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DEPARTMENT OF THE ARMY
HEADQUARTERS, U.S. ARMY DUGWAY PROVING GROUND
DUGWAY UT 84022-5000

August 25, 2009

REPLY TO
ATTENTION OF:

Office of the Command Judge Advocate

Mr. John Greenewald, Jr.



Dear Mr. Greenewald:

Your request made under the provisions of the Freedom of Information Act (FOIA), 5 U.S.C. Section 552 was forwarded to our office as a matter under our purview. You requested documents pertaining to Operation Big Itch. Please find enclosed an unclassified document titled "BW-1-55, Operation Big Itch, 17 November 1954." It is the only document in our Technical Library specifically responsive to your request.

You indicated a willingness to pay fees; however, the costs to process your request were less than the minimum charge.

If you have questions regarding this letter, please address them to Ms. Teresa S. Shinton, FOIA Officer, (435) 831-3333; email: teresa.shinton@us.army.mil.

Sincerely,

A handwritten signature in cursive script, reading "Kateni T. Leakehe", is positioned above the typed name.

Kateni T. Leakehe
Major, U.S. Army
Command Judge Advocate

Enclosure

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BW 1-55

[REDACTED]

OPERATION "BIG ITCH"

Auch Marshall Everts
Maj Gen Comd

17 NOVEMBER 1954

*Requested unclassified
Rec Bd*

W. Holman 21 Dec 76

BWALR

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TECHNICAL REPORT

Distribution limited to U.S. Government agencies only;
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Ground, AECW: Technical Library, Documents Section,
Dugway, Utah 84022-5000.

DUGWAY PROVING GROUND

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(Identify Reclassification Authority)
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AUTHORITY

(SECRET) Authority for this test was contained in:

- (1) Letter, CMLCD-12, dated 9 August 1954, subject: Test Directive No. 7, 1954, Insect Munition Test (SECRET); and
- (2) Letter, CMLCD-10-AS, dated 4 August 1954, subject: Request for Field Test--Airplane Dropping of Uninfected Plague Fleas from E-14 and E-23 Munitions at DPG, and Inclosure (SECRET).

(UNCLASSIFIED) This project was funded under Project Order Number 0085.

NOTE

(UNCLASSIFIED) To transmit urgently-needed information, this report was published without editing by TD&E, Dugway Proving Ground. This action was taken on instructions of the Director of Assessment, with concurrence of the Commanding Officer, BWAL

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ABSTRACT

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(SECRET) One trial was conducted to investigate the suitability of the E-14 munition as a disseminator of arthropod vectors, to plot carrier patterns of this munition, and to determine the survival rate and host acquisition ability of Xenopsylla cheopis disseminated from the above munition. A preliminary trial was conducted in which unfilled E-14 and E-23 munitions were dropped to check functionality of these items.

(SECRET) Five E-14 and eight E-23 munitions were dropped in the preliminary trial. Half of the E-23's malfunctioned, but all five of the E-14 munitions functioned properly. Considering these results, the E-14 was selected as the munition to be used in the test. One of the four E-14 munitions used malfunctioned during the "hot" trial.

(SECRET) The arthropod vectors were successfully reared to the proper stage, dropped on the target and disseminated with little or no die-off. After release, the insects were successful in acquiring hosts, but were not active longer than 24 hours unless protected. The sponge carriers were the most widely distributed, as indicated by carrier patterns.

(SECRET) The results of this test appear to justify continued research of Biological Warfare with arthropod vectors.

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INTRODUCTION

HISTORICAL BACKGROUND

Description of Munitions

(SECRET) The E-14 and E-23 munition components selected for this test were designed for incorporation in the E-86 and E-77 clusters, respectively, for use in the dissemination of dry anti-crop agents. The E-23 is composed of a cylinder 9 3/4 inches in diameter and approximately 18 inches in length, and is equipped with an external actuating mechanism that releases CO₂ which, in turn, reverses a plastic bag inserted in the cylinder, thus ejecting the fill. The cardboard cylinder of the E-14 is 13 inches in diameter and 9 3/4 inches long, and contains a piston-ejection mechanism with an internal CO₂ actuating device.

Early Testing

(SECRET) Development of the munitions and their components was begun by General Mills, Inc. Results of investigations by the Ralph M. Parsons Co.¹ and the US Air Force² indicate a need for refinements in design.

(SECRET) Testing of the components by BWAL included 24 static and dynamic functions of the E-14 (of which two malfunctioned), and seven activations of the E-23 (of which two malfunctioned)³.

¹BW MUNITIONS DEVELOPMENT, Chemical Corps, US Army, Semi-Annual Report, July-December 1953. The Ralph M. Parsons Co. (Contract No. DA-18-064-CML-2283) (Secret)

²TECHNICAL NOTE NO. 54-10, Air Force Armament Center, Air Research and Development, Eglin Air Force Base (Secret)

³BW 13B & C-54 (Report nearing completion for publication by D&A Office, BWAL, Dugway, Utah) (Secret)

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Request for BWAL Testing

(SECRET) The request for this entomological test (the dissemination of plague fleas from airdropped E-14 or E-23 inserts) was forwarded to BW Assessment Laboratories by the Director of Assessment; accordingly, BW 1-55 was planned and executed.

OBJECTIVES

(SECRET) The objectives of this test were:

- (1) To investigate the suitability of the munition components for dissemination of arthropod vectors;
- (2) To determine the survival rate and host acquisition ability of Xenopsylla cheopis disseminated from these devices; and
- (3) To plot carrier patterns produced by these components when filled with special carriers.

SCOPE

(CONFIDENTIAL) One preliminary trial was conducted in which eight E-23 and five E-14 munitions were dropped to test the functionability of these items. In addition, guinea pigs were exposed overnight in the field to determine their hardiness.

(SECRET) One "hot" trial was conducted 17 September 1954 in which four E-14 munitions, filled Xenopsylla cheopis, were dropped to obtain data pertinent to the formal objectives of this test.

METEOROLOGICAL CONDITIONS

(UNCLASSIFIED) The test was carried out under meteorological

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requirements specified in the test plan⁴. Wind speed, direction and temperature data were collected and reported by Meteorological Branch, DPG (Appendix I).

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⁴Test Plan BW 1-55: Operation "BIG ITCH". CMLBD-A6. 16 August 1954
(Secret)

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MATERIALS AND METHODS

GRID ARRAY AND SAMPLING EQUIPMENT

(UNCLASSIFIED) The test was conducted on a temporary Salt Flats Grid. Guinea pig pens 10 by 10 feet, constructed of 1/2-inch wire netting to a height of 18 inches, were arranged as follows (Figures 1 and 2):

- (1) One pen at the center of the grid;
- (2) Eight pens evenly distributed on the circumference of Circle I, 220 yards in radius; and
- (3) Sixteen pens evenly distributed on the circumference of Circle II, 440 yards in radius.

(4) Two sampler plates were placed beside each of the pens and, in addition, 32 plates were located on the circumference of Circle III, 660 yards in radius. Samplers consisted of Plexiglas sheets approximately 10 by 10 inches covered with Tanglefoot. These plastic sheets were mounted 6 inches above the surface on stakes driven approximately 6 inches into the ground. All stations on each circle were numbered consecutively (clockwise), beginning with 1 at 0° bearing.

DESCRIPTION OF MUNITION

(SECRET) Each of three E-14 components was filled with 80 cardboard inserts; these three components contained an approximate total of 560,000 fleas. Each insert was closed with a crepe paper streamer of an identifying color. Streamers were so connected that each would hold a tube in a generally horizontal position during the free fall after expulsion from the carrier. A fourth E-14 component was loaded with 100,000 fleas and numerous small sponges. Handling, sorting and counting of fleas, and loading of munitions was accomplished by Entomology Branch

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Figure 1. - Terrain at the site of BW 1-55 (UNCLASSIFIED)

personnel from Camp Detrick, assisted by Test Division personnel from BWAL.

MUNITIONS SCHEDULE

(SECRET) For preliminary testing, eight B-23 and five B-14 components were dropped the day preceding the test. One of these trial munitions contained 10,000 fleas, thus providing a preliminary check of the filled test munition.

(SECRET) During the test, four filled munitions were dropped on target by an experienced bombardier. Three munitions were dropped from a light aircraft flown 2,000 feet above terrain and one was dropped from 1,000 feet above terrain. One item was dropped on each of four successive flights over the target.

DISTRIBUTION OF TEST ANIMALS

(UNCLASSIFIED) The day preceding the test, five guinea pigs were placed in a pen (Figure 3) and other animals were placed in the

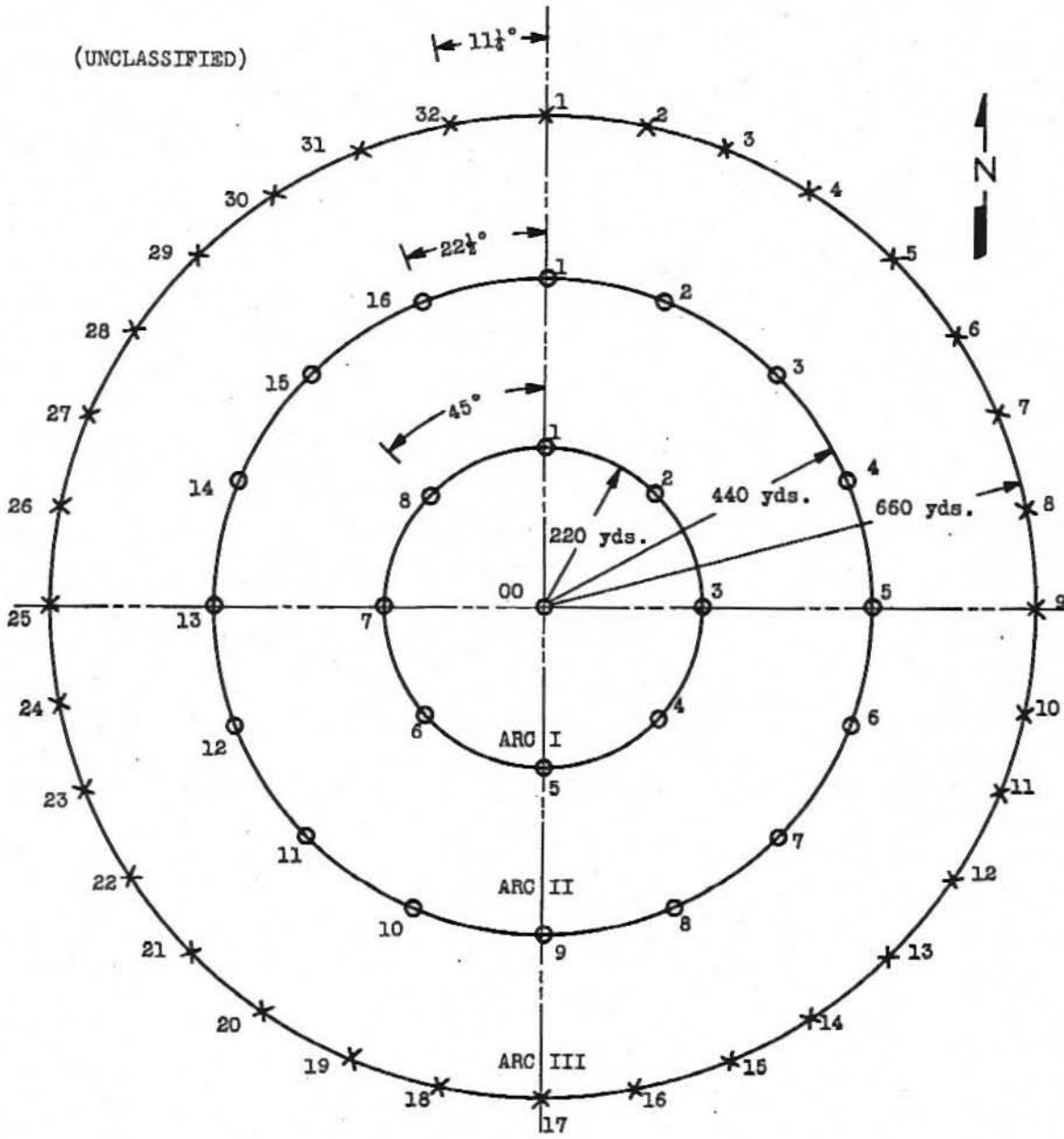
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○ Guinea pig pen (5 pigs)
and flypaper station
× Flypaper station

Scale
220 yds

Fig. 2.- Diagram of grid and sampling array used in BW 1-55.

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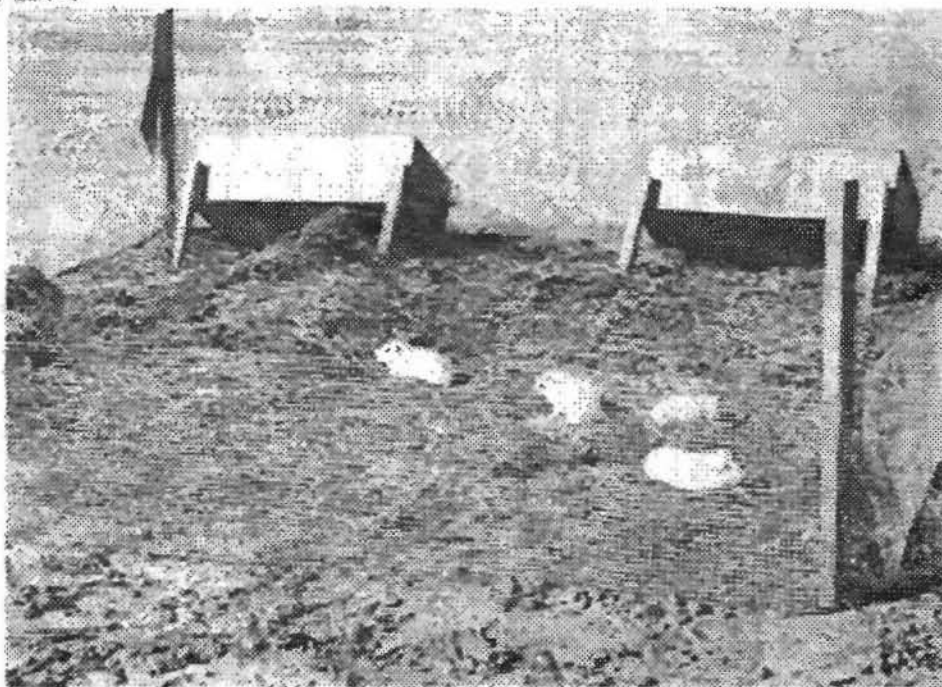


Figure 3. - Placement of guinea pigs in pen (UNCLASSIFIED)

carrier pattern of the filled trial munition. These animals were exposed to provide overnight survival observation. Each guinea pig was marked by blotches of green dye for identification.

(UNCLASSIFIED) Immediately prior to the test, five guinea pigs were placed in each pen, a total of 25 guinea pigs was released at regular intervals about the grid, and the sampler plates were emplaced. After meteorological requirements were obtained and the munitions had been dropped, five guinea pigs were released in the individual carrier pattern; these guinea pigs were striped with India ink for identification.

SAMPLING SCHEDULE

(SECRET) Following the drop of each tube-containing munition, three randomly-selected tubes were immediately plugged and returned to the laboratory for counting. Following the drop of the sponge-containing

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munition, three sponges were retrieved and the number of fleas remaining on each was determined by Entomology Branch personnel; as soon as the sampler plates were collected the same persons counted the fleas thereon.

(SECRET) One hour after the last "hot" munition was functioned, half of all guinea pigs from the grid array were collected by selecting three guinea pigs from each even-numbered pen, two from each odd-numbered pen, and every other loose animal. After dusting with pyrethrum and DDT each guinea pig was returned to the laboratory in an individual 1-gallon ice cream carton. All remaining test animals (including guinea pigs under overnight survival observation) were collected 24 hours after the trial.

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RESULTS AND DISCUSSION

MUNITION FUNCTIONING

(SECRET) The eight E-23 components dropped during the first preliminary trial had been prepared at Camp Detrick. When half of these munitions malfunctioned, it was deemed advisable to use the alternate E-14 munition which had exhibited 100% functioning.

(SECRET) During the "hot" trial, the second munition dropped malfunctioned and fell outside the target area; no guinea pigs were placed in the pattern of this munition.

(SECRET) Numerous fleas escaped from the munition carrier into the plane when the sealing tape was removed immediately prior to arming and dropping. Thus, numerous fleas bit the pilot, bombardier and observer.

(SECRET) The guinea pigs placed on the grid for overnight survival observation suffered no apparent ill effects; the number of fleas counted on these animals is shown in Table 1.

(SECRET) Estimates on the numbers of live fleas reaching the ground were obtained by the counts of fleas remaining in the tubes and sponges collected immediately after activation, and in those collected 24 hours later (Table 2); those captured on the sampler plates and observed on the test animals (Table 3). Figure 4 shows fleas harbored on a guinea pig. Figures 5 and 6 show the carrier patterns on the grid, and the insect recoveries, respectively.

(SECRET) Discussion of the dangers attendant to the dissemination, and of the precautions to be taken against the spread of the arthropod vectors to the local animal populations are discussed in Appendix II.

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Figure 4. - Fleas harbored on a guinea pig
(SECRET)

PERSISTENCE

(SECRET) Investigation by Test Branch and Ecology Branch personnel indicated no persistence of live fleas 24 hours after munitions were functioned, except in instances where they were attached to animals or

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protected in the munition containers (Table 2). Rodents trapped in areas adjacent either to the target or the munitions loading building harbored no plague fleas.

TEST PLAN CHANGES

(SECRET) Minor deviations from the published test plan were made after preliminary munition trials. The changes were as follows: The tube-containing munitions were dropped from 2,000 feet and the sponge-containing munition from 1,000 feet⁵ above terrain; five guinea pigs were placed in each pen. These guinea pigs were collected in two groups (1 hour and 24 hours after munitions functioned and after the activity of the arthropods was observed and the overnight survival of test animals recorded).

⁵(UNCLASSIFIED) This altitude was used to limit area coverage to the grid.

(SECRET)

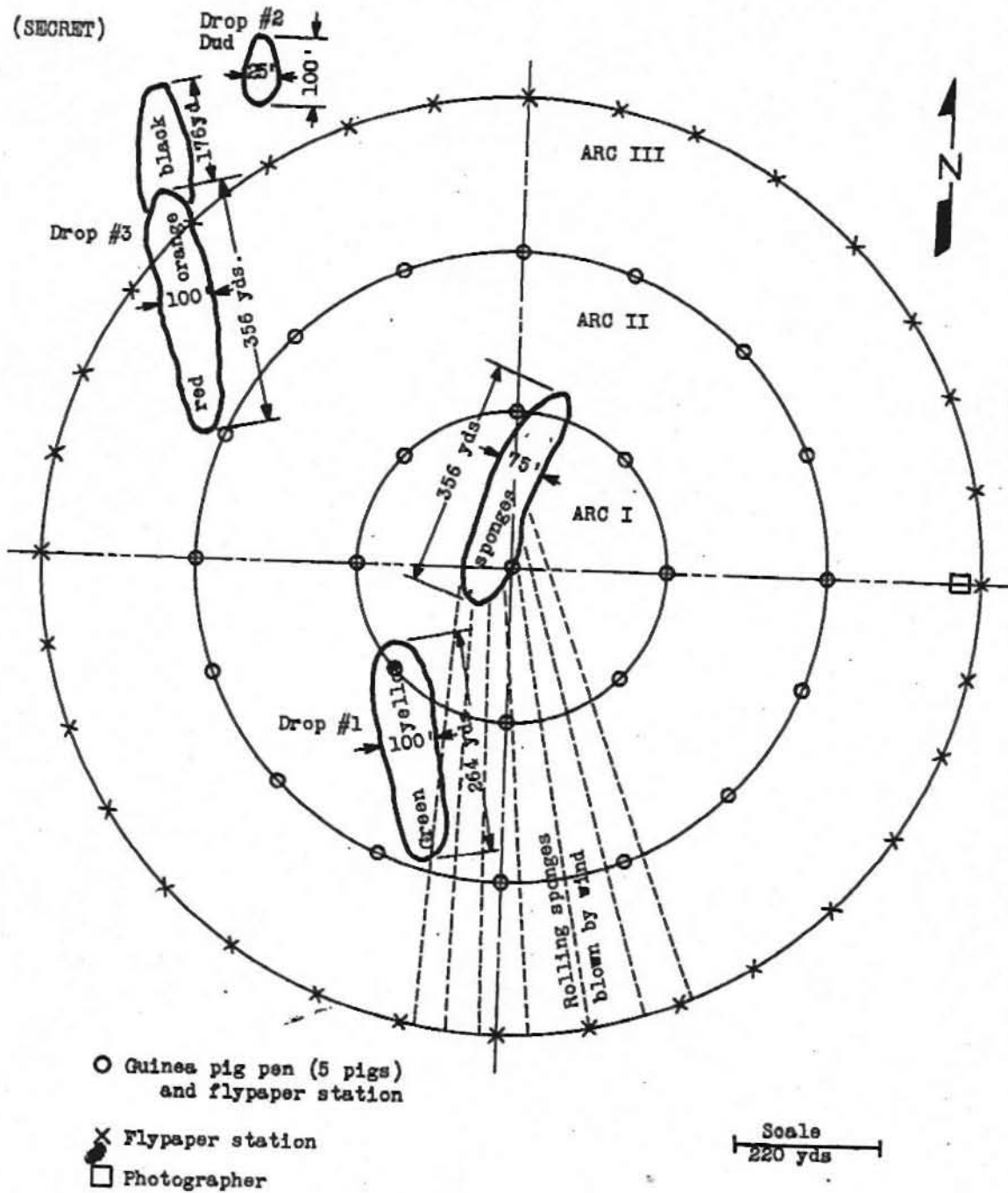


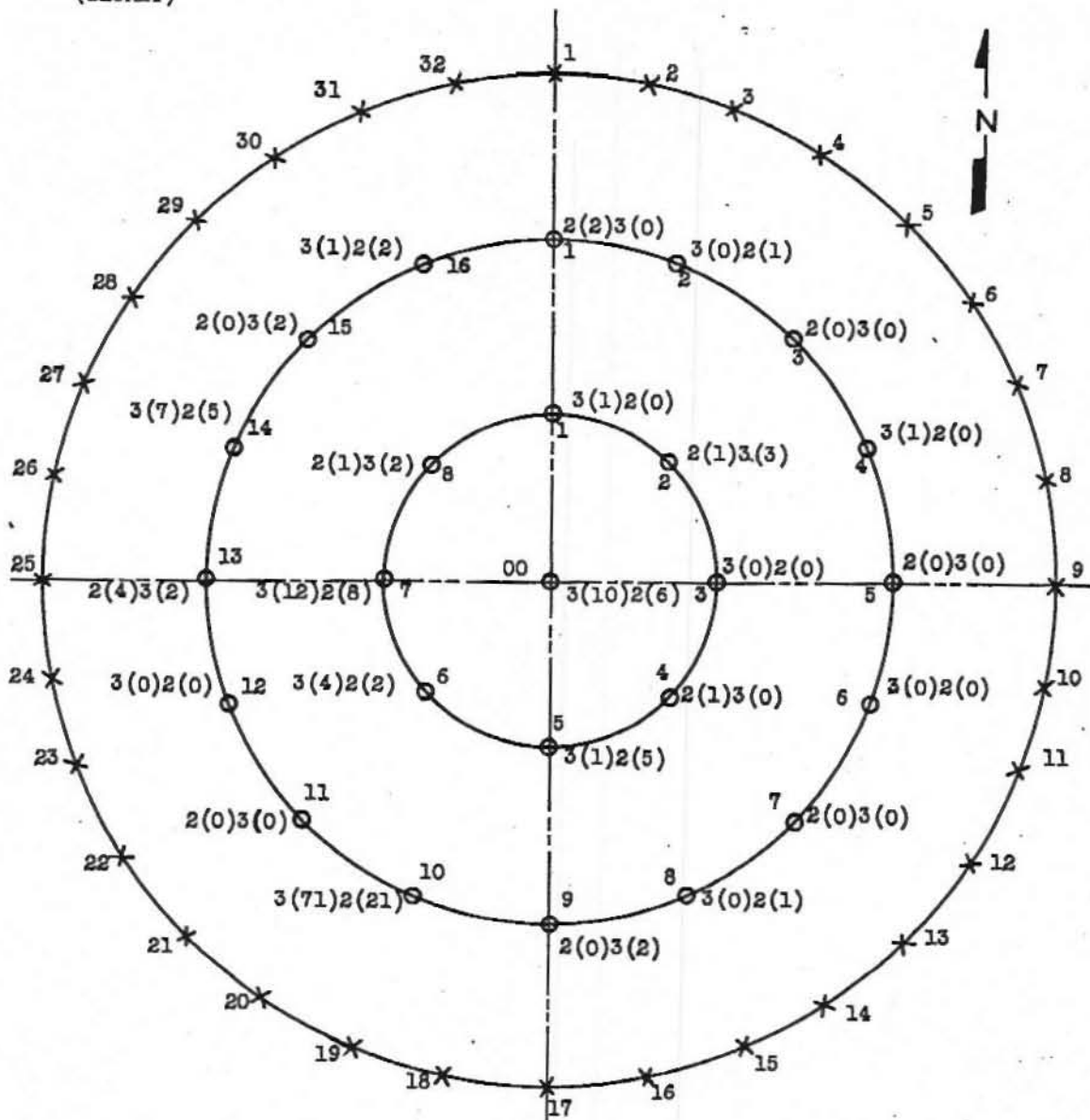
Fig. 5. Deposition patterns of the various munitions detonated in BW 1-55.

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(SECRET)



O Guinea pig pen (5 pigs)
and flypaper station
X Flypaper station

Scale
220 yds

First No.--Number of pigs collected at Z + 1.
() No.--Number of fleas on pigs collected at Z + 1.
Second No.--Number of pigs collected at Z + 24.
() No.--Number of fleas on pigs collected at Z + 24.

Fig. 6.- Recoveries of fleas, and the distributions of these recoveries in BW 1-55.

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TABLE 1: Overnight Guinea Pig Survival Observations (SECRET)

	ANIMAL NUMBER	NUMBER OF FLEAS OBSERVED
Animals Penned at Position I-2	1	0
	2	0
	3	2
	4	2
	5	1
Animals Loos on Grid	1	4
	2	6
	3	2
	4	2
	5	10

NOTE: Placed 16 September 1954, and removed 18 September 1954 - all animals survived.

TABLE 2: Counts of Fleas Remaining in Tubes, Sponges and Munitions (SECRET)

DROP NO.	TIME COLLECTED	PART OF MUNITION	NUMBER OF FLEAS	
			Alive	Dead
1 Green & yellow	Z	Tubes	60	
			70	
			40	
2 Dud	Z / 24 hrs	Munition	55	100
	Z / 24 hrs	Tubes	8	131
	Z / 24 hrs	Tubes	1	30
3 Black & orange	Z / 24 hrs	Munition	200	2,000
	Z / 24 hrs	Tubes	35	
			50	
4 Sponges	Z / 24 hrs	Tubes	20	
	Z / 24 hrs	Tubes	15	177
	Z / 24 hrs	Lid	350	7,000
4 Sponges	Z	Sponges	300	
			300	
			300	
4 Sponges	Z / 24 hrs	Munition	30	50
		Lid	15	50

NOTE: Z means Zero Hour.

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TABLE 3: Recoveries of Fleas on Guinea Pigs Exposed on the Grid During Operation "BIG ITCH". (SECRET)

POSITION	PIG NO.	NO. OF FLEAS (Z / 1 hr)	NO. OF FLEAS (Z / 24 hrs)	POSITION	PIG NO.	NO. OF FLEAS (Z / 1 hr)	NO. OF FLEAS (Z / 24 hrs)
Grid Center	1	7		I-5	1	1	
	2	3			2	0	
	3	0			3	0	
	4		3		4		1
	5		3		5		4
I-1	1	0		I-6	1	2	
	2	1			2	2	
	3	0			3	0	
	4		0		4		1
	5		0		5		1
I-2	1	1		I-7	1	1	
	2	0			2	10	
	3		1		3	1	
	4		1		4		8
	5		1		5		0
I-3	1	0		I-8	1	1	
	2	0			2	0	
	3	0			3		1
	4		0		4		1
	5		0		5		0
I-4	1	1		II-b	1	1	
	2	0			2	1	
	3		0		3		0
	4		0		4		0
	5		0		5		0

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TABLE 3: Continued

POSITION	PIG NO.	NO. OF FLEAS (Z / 1 hr)	NO. OF FLEAS (Z / 24 hrs)
II-2	1	0	
	2	0	
	3	0	
	4		1
	5		0
II-3	1	0	
	2	0	
	3		0
	4		0
	5		0
II-4	1	0	
	2	1	
	3	0	
	4		0
	5		0
II-5	1	0	
	2	0	
	3		0
	4		0
	5		0
II-6	1	0	
	2	0	
	3	0	
	4		0
	5		0

POSITION	PIG NO.	NO. OF FLEAS (Z / 1 hr)	NO. OF FLEAS (Z / 24 hrs)
II-7	1	0	
	2	0	
	3		0
	4		0
	5		0
II-8	1	0	
	2	0	
	3	0	
	4		1
	5		0
II-9	1	0	
	2	0	
	3		0
	4		0
	5		2
II-10	1	39	
	2	13	
	3	19	
	4		11
	5		10
II-11	1	0	
	2	0	
	3		0
	4		0
	5		0

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TABLE: 3 Concluded

POSITION	PIG NO.	NO. OF FLEAS (Z / 1 hr)	NO. OF FLEAS (Z / 24 hrs)	POSITION	PIG NO.	NO. OF FLEAS (Z / 1 hr)	NO. OF FLEAS (Z / 24 hrs)
II-12	1	0		II-15	1	0	
	2	0			2	0	
	3	0			3		0
	4		0		4		2
	5		0		5		0
II-13	1	3		II-16	1	1	
	2	1			2	0	
	3		0		3	0	
	4		1		4		0
	5		1		5		2
II-14	1	1					
	2	0					
	3	6					
	4		2				
	5		3				

NOTE: Only four fleas were trapped in the Tanglefoot on the sampler plates.
One flea was recovered at each of positions I-5, I-6, III-22 and III-28.

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CONCLUSIONS

(SECRET) The following conclusions were formulated on the basis of data obtained in this test:

- (1) The arthropods were successfully transferred, reared to the proper stage and dropped on the target with little or no die-off;
- (2) The drop did not inactivate the insects;
- (3) Successful dissemination was accomplished as indicated by the carrier patterns;
- (4) After release, the insects were successful in acquiring hosts;
- (5) The insects were observed to be active for less than 24 hours after drop time unless harbored on a test animal or other wise protected; and
- (6) The sponge carriers were the most widely distributed.

RECOMMENDATIONS

(SECRET) Results from BW 1-55 indicate:

- (1) A more suitable munition component should be designed to seal the fill in the munition, and to provide a more dependable ejection mechanism; and
- (2) Continued research of Biological Warfare with arthropod vectors apparently is justified.

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ADDITIONAL LITERATURE

1. Supplementary Report on the Engineering Study, Contract DA-18-064-CML-2104, General Mills, Inc., Report No. 1147, dtd 21 October 52. (Secret)
2. Report of Progress for February 1953, Contract DA-18-064-CML-2104, General Mills, Inc., Report No. 1177. (Secret)
3. Report of Progress for March 1953, Contract DA-18-064-CML-2104, General Mills, Inc., Report No. 1183. (Secret)
4. Progress Report, November 1953, Contract DA-18-064-CML-2104, General Mills, Inc., Report No. 1261. (Secret)
5. Supplement to Report on Eighth Tripartite Conference on Chemical, Biological and Radiological warfare, 28 September - 9 October 1953, Army Chemical Center, Maryland. (Top Secret)
6. Progress Report, May 1954, Contract DA-18-064-CML-2104, General Mills, Inc., Report No. 1306. (Secret)
7. Progress Report, July 1954, Contract DA-18-064-CML-2104, General Mills, Inc., Report No. 1321. (Secret)
8. Status Report No. 53-1, Cml C Biological Laboratories, 15 May 53. (Secret)

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APPENDIX I

METEOROLOGICAL DATA

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TABLE 1: Wind Direction and Speed Data Collected at Meteorological Station Located 1 Mile SSE of Grid Center at the 2-Meter Level, BW 1-55. (UNCLASSIFIED)

TIME	AVERAGE DIRECTION (°)	DIRECTION RANGE (°)	AVERAGE SPEED (mph)	SPEED RANGE (mph)
0953-54	002	346-012	14.2	12.6-16.0
54-55	340	331-001	14.5	12.5-16.3
*0955-56	352	340-011	13.0	10.1-14.5
56-57	352	338-009	13.7	12.1-15.5
57-58	354	339-020	13.7	12.5-14.8
58-59	010	001-022	14.0	12.4-15.2
59-60	002	343-026	12.2	9.9-14.0
1000-01	360	338-019	13.0	11.9-15.3
01-02	005	355-016	15.2	14.0-17.0
02-03	358	344-012	13.8	12.6-15.5
03-04	008	001-019	13.5	11.6-15.2
04-05	360	343-012	13.4	11.2-14.7
05-06	005	355-021	13.8	11.4-15.7
*1006-07	012	008-019	14.2	12.5-16.6
07-08	008	345-018	13.6	11.5-15.7
08-09	353	342-009	13.8	12.0-15.0
09-10	001	353-012	13.6	12.2-15.1
10-11	008	353-019	14.0	11.4-16.2
11-12	010	002-018	15.2	13.2-16.7
12-13	007	355-019	13.0	11.3-14.8
13-14	017	009-026	12.8	11.4-15.0
*1014-15	008	359-020	13.6	11.6-15.3
15-16	356	341-021	12.4	10.4-14.0
16-17	010	357-027	13.6	12.0-15.3
17-18	010	357-018	14.0	12.2-16.5
18-19	012	354-023	13.8	12.2-14.8
19-20	010	001-029	12.6	10.2-13.6
20-21	007	353-017	14.0	12.1-16.4
21-22	006	357-015	14.4	12.2-16.0
22-23	360	350-007	14.2	12.3-15.5
23-24	358	351-014	14.4	11.4-16.8
24-25	359	346-009	14.2	11.0-16.0
25-26	001	351-008	13.7	12.4-15.6

*Functions: 0955, 1006, 1014 MST, 17 September 1954.

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TABLE 2: Winds Aloft (Pibal) Data, BW 1-55. (UNCLASSIFIED)

Height (ft)	0830-0836 MST		0915-0920 MST		1014-1020 MST	
	Direction (°)	Speed (mph)	Direction (°)	Speed (mph)	Direction (°)	Speed (mph)
250	192	4.3	349	2.5	000	15.8
480	184	7.0	239	4.0	002	16.9
670	218	6.5	340	4.0	004	13.4
850	244	7.4	335	6.2	006	12.6
1030	261	5.7	321	9.2	015	9.9
1210	267	6.0	207	9.9	014	5.8
1390	254	6.7	295	9.2	338	6.0
1570	239	6.6	285	9.3	303	6.4
1750	221	9.1	277	10.6	267	8.0
1930	202	14.0	274	11.0	256	9.9
2110	211	17.6			260	6.7
2290	228	19.3			288	3.6

TABLE 3: Temperature Data, BW 1-55. (UNCLASSIFIED)

TIME (MST)	GROUND TEMPERATURE (°F)	AIR TEMPERATURE (°F at 0.5m)
0830	67.0	68.0
0850	67.5	70.0
0945	69.0	73.0
1010	74.0	73.0

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APPENDIX II

Part 1

INFORMATIONAL BRIEF

Part 2

ENTOMOLOGIST'S REPORT

NOTE

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(The material in this Appendix was given limited distribution in publication CMLBD-A6, dated 13 September 1954.)

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PART 1

INFORMATIONAL BRIEF - BW 1-55 "BIG ITCH"

Problem: Is the release of the flea, Xenopsylla cheopis, dangerous from the standpoint of:

A. Establishing a new arthropod vector in an area where it is not now found.

B. Providing another well-known plague vector in an area in close proximity to an endemic plague region.

In the affirmative for the above question, it first should be noted that in the vicinity of the proposed release site there are many wild rodents and other warm-blooded forms capable of acting as hosts for Xenopsylla cheopis. Second, for the affirmative, the area into which it is proposed to release these arthropods is close to a known plague area. It is known that within 100 miles of the test site, plague (Pasteurella pestis) is endemic in wild rodents. Further, it is postulated that plague is moving to encompass this area and at a relatively rapid rate. In fact, it is quite possible that the area is already endemic for plague.

It is also of note that this species of flea has been captured in the garbage dumps at Salt Lake City, Ogden, and Provo, Utah, relatively large communities within a 90-mile radius of Dugway Proving Ground.

The points in the affirmative become less worrisome when the problem of the requirements for life of Xenopsylla cheopis are examined. It must be noted that there is great contrast between the environment at the proposed release site, the surrounding environments in which susceptible hosts exist, and the environments of the Salt Lake, Ogden or Provo garbage dumps. These highly artificial dump areas are, without exception, built on swamp lands; in fact, most of them are in process of formation to fill swamp areas for reclamation as suitable building sites. The high humidity and presence of a host not found in the target site (i.e. the Norwegian rat, Rattus norvegicus) combine to make an environment in which the plague flea has become established. It is worthy of note, however, that no reservoir of plague has as yet been discovered in any of these artificial sites. Cold winters of this area cause decreases in the numbers of fleas present on rats to the point where survival numbers are barely present. If the garbage dumps are contrasted with the target site and the surrounding highly arid areas, one can at once note the absence of one of the prime requisites for the development of the larval stages of Xenopsylla cheopis, that is, high humidity in the larval period of development.*

*See Carl O. Mohr, Newell E. Good, and Joseph H. Schubert. Status of Murine Typhus Infection in Domestic Rats --- AMERICAN JOURN. PUB. HEALTH, Vol. 43, No. 12, Dec. 1953.

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The surrounding area, exclusive of the proposed release site (which is a barren salt flat on which no suitable hosts for this flea exist) is an area of stabilized sand dunes in which many rodents find haven. Further, the native predators and raptors visit these areas in fair numbers in search of prey and it is thought that the predators act as an intermediate reservoir for fleas. Many native fleas have been recovered from both predators and raptors; it has been established that part of the dissemination of the native fleas is done by predators. However, considering the required humidity in the larval development of Xenopsylla cheopis, only the rodent burrows would supply a steady humid condition. Within these rodent burrows the native fleas find a suitable environment for their development. The requirements of the plague flea (70 to 80 per cent humidity over relatively long periods of time) will seldom, if ever, obtain in these burrows.

The transportation of the native fleas to outside areas is extremely improbable since virtually all of the native animals have home ranges that keep them within the Dugway area. In the event that a predator wanders outside this area, there are no suitable developmental sites for the larvae of the plague flea within a 60-mile radius of the target area.

The release of these arthropods will be made in the center of the Salt Flat west of Wig Mountain, north of GPI-3 and south of Wildcat Mountain. This area will be at least 1 mile from the nearest rodent hosts that are suitable for carrying or preserving the arthropod in question. The question might at once arise, is it possible for this flea to move under its own power to susceptible rodent hosts? The answer is negative, for these reasons:

(1) The movement of these fleas is only 5 or 6 inches to a hop, and their movements in the absence of light and in the absence of warm-blooded organisms on which they can establish themselves is entirely random; therefore, they should not be able to reach a suitable area without the presence of suitable hosts on which to travel.

(2) The flea itself has not enough energy to travel this distance even if it were to be directed in one solid line by chance in every one of its total number of jumps.

(3) Let us consider the time of this release. The fleas will be turned loose in the mid-morning hours between 9 and 10 o'clock, at a time suitable for their rapid movements because of warm air and ground temperatures. The fleas will, under such conditions, be able to move a short distance, and if chance favors them, to get on the warm-blooded hosts (guinea pigs) used as test animals. Many more, however, will wander aimlessly about the Salt Flats, driven by their desire to escape from the sun. They will become localized in the shade or in the protection of cracks, crevices and whatever shade is afforded by animal shelters. With the falling of the sun, temperatures on these flats will drop very rapidly to levels which should cause the

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immobilization of the fleas. Hence, the chance of wandering predators coming into contact with them is extremely slight, for, in the event a coyote or fox should wander across the grid, the fleas will be so cold that they cannot move to establish themselves upon the predator. With the coming of morning and the resumption of high temperatures, the animals can again move, but most will have been killed by the cold night preceding. It is possible then to state with some assurance that the location of the release, coupled with the cold, immobilizing temperatures of night, will suffice in themselves to severely limit (or stop) all possibility of travel of the fleas toward surrounding rodent-populated areas.

(4) Reverting to our discussion of the requirements for fleas to become established (the requirement for a basic host and a humid, warm, protected area in which the larvae could develop) it is rather apparent that at this time of the year temperatures will successively become lower, and that the chance of establishment anywhere is even more slight. It was, in fact, this consideration above most others that influenced the choosing of late September as the time in which this test could be run (i.e. period during which the daylight temperatures were sufficiently high to allow maximum freedom, but with night temperatures sufficiently low to immobilize or kill the insects with the knowledge that the subsequent, more severe autumn temperatures would preclude any possibility of this insect becoming established in the area).

It is, however, quite apparent in the history of purely reasoned programs that chance of a perverse nature might upset the calculations, no matter how carefully they may have been made. It is to remove the possibility of any upset in plans that control programs have been drawn up.

The Ecological Research Branch (a group in which we have numerous specialists and students of birds, mammals and arthropod vectors) already has been consulted, and will form an integral part of the test personnel. This group will establish a peripheral sampling program of an intensity sufficient to determine whether any of the fleas reach the surrounding populated area. Following a positive determination that fleas had reached the rodents, an intensive trapping and poisoning program would be instituted to isolate the area in which the fleas had become established, and to kill out the rodent population to a level where the fleas could not persist. Further, highly ingenious dusting traps previously employed in Hawaii in the control of the plague flea can be readily built and supplied in numbers sufficient to keep all fleas in the area killed out.

To insure against the improbable chance that one of the large raptors, that is birds of prey such as the Golden Eagle, Red-tailed Hawk, Rough-legged Hawk and the Great Horned Owl, should fly over the grid and carry one of the guinea pigs to a surrounding area where the fleas might possibly escape into a suitable environment, special controls will be set up to trap or prevent all raptors from coming into the area. This will be

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done in two ways: (1) A guard with a shotgun will be on the periphery of the area at all times, and (2) for night operations, when there is a possibility of owls coming in unseen, pole traps will be put up to take advantage of the known habit of the owl (after killing prey, these owls fly to the nearest high point to tear the prey to pieces and devour it). The pole traps will capture these animals if any make their kills. Predators will be kept out of the area by a guard who will be present day and night armed with a shotgun. At night the guard will have a flare gun which he will fire at regular intervals to discourage any of the native predators from coming into the area.

All personnel working within the grid will be decontaminated by dusting with flowers of pyrethrum before they are allowed to leave the area. All vehicles will be similarly decontaminated and all test animals (Test Plan, BW 1-55: Secret: in publication) will have been freed of ectoparasites by dusting with flowers of pyrethrum.

Summation:

Based on the information supplied above, and the brief supplied by the Ecological Research Branch, it is concluded that the probability of the fleas reaching the peripheral area is so low that it is virtually non-existent. Further, the absence of suitable temperatures and suitable humid warm areas (in which larvae might develop) enforce the belief that it is virtually impossible that this insect will become established here. It must be concluded, therefore, that the operation, as planned, is as safe as can be reasonably expected. However, it might be pointed out that no amount of planning can totally eliminate chance.

It is the opinion of the writer of this brief that this test has a potential that far outweighs the possibility of damage accumulating from it. Further, it may be the first historic step in the development of a highly workable BW disseminating method with sufficient strength to be a serious deterrent to the possibility of warfare.

ROBERT C. PENDLETON
Chief, D&A Office
BW Assessment Laboratories

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PART 2POSSIBILITIES OF ESCAPE OF Xenopsylla cheopis
FROM THE SALT FLAT GRID AND ITS SUBSEQUENT ESTABLISHMENT

In October of 1953 Ecological Research was requested to make a survey of the wildlife on and in the vicinity of the Salt Flat Grid. The results of this survey were submitted as a special report and serve as a basis for the discussion that follows.

It is proposed that large numbers of the flea Xenopsylla cheopis be introduced onto the Salt Flat Grid by aerial drop. If this efficient plague vector, which is not now known to occur here, were to become established in such an area where plague is known to be endemic, a hazard of considerable proportions would be created. However, for the various reasons detailed below, the possibility that this would happen appears extremely unlikely.

- 1) The Salt Flat Grid itself and the area surrounding it within a radius of ten miles is a barren flat in which fleas could not become established nor support themselves for any appreciable period of time.
- 2) Xenopsylla cheopis is almost exclusively an external parasite of introduced rats and mice, the nearest of which occurs at considerable distance from the grid.
- 3) No rodents of any kind are established on the grid proper nor within many miles of it, and it is extremely doubtful that this flea could propagate itself under the conditions prevailing in the burrows of wild rodents in peripheral areas.
- 4) Fleas, being wingless, are incapable of leaving the area except on birds or mammals which cross the grid area only rarely as transients.
- 5) In the absence of host animals, the fleas involved in the drop will immediately disperse throughout the immediate area. The chances of passerine birds picking up and transporting any appreciable number of these out of the test area is slight. Unless the insect is carried from the area in numbers, the chances of establishment even under favorable conditions are negligible.
- 6) Hawks and owls may be attracted by the animals used in the test, but they are not present in large numbers and, as indicated below, may be easily controlled.

Hawks and owls can be dealt with effectively by placing pole traps at intervals around the periphery of the grid. These birds habitually fly to a nearby elevation to consume their prey. Pole traps would effectively prevent them from leaving the area with infested animals.

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The larger mammals present a slightly different problem which is simplified somewhat by the fact that very few of them would deliberately cross an expanse of unvegetated flats as broad as that on which the grid is situated. Horses and antelope would move during the day and could be observed and intercepted long before reaching the grid. Coyotes, kit foxes and bob cats would move at night, being most active at dawn and dusk. Armed patrols and cyanide guns placed at intervals around the periphery of the ten-mile arc would effectively minimize the chances that these animals would enter the drop area.

H. EDWIN COTT
Entomologist
Ecological Research Branch
BW Assessment Laboratories

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APPENDIX III

Extract from
"SAMPLING DATA

AND

PROCEDURE OF TEST BW 1-55⁸

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INNOVATION IN THE FUTURE

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I. Test Execution

A. Briefing of duties and test functions was given at 0640 hours at GPI-1. Crews left for Baker Change House at 0645 hours, and departed for the field at 0715 hours, 17 September 1954.

B. Grid Decoration

1. 5 pigs were placed in each pen.
2. 25 pigs were turned loose being distributed equally over grid.
3. Plexiglas plates 10" x 10" x 1/8" painted with tree tangle-foot were placed on stations.
4. Survival pigs from night on grid, were picked up and examined.

II. Drop

- | | | |
|--------------------------------------------|-------------------------------|----------------------------------------------------------------------------------------|
| A. Practice Drop
± 3 mph Wind Time 0920 | Height 2000'
Function good | Munition E 14
pattern 100 yds SE 3-12 |
| B. Drop #1
350° Wind 13 Time 0955 | Height 2000'
Function good | Munition E 14 tubes Gr &
yl pattern So from 1-6 to
between 2-9 & 2-10, 264 yds |
| C. Drop #2
350° Wind 14 Time 1002 | Height 2000'
Function dud | Munition E 14 tubes
pattern 200 yds NW 3-31
100 ft long |
| D. Drop #3
360° Wind 12 Time 1006 | Height 2000'
Function good | Munition E 14 tubes R.B.O.
pattern 200 yds NW 3-30 &
176 yds So of E 14 Munition |
| E. Drop #4
360° Wind 10-15 Time 1014 | Height 1000'
Function good | Munition E 14 (sponge)
pattern 100 yds NE 1-1 to
SW between 0-0 & 1-7 365 yds |

III. Crew Function During Drop

- | | |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| A. Crew #1 | Made plot diagram of pattern of each drop. |
| B. Crew #2 | Dropped 5 pigs in the carrier pattern after each drop. |
| C. Crew #3 | Safety crew stationed along downwind side of grid to retrieve sponges that might blow from grid. To collect all remaining sponges at 0 / 2 hours. |
| D. Crew #4 | Same as Crew #3. |
| E. Crew #5 | Selection of random tubes and sponges following drop. |



F. Crew #6 Target vehicle - To adjust for wind change and mark with smoke grenade.

IV. Collection 0 / 1 hours

- A. Crew #1 Picked up three (3) pigs in even number pen and two (2) in odd number pen, as per test plan.
- B. Crew #2 Picked up every other pig placed in the cloud and turned loose in the area, as per test plan.
- C. Crews #3 & 4 Picked up remaining sponges and sampler plates, recording number of vectors per plate.
- D. Crew #6 Recon. of area with Test Officer.

V. Instructions were given to Security Guard by Test Officer, and crews and observers left the grid at 1300 hours.

Xenopsylla cheopis Oriental Rat Flea

Raised on rats at Camp Detrick.

Peak of emergence was 15 September.

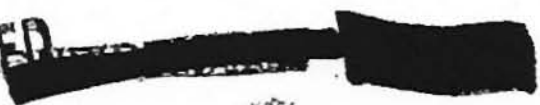
No mortality of any fleas observed after storage.

Fleas were shipped via commercial plane at 20,000 ft. Fleas were in cardboard containers and put in forward baggage compartment on DC 6 to Denver and Convair to Salt Lake.

Fleas were packed into munitions on Thursday, 16 September, at 2000 to 2400 hours.

In munition 1 - green and yellow 3000 fleas were put in each insert, and about 80 inserts were packed	<u>240,000</u>
In munition 2, orange, and munition 3, red-orange-black; about 2000 fleas were put in each insert	160,000
	160,000
In munition 4 in sponges, about 100,000 fleas were put in the container	<u>100,000</u>
	660,000
In munition dropped 16 September, 5 inserts holding 2,000 fleas each were dropped	<u>10,000</u>
Total fleas used	670,000

Approximately 1,000,000 fleas were brought to Dugway. All excess



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were given to Ecological Research, or killed.

After the drop, at various intervals, guinea pigs were examined and all fleas had fed on the guinea pig and all contained full blood meals(sic).

No fleas were killed during or immediately following the munition drop so that 100% survival of fleas was observed. All fleas readily bit humans or guinea pigs. Their behavior was completely normal(sic).

MARK W. McBRIDE
Test Officer, BW 1-55

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