Quarantine. Further tests on this spray tank were deleted from the project due to attention now being given to development of large spray tanks for cargo type airplanes to be used in base and rear area control.

(3) Approximate distance downwind from line of flight at which first droplets hit were as follows: With the wind from five (5) to ten (10) miles per hour and a release altitude of one hundred (100) feet, the first droplets hit from twenty (20) to twenty-five (25) yards downwind; at two hundred (200) feet altitude from forty (40) to fifty (50) yards; and at three hundred (300) feet altitude from fifty (50) to seventy-five (75) yards. With a wind of seventeen (17) miles per hour and a flight altitude of two hundred (200) feet, the first droplets hit from seventy-five (75) to one hundred (100) yards downwind.

(4) Restriction of the discharge line of the M-10 chemical tank indicated unsatisfactory and uneven coverage. A modification of the tail pipe tested in an attempt to produce a smaller range of droplet sizes

showed no improved characteristics of spray pattern or of droplet range over the standard M-10 tank. Since time did not allow further attempts at modification, it was decided to carry on further tests with unmodified chemical tanks to determine the capabilities of standard items of issue.

(5) On typical crosswind flights, wind from five (5) to ten (10) miles per hour, ground speed two hundred and fifty (250) miles per hour, with the M-10 chemical tank, the lineal dispersion was six hundred (600) to six hundred and fifty (650) yards and lateral dispersion was two hundred and fifty (250) to two hundred and seventy-five (275) yards at one hundred (100) feet altitude; two hundred and seventy-five (275) to three hundred and fifty (350) yards at two hundred (200) feet altitude; and two hundred and twenty (220) to four hundred and fifty (450) yards at three hundred (300) feet altitude. Under similar conditions, ground speed two hundred (200) miles per hour, with the M-33 chemical tank, the lineal dispersion was nine hundred (900) to nine hundred and fifty (950) yards and lateral dispersion was two hundred and fifty (250) to three hundred and fifty (350) yards at one hundred (100) feet altitude; three hundred and fifty (350) to five hundred and fifty (550) yards at three hundred (300) feet altitude.

(6) Flight parallel to the wind yielded very heavy ground contamination but lateral dispersion of only twenty-five (25) to seventy-five (75) yards.

(7) Recorded range of droplet sizes for both the M-10 and M-33 chemical tanks on all missions was very similar, varying from two thousandths (2/1000) to two tenths (2/10) of an inch in diameter. As can be expected, the largest droplets were recorded near the upwind edge of the target.

(8) Four (4) tests were run with the M-10 and M-33 chemical tanks, releasing oil spray over jungle type terrain to determine preliminary capabilities of canopy penetration. A blue dye was dissolved in the oil and paper records were set up on the ground at ten (10) and twenty (20) foot levels. Two (2) tests were run with each tank at minimum and one hundred (100) foot levels above the tops of the trees. Results of penetration varied from one (1) to sixty (60) droplets per square inch being recorded. Greater lateral penetration was achieved at the higher altitude of release than at minimum altitude.

b. Applications of Patterns to Adult and Larval Populations - Event II.

(1) Following the tests discussed above, it was decided to begin field trials against natural populations of mosquitoes in jungle type terrain in order to determine the control area (lineal and lateral dimensions) resulting from the release of a single tank of insecticide. Proposed tests against test insects in cages and pans were deleted, being considered an unnecessary duplication of results to be determined against natural populations of mosquitoes.

(2) Test areas were chosen in heavy mangrove and palm jungles near Cocoa Beach, New Smyrna Beach, Vero Beach, and Leesburg, Florida. A high population of adult mosquitoes was present in all areas. Larval breeding areas were not present to any extent, however, in these jungle test plots. In all cases of release from chemical tanks dosage of DDT per acre (range 0.73 to 2.26 lbs. of DDT per acre) are materially greater than the dosage of 0.1 to 0.25 lbs. of DDT per acre as recommended for minimum larval control in War Department Technical Bulletin, Medical Department, No. 14, subject: Use of DDT as a Mosquito Larvicide, dated 3 March 1944.

(3) Effectiveness in reduction of mosquito population was determined by means of recording the reduction in mosquito counts. Field crews recorded the number of mosquitoes alighting on the front of one leg, from waist to ankle, in a period of one minute. Counts were taken at twenty-five (25) yard intervals along three lines, three hundred (300) yards in length, two hundred (200) yards apart, and running through test area perpendicular to crosswind line of release. Contents of tanks were released one hundred (100) yards before reaching the first record line. Pre-counts to determine the natural population of adult mosquitoes were made twenty-four hours and immediately prior to test. Test counts were made four (4), twenty-four (24), and forty-eight (48) hours after treatment and in some cases, an additional count was made at a five (5) or seven (7) day interval after treatment. Recorded pre-counts varied from an average of six (6) to seventy-five (75) adult mosquitoes alighting in the one (1) minute period.

c. Preparation of DDT Oil Solutions.

(1) To prepare a ten percent (10%) solution of DDT the following approximate amounts of materials are necessary per M-10 or M-33 chemical spray tank, respectively:

	M-10	M-33
(a) DDT	28 lbs.	61 lbs.
(b) Auxiliary Solvent	3 - 6 gals.	7 - 14 gals.
(c) Primary Solvent	26 -29 gals.	56 - 63 gals.

(2) Mixing was most readily accomplished in open containers by the addition of the correct amount of DDT to the correct amount of auxiliary solvent for a single chemical tank with sufficient agitation to achieve solution or near solution. This material was then added to a prepared chemical tank and the primary solvent was added to proper fillable capacity. By allowing the tanks to stand for twelve (12) to twenty-four (24) hours previous to use, complete solution was obtained.

d. DDT, as usable for preparation of oil solutions for airplane spray, is listed by the Office of The Quartermaster General as follows:

(1) Item No. 51-I-120 - Larvicide, DDT, powder, dissolving (straight commercial DDT).

e. The following possible auxiliary solvents are issued by the U. S. Army:

(1) Air Corps Issue:

Item	Class	Stock No.	Spec:	Solubility DDT (grs. per 100 mls. solvent)
(a) Benzene	24	8500-220200	4-1016	77-83
(b) Trichloroethylene	24	8500-950000	AN-O-T-631	72-83
(c) Ethylene dichloride	24	8500-460000		56-62
(d) Xylene	24	8500-982000	AN-R-X-876	56-62
(e) Carbon tetrachloride	24	8500-278000	4-503-110	46-48

(2) Chemical Warfare Service Issue:

(a) Acetylene tetrachloride	55-62

(3) Quartermaster or Corps of Engineers Issue:

(a) Carbon tetrachloride 46-48

6. Inclosures:

a. Inclosure No. 1 - Ltr., subject: Board Project on Dissemination of Insecticide DDT, dated 20 April 1944.

b. Inclosure No. 2 - Ltr., subject: Test to Determine the Most Practicable Means of Disseminating Insecticides D.D.T. from Aircraft, Army Air Forces Board Project Number (M-5) 212, dated 10 May 1944.

c. Inclosure No. 3 - Table, DDT Requirement for Aircraft Spraying.

d. Inclosure No. 4 - Table, Airplane Smoke Tanks.

e. Inclosure No. 5 - Table, Preliminary Tests to Determine Effectiveness of DDT Sprayed from Aircraft....Cocoa.

f. Inclosure No. 6 - Table, Preliminary Tests to Determine Effectiveness of DDT Sprayed from Aircraft...New Smyrna.

g. Inclosure No. 7 - Table, Tests to Determine the Effectiveness of Spraying DDT from Mass Plane Formations, A-20G Airplanes with M-10 Tanks Used. Spray Solution Containing 10% DDT and 10% Cyclohexanone and 10% Fuel Oil...Vero Beach.

h. Inclosure No. 8 - Table, Tests to Determine the Effectiveness of Mass Plane Formations Spraying DDT to Control Wild and Domestic Type Mosquitoes Infesting a Military Camp Site. 3 A-20's (4 tanks 10% DDT each) Flown 200 yards Apart at 200 feet Altitude...Leesburg Service Center.

i. Inclosure No. 9 - Report, subject: Tests with M-10 Tank at Vero Beach, Florida, dated 6 September 1944.

j. Inclosure No. 10 - Pictures, B-25's Spraying DDT from M-33 Chemical Tanks.

k. Inclosure No. 11 - Pictures, A-20 Airplanes in Formation Spraying DDT.

Prepared by:

/s/ Ralph B. March
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AAFTAC C.W.S. Project Officer.

Concurred in:

/s/ William N. Sullivan
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Concurred in:

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Approved by:

/s/ Richard W. Simons
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Colonel, Air Corps,
Dep. Director, Operations & Training, AAFTAC.

WAR DEPARTMENT
HEADQUARTERS OF THE ARMY AIR FORCES
WASHINGTON

20 April 44

SUBJECT: Board Project on Dissemination of Insecticide DDT

TO: Executive Director
Army Air Forces Board
Orlando, Florida

1. It is desired that the AAF Board establish a project for test of practical means for distributing insecticide DDT from aircraft for large scale area control.

2. Attached hereto as inclosures Nos. 1, 2, 3, 4 and 5 are notes and other data referable to DDT.

3. The primary object of this project will be to determine the practicability of employing standard aircraft and equipment as means of disseminating insecticide DDT for area insect control, especially mosquito control. The investigation should be carried out under varying conditions of climate and topography and consideration should be given to abundance of vegetation in the area treated.

4. It is expected that findings of the Board will determine whether changes in T/O & T/E's are necessary. From information presently available, it is believed that personnel and tactical equipment now available can be employed to affect insect control.

5. Practice regarding materiel, liaison and reports pertaining to this project will be as follows:

a. Necessary supplies and equipment for this project, not procurable locally, will be requested through this Headquarters, Attention: The Air Surgeon.

b. Direct communication between the AAF Board Project Officer and the Office of the Air Surgeon, this Headquarters, is authorized for purposes of this project and close liaison will be maintained. Liaison will also be maintained with the Chief, Air Surgeon Branch, AAF Tactical Center and with the Bureau of Entomology and Plant Quarantine of the

Incl 1.

Department of Agriculture at Orlando, Florida, by the Project Officer.

c. An informal letter report of the progress will be furnished to this Headquarters at the end of each month.

d. When the limiting factors in the procedure have been determined, field trials in various geographical overseas areas are indicated. The report of the Army Air Forces Board forwarded to this Headquarters for approval will contain recommendations regarding details of proposed trials in overseas areas.

6. The importance of insect-born diseases in practically all theaters of operation is emphasized. The already indicated revolutionary properties of DDT in controlling insect vectors of diseases make it imperative that this project be carried out with vigor and dispatch. This project is assigned a number 2 priority.

By command of General ARNOLD:

/s/ R. H. Macklin

For WILLIAM F. McKEE
Colonel, Air Corps
Deputy Asst. Chief of Air Staff,
Operations, Commitments & Requirements.

5 Incls (in dup)
Incl 1. WD Tech Bul TB Med 14
Incl 2. Notes on DDT
Incl 3. Ltr to AAFTAC 11 Jan 44
Incl 4. Ltr to Gen. Arnold 4 Apr 44
Incl 5. Memo to Col Griffis 12 Apr 44

C O N F I D E N T I A L

BRIEF: Basic ltr dtd 20 Apr 44 fr Hq, AAF, Wash. D.C., Subj: "Bd Proj on Dissemination of Insecticide DDT".

(20 Apr 44) 1st Ind. ELE/VCH/dh-F

THE ARMY AIR FORCES BOARD, Orlando, Florida. 27 April 1944.

TO: Commanding General, AAF Tactical Center, Orlando, Florida. (Attn: Deputy Commander of Operations)

1. The AAF Board requests that the AAF Tactical Center conduct tests to establish practical means for distributing insecticide D.D.T. from aircraft for large scale area control.

2. The AAF Board concurs in the test objective outlined in par. 3 of basic communication, and assigns this test the AAF Board Project No. (M-5) 212, and title, "Test to Determine the Most Practicable Means of Disseminating Insecticides D. D. T. from Aircraft".

3. This is a SECOND PRIORITY experimental test.

4. It is further requested that Lt. Colonel J.Q.A. Daniels, M.C., Medical Inspectors Section, AAF Tactical Center, be appointed Consultant in this test. Attention is also invited to the fact that Captain Ralph B. March, CWS, Chemical Officer, Operations and Training Division, AAF Tactical Center, has participated in a number of preliminary tests in this connection.

5. Lt. Colonel Ted E. Enter, CWS, is appointed the AAF Board Project Officer for this test. The AAF Board further requests that the AAF Board Project Officer be consulted in the preparation of the test program, and that liaison requested in par. 5b, of basic communication be effected.

6. The AAF Board also requests that three (3) copies of the final report, bearing the AAF Board project number be forwarded upon completion of the test.

For the Army Air Forces Board:

/s/ G. W. Mc Gregor, Col. AC

for E. L. EUBANK
Brigadier General, US Army
Executive Director

5 Incls.: 1 cy W/d

S# 5617-16

OLG/RBM/jwb-CTD

10 May 1944

SUBJECT: Test to Determine the Most Practicable Means of Disseminating Insecticides D.D.T. from Aircraft, Army Air Forces Board Project Number (M-5) 212.

TO : Executive Director, Army Air Forces Board, Orlando, Florida.

1. GENERAL:

a. DDT, a whitish, light powder is a synthetic product with the following chemical formula: 2, 2-Bis-(p-chlorophenyl)-1, 1-trichlorethane (Dichloro-diphenyl-trichloroethane). Experimental work during the past year has shown that this substance has a great variety of insecticidal properties, including a high degree of toxicity for mosquito larvae and adults. The larvacidal and insecticidal properties of this chemical have been developed largely by the Bureau of Entomology and Plant Quarrantine, Department of Agriculture, Orlando, Florida, with the encouragement of the Surgeons General of the U. S. Army, U. S. Navy, and the U. S. Public Health Service. Preliminary application of the material by dissemination from aircraft has been carried out by the Department of Agriculture at Orlando, Florida in conjunction with the Army Air Forces Tactical Center, Orlando, Florida. This included development of the first aerosolizing spray unit for use on light (liaison) type aircraft and use of standard CWS smoke tanks employed on tactical aircraft to effect area dissemination. These studies have indicated that it is practical to disseminate solutions of DDT in oil from aircraft.

b. This is a SECOND PRIORITY experimental test.

c. A request has been made for the chemicals which cannot be acquired locally to be shipped to Base Chemical Property Officer, AAFTAC Air Base, Orlando, Florida.

d. The following materials are required for this test:

5500 gals	diesel oil
850 gals	#10 lube oil
2000 gals	DDT
225 lbs	cyclohexanone
60 lbs	anthraquinone blue AF base (dye)
300 ea	pot, smoke, AC, M1
150 yds	target cloth, white
90 ea	air inlet closure plates for M10 smoke tanks

Incl 2

S# 5617-17

180 ea	air inlet gaskets for M10 smoke tank
90 ea	discharge closure plates for M10 smoke tank
180 ea	discharge gaskets for M10 smoke tank
180 ea	No. 4, electric blasting caps, 4 to 6 ft. leads
1 ea	set, accessories for airplane smoke tank M33

The above requirements are necessary in order to cover variations in flight methods and unforseen field contingencies such as test repetitions.

e. This test is requested by 1st Ind, Army Air Forces Board, Orlando, Florida, dated 27 April 1944, to Commanding General, Army Air Forces Tactical Center, Orlando, Florida, to letter from Headquarters Army Air Forces to Executive Director, Army Air Forces Board, Orlando, Florida, dated 20 April 1944, subject: "Board Project on Dissemination of Insecticide DDT".

f. Captain Ralph B. March, CWS, Chemical Officer, Operations and Training Division, Army Air Forces Tactical Center, Orlando, Florida, is designated AAFTAC Project Officer. Lt. Col. J. Q. A. Daniels, MC, Air Surgeon Branch, Army Air Forces Tactical Center, is designated AAFTAC Consultant.

2. OBJECT:

To determine the practicability of employing standard aircraft and equipment as a means of disseminating insecticide DDT for area insect control, expecially mosquito control.

3. METHOD OF CONDUCTING TEST:

a. Phases.

(1) Preliminary.

(a) Test areas, ½ mile square, of the following types will be provided.

1. Open, clear of trees and high vegetation.

2. Wooded, jungle type foliage.

3. Natural, including open, jungle, and marshes, containing mosquito population.

(b) Storage of chemicals, mixing of insecticide, filling, handling, and hanging (when necessary) of chemical spray tanks will be performed by chemical troops. Test area duties, including conduct of mosquito biting tests, will be performed by medical troops.

(c) The following mixtures of DDT will be prepared:

1. 10% DDT in 40% diesel oil, 40% #10 lube oil, 10% cyclohexanone.

2. 5% DDT in diesel oil.

(d) M10 and M33 smoke tanks will be provided by CWS. Smoke tanks for liaison type aircraft will be provided by Medical Department or Department of Agriculture.

(e) General airplane requirements will be as follows:

1. Two A20G airplanes each capable of carrying four (4) M10 smoke tanks, two B25 airplanes each capable of carrying one (1) M33 smoke tank, and one liaison type aircraft during Event I and tests 1, 2, and 3 of Event II.

2. Four A20G airplanes, four B25 airplanes, and one liaison type aircraft during tests 4 and 5 of Event II.

3. One P51B airplane capable of carrying two (2) M10 smoke tanks and one (1) P63 airplane capable of carrying one (1) M10 smoke tank during portion of tests 1 and 2 of Event I.

4. Services of the same airplanes and same pilots will be provided for all tests if practicable.

(f) Daily operations' schedules will be prepared by AAFTAC Project Officer as far in advance as possible and submitted to all agencies concerned.

(g) Test insects will be provided by Medical Department or Department of Agriculture. Reconnaissance for mosquito populations and breeding areas will be the responsibility of the Medical Department or Department of Agriculture.

(2) Main.

(a) Event I - Distribution Patterns.

1. Crosswind spray pattern with diesel oil from one M10 smoke tank, modified and unmodified tail pipes, from altitudes of 100, 200, and 300 feet.

2. Crosswind spray pattern with diesel oil from two (2) M10 smoke tanks (simultaneous release), modified and unmodified tail pipes, from altitudes of 100, 200, and 300 feet.

3. Crosswind spray pattern with diesel oil from one M33 smoke tank from altitudes of 100, 200, and 300 feet. Results of this test will indicate modification of discharge line, if necessary.

4. Crosswind spray patterns with diesel oil from spray tank on liaison type aircraft from altitudes of 10, 50, and 100 feet.

5. Upwind, down wind, and quartering wind spray patterns with diesel oil using best of each of above installations and best altitude of release as determined from above tests.

6. Penetration of jungle foilage with diesel oil spray from one and two (simultaneous release) M10 smoke tanks, modified and unmodified tail pipes, from altitudes of 100, 200, and 300 feet.

7. Penetration of jungle foilage with diesel spray from one M33 smoke tank from altitudes of 100, 200, and 300 feet. This test will be repeated with modified discharge line if shown necessary in above tests.

8. Penetration of jungle foilage with diesel oil spray from spray tank on liaison type aircraft from minimum altitude.

(b) Event II - Application of Patterns to Larval and Adult Populations.

1. Larval and adult test insect kill with best adaptation of M10 smoke tank from 100, 200, and 300 feet using 5% and 10% solutions of DDT.

2. Larval and adult test insect kill with best adaptation of M33 smoke tank from 100, 200, and 300 feet, using 5% and 10% solutions of DDT.

3. Larval and adult test insect kill with spray tank on liaison type aircraft from altitudes of 10, 50, and 100 feet, using 5% and 10% solutions of DDT.

4. Larval and adult insect kill under natural breeding conditions with M10, M33, and liaison type aircraft spray tanks, using best methods of release determined from the above.

5. Larval and adult insect kill under natural breeding conditions using best methods of previous tests before and after precipatation.

(c) Event III - Overseas Application in Combat Areas.

Scheduling of tests for this event is dependent upon the final results of Event I and II. Upon assignment to an active theater, representative of Theater Commander, and Army Air Forces Board, will schedule the necessary test programs.

(d) General.

1. The procedures as outline herein to conduct these tests may require modification and changes based on conditions and factors existing at the time of the tests. These modifidations may be made at all times at the discretion of the project officer.

2. Any test or event may be repeated at the decision of the project officer.

3. Liaison will be maintained with Chief, Air Surgeon Branch, AAFTAC, and with the Bureau of Entomology and Plant Quarrantine of the Department of Agriculture at Orlando, Florida, by the project officer.

(3) Final.

At the conclusion of these tests a conference of all participating personnel will be held.

4. RECORDS.

a. The lateral and lineal dispersion of spray from all representative flights will be recorded by ground measurement.

b. The approximate droplet sizes from all representative flights will be measured.

c. The penetration thru foliage for all representative flights will be noted at tree top, medium and ground level.

d. Test insect kill will be recorded both from contact and residual standpoint.

e. Area control will be measured by larval kill and biting rates for two nights previous to insecticide application and five (5) nights, or longer, after application.

f. All pertinent flight data, spray tank data, and meteorological data will be recorded for each test.

g. Motion pictures and still photographs will be taken as directed by project officer.

5. REPORTS.

A final report will be prepared by the project officer, after a conference of all participating personnel and will be submitted to Deputy Commander for Operations, AAFTAC, thru Chief, Air Surgeon Branch, AAFTAC, for approval, immedately upon completion of the test.

By command of Major General HOUSE:

O. L. GROVER
Colonel, Air Corps
Deputy Commander for Operations

Prepared by:

RALPH B. MARCH
Capt, CWS
AAFTAC Project Officer

Concurred in:

J. Q. A. DANIELS
Lt Col, MC
AAFTAC Consultant

Concurred in:

R. W. SIMONS
Colonel, AC;
Actg. Chief,
Operations and Training Division

TABLE - DDT REQUIREMENT FOR AIRCRAFT SPRAYING

Spray Tank	Altitude Above Tops of Trees	Lineal Coverage in Yards	Lateral Spacing Between Airplanes in Yards (Lateral control 90-100% mosquito reduction	Single Tank Coverage, 90-100% Control in Acres	Liquid Insecticide per Acre in Gallons	DDT per Acre in Pounds	Spray Tanks Required per Sq Mile	Liquid Insecticide required per Sq. Mile in Gallons	Auxiliary Solvent 10-20% by Weight Required per Sq.Mile in Gallons	DDT Required per Sq. Mile in Pounds
MIO	Minimum less than 50 feet	600	100	12.4	2.5	2.26	51	1632	153-306	1428
MIO	100 feet	600	150	18.6	1.7	1.50	34	1088	102-204	952
MIO	200 feet	600	200	24.8	1.3	1.13	26	832	78-156	728
MIO	300 feet	600	250	30	1	.93	22	704	66-132	616
M33	Minimum less than 50 feet	900	200	37.2	1.9	1.87	18	1260	126-252	1098
M33	100 feet	900	250	46.5	1.5	1.31	14	980	98-196	854
M33	200 feet	900	350	65.1	1.07	.94	10	700	70-140	610
M33	300 feet	900	450	83.7	.84	.73	8	560	56-112	488

Incl 3

S# 5617-23

C O N F I D E N T I A L

TABLE - AIRPLANE SMOKE TANKS

Gross Capacity (gal)	Fillable Capacity (gal)	Empty Tank Weights (lbs)	Discharge Time (sec/tank)	Wt. of Filling (lbs)	Airplane	Tanks per Plane	Position	Load Limit
M-10 Tank 33 gal	32 gal	Empty Tank & Fitting- 68 lbs.	6 sec	DDT Oil Solu-	P-38, F-M	2	Wings	Full Tanks
				tions	P-39, D-Q	1	"	"
				284 lbs	P-40, E-N-1	1	"	"
					P-40, N-5-40	2	"	"
						1	Fuselage	"
					P-51, A-D	2	Wings	"
					P-63, A-D	1	Fuselage	
					A-20, 6, H, J, K	4	Wings	"
					A-26, A, B,	4	"	"
					A-36 A	2	"	"
					B-25, C-J	4	"	"
M-33 Tank 78 gal	70 gal	Empty Tank & Fittings 155 lbs. M 1 Discharge line for bomb bay tanks M 2 Discharge for wing tanks	8 sec	DDT Oil Solu-	P-38, F-M	2	Wings	Full Tanks
				tion	P-47, DH5-D25	2	"	"
				616 lbs	B-25, C-4	1	Bomb Bay	"
					B-26,	2	"	"

Incl 4

S# 5617-24

INCLOSURE V

Table, Inclosure No. 5, represents the results obtained with the first tests which were run at Cocoa. An A-20G airplane with two (2) M-10 tanks mounted under each wing was used for these tests. Flying crosswind, wind velocity 6 - 7 miles per hour, at air speed of 220-250 miles per hour, and at minimum altitude, one tank was discharged spraying DDT over an area 100 yards wide by 600 yards in length. This predetermined area had been studied to determine mosquito population density and was checked at 4, 24, and 48 hour intervals following spraying. The superiority of 10% DDT is immediately apparent, although further investigation of the 5% DDT emulsion is indicated. Attention is called to the residual action 48 hours later and to the effect on the mosquito populations further than 100 yards from the line of flight.

TABLE - PRELIMINARY TESTS TO DETERMINE EFFECTIVENESS OF DDT SPRAYED FROM AIRCRAFT

TANK TYPE	ALTITUDE ABOVE TREE TOPS	SOLUTION USED	NUMBER OF OBSERVATIONS	PERCENTAGE OF REDUCTION REDUCTION OF MOSQUITOES LATERAL TO LINE OF SPRAY					
				0-100 yards from spray point			101-200 yards from spray point		
				4 hr.	24 hrs.	48 hr.	4 hr.	24 hr.	48 hr.
M-10	Minimum	5% DDT 47½% #2 Fuel Oil 47½% #10 Lube Oil		0 0 0	0 31 0	0 15 12	0 0 0	93 17 3	0 0 0
			Total 96	Ave 0	10	9	0	38	0
M-10	Minimum	5% DDT 10% Cyclohexanone 42½% #2 Fuel Oil 42½% #10 Lube Oil		0 0 68	60 59 64	0 0 20	0 24 0	0 12 43	0 15 0
			Total 98	Ave 23	61	7	8	18	5
M-10	Minimum	5% DDT in #2 Fuel Oil		0 0 10 0	51 10 8 50	43 54 62 27	28 36 0	28 24 0	54 50 0
			Total 21	Ave 2	30	47	21	18	34
M-10	Minimum	5% DDT Emulsion		54 65 68 60 73 66	99 99 100 95 - -	100 100 90 93 78 77	35 66 	- - 	0 90
			Total 20	Ave 64	98	90	50		45
M-10	Minimum	10% DDT 10% Cyclohexanone / 80% fuel oil		58 74 40 0 36 0	90 95 93 90 67 60	100 100 96 89 83 90	25 55 	35 0 	42 55
			Total 24	Ave 35	82	93	40	18	49

INCLOSURE VI

Table, Inclosure No. 6, represents results obtained with two different tank types and two different DDT concentrations. They were performed at New Smyrna by an A-20G airplane with the M-10 wing tanks and a B-25H airplane with M-33 tank in bomb bay. Flying crosswind at 220 - 250 miles per hour, wind velocity 6 - 7 miles per hour, and at varying altitudes, DDT was discharged in the conventional manner. The ususl mosquito density studies pre-count 4, 24, and 48 hours were made. The excellent 24 and 48 hour reduction of mosquito density with 10% DDT from varying altitudes is well demonstrated and the superiority of a 200 ft. altitude above tree tops over other altitudes is shown. Once again the 10% solution was shown to be more effective than the 5%. Attention is drawn to the good lateral effectiveness of the spray, with a 50% or greater reduction of mosquitoes 300 - 400 yards from line of flight. The chief advantages of using the M-33 type tank noted were that a 50% increase in length of spray path and a better lateral distribution of DDT was effected. However, the doubling of the amount of oil sprayed (M-10 = 32 gallons, while M-33 = 70 gallons) over a slightly larger area resulted in slightly better rates with 5% DDT than achieved elsewhere, but the results do not compare with those of 10% DDT in the M-10 tank.

TABLE PRELIMINARY TESTS TO DETERMINE EFFECTIVENESS OF DDT SPRAYED FROM AIRCRAFT

TANK TYPE	ALTITUDE ABOVE TREE TOPS	SOLUTION USED	NUMBER OF OBSERVATIONS	PERCENT REDUCTION OF MOSQUITOES LATERAL TO LINE OF SPRAY											
				0 - 100 Yards			101 - 200 Yards			201 - 300 Yards			301 - 400 Yards		
				4 hr	24 hr	48 hr	4 hr	24 hr	48 hr	4 hr	24 hr	48 hr	4 hr	24 hr	48 hr
M-33	50	5% DDT in #2 Fuel Oil	141	78	89	76	63	88	80	71	89	60	60	72	52
				81	92	41	80	84	32	80	63	10	80	96	48
				65	79	25	76	92	10	88	72	28	60	72	40
				87	9	41	68	44	22	64	30	0	52	8	14
				Ave 78	67	46	72	77	36	76	64	24	63	62	39
M-33	150	5% DDT in #2 Fuel Oil	184	68	73	63	72	69	64	68	84	60	36	72	60
				23	79	47	20	80	84	32	96	56	36	60	80
				31	70	60	14	72	40	32	64	59	18	76	44
				89	84	41	76	80	48	68	64	56	68	60	60
				Ave 53	77	53	45	75	59	50	77	58	39	67	61
M-33	300	5% DDT in #2 Fuel Oil	169	65	81	72	59	60	59	35	65	60	-	67	-
				69	-	71	52	-	91	60	-	87	-	-	85
				71	95	92	51	92	91	58	94	86	35	90	91
				83	100	86	-	87	65	-	84	52	-	81	21
				Ave 72	92	80	54	80	76	51	81	71	35	79	66
M-10	100	10% DDT 10% Cyclohexanone 80% #2 Fuel Oil	109	0	71	96	33	53	41	42	37	22	33	50	21
				0	-	87	16	83	88	16	50	71	0	50	62
				66	45	83	75	75	92	67	62	62	66	54	66
				Ave 22	58	89	41	70	74	42	50	52	33	51	50
M-10	200	10% DDT 10% Cyclohexanone 80% #2 Fuel Oil	123	89	100	100	44	50	87	75	46	92	67	33	79
				83	96	96	61	79	92	89	41	83	77	62	83
				58	92	92	94	89	94	87	55	44	83	50	41
				Ave 77	96	96	66	73	91	84	47	73	76	48	68
M-10	300	10% DDT 10% Cyclohexanone 80% #2 Fuel Oil	143	44	90	100	33	83	94	48	54	87	50	58	89
				25	92	67	0	87	79	25	79	70	0	54	62
				58	96	54	67	83	47	58	62	58	50	58	58
				25	84	92	50	72	72	25	83	100	50	78	72
				Ave 38	90	78	37	81	73	39	69	79	37	62	70

S# 5617-28

TABLE - PRELIMINARY TESTS TO DETERMINE EFFECTIVENESS OF DDT SPRAYED FROM AIRCRAFT (Continued)

TANK TYPE	ALTITUDE ABOVE TREE TOPS	SOLUTION USED	NUMBER OF OBSERVATIONS	PERCENT REDUCTION OF MOSQUITOES LATERAL TO LINE OF SPRAY 0-100 yards from spray point 4 hr.	24 hr.	48 hr.	101-200 yards 4 hr.	24 hr.	48 hr.
M-10	Minimum	5% DDT		0	96	76	-	15	-
		10% cyclohexanone		25	99	75	-	75	-
		85% Fuel Oil		70	88	84	-		
				68	80	83			
				78	82	64			
				87	75	37			
			Total 20	Ave 55	87	70		45	
M-10	Minimum	10% DDT	31	0	96	57	0	57	20
		10% Cyclohexanone	31	69	79	69	31	63	65
		40% #2 Fuel Oil	24	80	-	-	53	75	56
		40% #10 Lube Oil							
			Total 86	Ave 50	88	53	28	65	47
M-10	Minimum	10% DDT	16	61	95	78			
		10% Cyclohexanone	16	32	74	0			
		80% Kerosene	16	59	85	28			
			Total 48	Ave 51	85	35			

INCLOSURE VII

Tests were run at Vero Beach, Florida, to determine whether a mass flight of planes, all spraying DDT at the same time, would give an increased kill against insects, by overlapping of spray deposits on the ground. In this investigation 5 A-20G airplanes, each with 1 M-10 tank containing 10% DDT were flown in line 100 yards apart at minimum altitude. T he plot treated was a dense jungle area approximately 500 yards square. In 252 pre-counts there was an average of 6.1 mosquitoes lighting on 1 trouser leg in one minute (each count). The contents of the M-10 tanks were released simultaneously over the area and good penetration and coverage were obtained. The results of these tests are shown in Table, Inclosure No. 7.

Excellent results were obtained and the increased kill over previous tests indicated the value of overlapping spray deposits. For instance, the adult mosquito population was reduced 54% in 4 hours, 92% in 24 hours, and 95% after 48 hours. A study of Table, Inclosure No. 7, shows that within 24 hours a soldier could go almost anywhere in the treated area with complete freedom from mosquitoes. The value of this treatment for beachhead areas where 20 - 30 percent of the troops sometimes contract malaria or dysentery on D to D plus 2 days becomes obvious.

Incl 7

TABLE - TESTS TO DETERMINE THE EFFECTIVENESS OF SPRAYING DDT FROM MASS PLANE FORMATIONS, A-20G AIRPLANES WITH M-10 TANKS USED. SPRAY SOLUTION CONTAINING 10% DDT & 10% CYCLOHEXANONE & 80% FUEL OIL.

Reduction Mosquitoes Along Line of Flight	Mosquito Reduction - Lateral Area Covered by 5 Plane Formation														
	Plane #1			Plane #2			Plane #3			Plane #4			Plane #5		
	100 Yd wide swath			100 yd wide swath			100 yd wide swath			100 yd wide swath			100 yd wide swath		
	4 hr	24 hr	48 hr	4 hr	24 hr	48 hr	4 hr	24 hr	48 hr	4 hr	24 hr	48 hr	4 hr	24 hr	48 hr
Yards	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
25	34	84	84	16	100	84	16	84	84	-	43	75	-	75	92
50	84	100	84	18	100	100	16	100	84	1.7	92	84	-	50	75
75	84	100	100	16	100	84	-	84	100	9.8	92	92	50	75	84
100	100	100	100	18	100	100	16	100	100	26	92	100		75	75
125	100	100	100	50	100	100	67	100	100	75	92	100			100
150	84	100	100	67	100	100	67	100	100	50	100	100			92
175	100	100	100	50	100	100	67	100	84	75	100	100			
200	100	100	100	84	100	100	84	100	100	92	100	100	LAGOON		
225	84	100	100	67	100	100	100	100	100	100	100	100			
250	67	100	100	100	100	100	100	100	100	92	100	100			
275	50	100	100	100	100	84	100	100	100	100	100	100			
300	84	100	100	100	100	100	100	100	100	100	100	100	1.7	59	92
325	67	100	100	84	100	100	100	100	100	100	100	100	-	75	100
350	100	100	100	100	100	100	100	100	100	100	100	100	-	100	100
400	67	100	100	100	100	84	100	100	100	100	100	100			
425	50	84	84	100	100	100	84	100	100	100	100	100			
450	67	100	84	84	100	100	100	100	100	100	100	100			
475							100	100	100						
500							100	100	100						

RIVER

S# 5617-31

INCLOSURE VIII

Tests were made at the Leesburg Service Center to determine the effectiveness of a massed flight of A-20G airplanes in spraying 10% DDT on a heavily infested military camp site. Pre-counts showed a heavy infestation of Anopheles quadrimaculatus adults within buildings and there were a large number of Psorophora outdoors. Here the main point was to determine the ability to kill mosquitoes indoors because most of the dangerous malaria carrying mosquitoes of the world are domestic. The plane formation used and the type of insect observations made are given in Table, Inclosure No. 8.

The ability of the fine DDT fog or mist to penetrate within buildings and kill adult anopheles mosquitoes was demonstrated. It will be noted that a 91% reduction of Anopheles quadrimaculatus was obtained in 48 hours and one week later the population was still reduced by 80%. Outdoors, biting records were obtained by enlisted men exposing legs over a 1/2 hour period. This method showed a 77% general mosquito reduction in 12 hours and an 80% reduction of A. quadrimaculatus. A light trap indicated a 64% mosquito reduction in 12 hours. It is to be remembered that the dense mosquito population in surrounding areas was continually migrating into the treated area. How many of these mosquitoes were killed by the spray residue deposit on entering the treated area is now known, but it was probably considerable.

TABLE - TESTS TO DETERMINE THE EFFECTIVENESS OF MASS PLANE FORMATIONS SPRAYING DDT TO CONTROL WILD AND DOMESTIC TYPE MOSQUITOES INFESTING A MILITARY CAMP SITE. 3 A-20's (4 TANKS 10% DDT EACH) FLOWN 200 YARDS APART AT 200 FEET ALTITUDE. LEESBURG SERVICE CENTER, FLA.

TEST INSECT	TYPE OBSERVATION MADE (All made in treated area)	PRECOUNT (NO INSECTS)	MOSQUITO REDUCTION 4 hrs. %	12 hrs. %	24 hrs. %	48 hrs. %	1 week %
Anopheles quadrimaculatus	Adult mosquitoes resting in house	44	60	-	91	90	87
	Adult mosquitoes in shed	85	5	-	79	87	79
	Adult mosquitoes in house & outlying shed	91	0	-	62	95	73
	Ave	73	22	-	77	91	80
General mosquito Population	Mosquitoes biting exposed EM at night	39		70			
	Same - Station #2	39		95			
		63		67			
	Ave	47		77			
Anopheles quadrimaculatus	Biting exposed EM at night	5		80			
General mosquito population	Light trap	109		64			

CONFIDENTIAL

P. O. Box 3391
Orlando, Florida
September 6, 1944

To: W. E. Dove, In Charge, Insects Affecting Man and Animals, Washington, D.C.

From: E. F. Knipling, Senior Entomologist

Subject: Tests with M-10 Tank at Vero Beach, Florida

At the invitation of Col. Otis B. Schreuder, Chief, Air Surgeon Branch, AAFTAC, Howard A. Jones; P. M. Eide; and A. H. Madden observed a test of the application of DDT spray with the M-10 tank (chemical warfare) for the control of salt-marsh mosquitoes at Vero Beach, Fla., on September 2 and 3.

The application was made at 11:00 a.m., September 2, by five A-20-G's flying in lateral formation 100 yards apart, each carrying an M-10 tank contained 27.5 gallons of 10 per cent DDT and 10 per cent cyclohexanone in No. 2 fuel oil. The test area consisted of a dense jungle 600 yards by 500 yards. The planes flew from north to south at an altitude of 100 to 150 feet and a speed of 250 m.p.h. The wind was east-northeast at about 3 to 4 m.p.h.

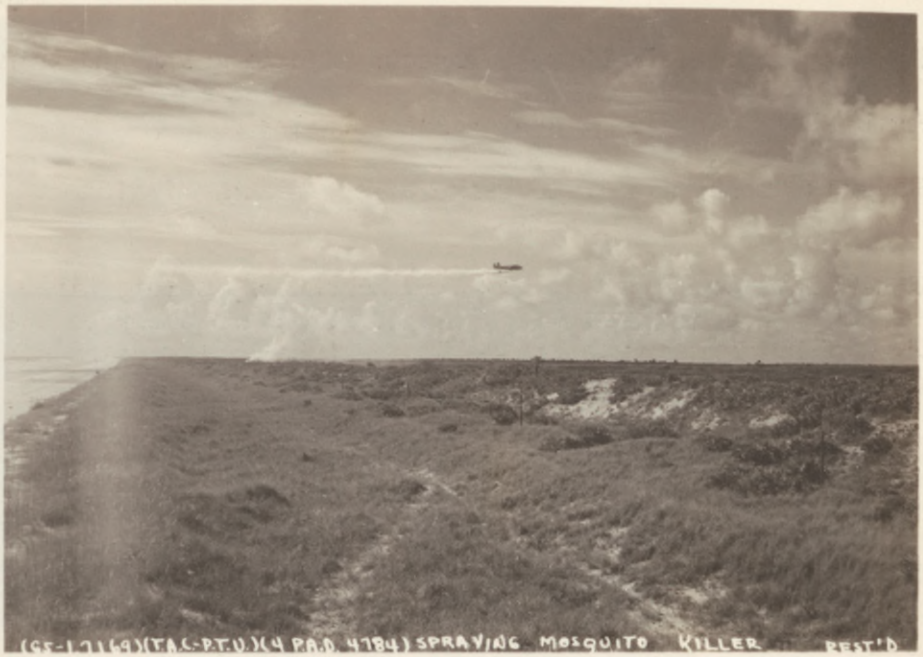
The adult population before treatment was low. Our count of adults 4 hours after treatment was made through the center of the plot by only one individual. This count showed a reduction in population of 77 per cent. A similar count made at the end of 24 hours showed a reduction of 88.5 per cent. Counts made by 12 enlisted men showed a reduction of about 45 per cent at the end of 4 hours and 90 per cent in 24 hours. These counts are considered more reliable since more were made and as they covered the entire area. Both our count and the Army count showed no decrease in adult population along the northern edge of the area. This indicated very definitely that this area had received no treatment, which was due either to the failure of the pilots to discharge the spray soon enough, adverse wind direction, or a combination of both. In the area where the spray was known to have been applied, the reduction in mosquitoes was near 100 per cent.

No larvae of either Aedes taeniorhynchus or A. sollicitans were to be found in the area. The only larvae present at the time were a few anophelines (probably A. stropos in a marshy region in the NW corner of the area. Ten dips counted at each of four stations gave an average of 2.5 larvae per dip before treatment. Five hours after application was made, the count for all 4 stations was 0.65 per dip, a decrease of about 74 per cent, and no further decrease was recorded 24 hrs. after. The closest plane to pass over the dipping station was at least 150 yards away, and quite possibly did not discharge the spray soon enough. The reduction in numbers was probably due to the finer particles of spray, which floated in the air for some time. The larvae were also protected by a dense growth of pickleweed. Fish in the open water did not seem to be harmed.

In general, this test was considered quite successful in reducing the adult mosquito population. The results indicate that it may be difficult to apply the material accurately over small areas. Under practical conditions, however where larger areas are being covered, this factor would not be so important.

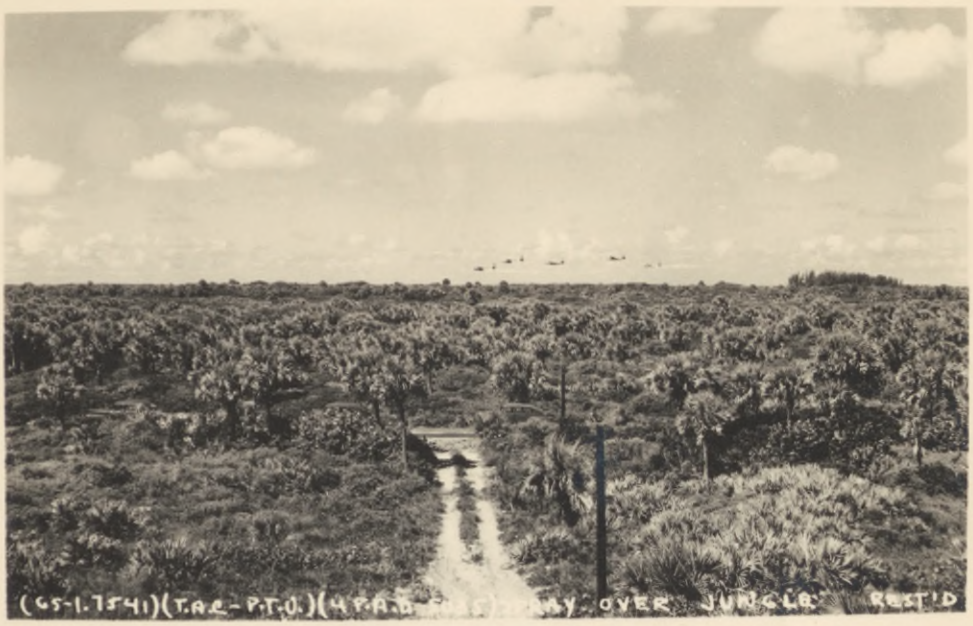
AHMadden/jr

Incl 9



B-25 Spraying DDT from M-33 bomb bay tank at New Smyrna, Fla. Note smoke pot to guide flight of plane. A cross wind gives good lateral dispersion of spray.

B-25 Spraying DDT at New Smyrna, Fla. A heavy stream of DDT in oil is seen emerging from the M-33 spray tank.



A formation of 5 A-20's spraying DDT from M-10 wing tanks over jungle country at Vero Beach, Fla. Note white trail of DDT oil solution following the planes. The slip stream and cross wind will deposit the DDT over a large area.

Another view of A-20's in formation spraying DDT. Overlapping spray deposits is the principal advantage of formation flying. A 95% reduction of adult mosquitoes was obtained in this test.