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EVALUATION OF COCKROACH SURVEILLANCE DEVICES.(U)
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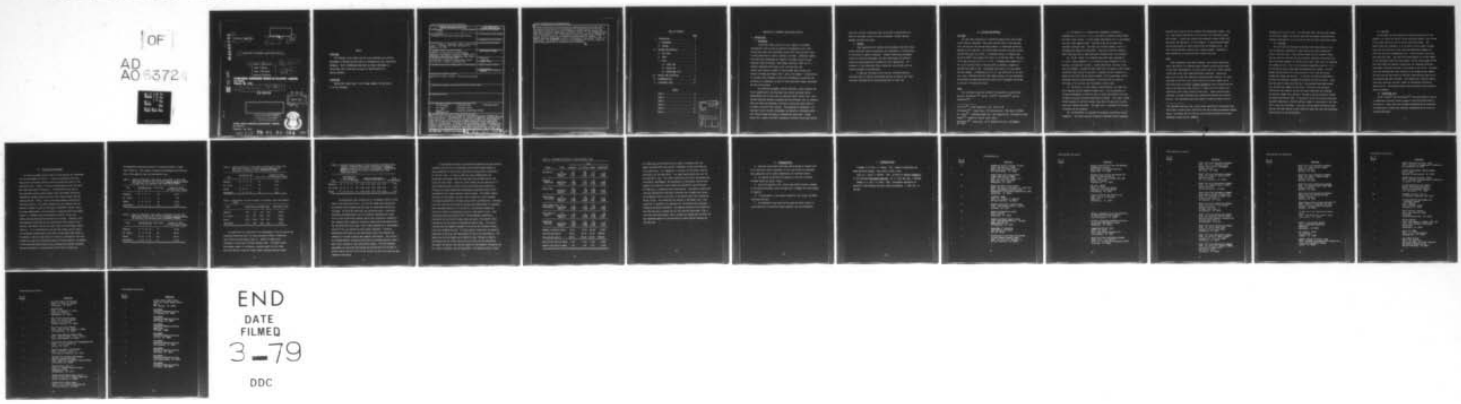

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Shock"M"All(R)

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Four cockroach traps were evaluated for potential Army use as cockroach surveillance devices. The Detector(R), Mr. Sticky(R), Roatel(R), and Shock"M"All(R) were evaluated in a series of tests designed to determine the effectiveness of each trap in sampling a population of known density and instar composition within a confined space. A second series was designed to test the comparative trapping capabilities of three traps, excluding the Shock"M"All. The Detector and Mr. Sticky, the two disposable traps which utilize adhesive surfaces, were evaluated in an operational test at two dining facilities. None of the traps

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produced statistically consistent results although three of the traps could be used as survey devices for cockroaches with varying degrees of utility. A cost-benefit analysis using seven parameters revealed that The Detector was the trap of choice followed closely by the Mr. Sticky. It was recommended that use of The Detector or Mr. Sticky should involve a minimum of two consecutive nights using the same trap, to dampen the inconsistency of sampling. The Roatel trap was recommended for use if colonization is the primary function of the survey. The Shock"M"All trap was not recommended for use as a control or surveillance device due to electrical hazard potential.

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I. INTRODUCTION.

A. BACKGROUND.

Cockroaches impact severely on man's domestic environment representing a major source of potential contamination to his food. Studies have shown that cockroaches spread filth from unsanitary areas to areas where food is stored, prepared, and eaten. Laboratory studies have shown that cockroaches are capable of carrying various disease organisms (Jung and Shaffer, 1952; Rueger and Olsen, 1969) and in a recently conducted field study it was concluded that cockroaches carry bacteria capable of causing human food poisoning and disease (Frishman and Alcamo, 1977). Even if the danger of contamination is excluded, odors imparted to food and surroundings by excretions and secretions of cockroaches in areas of high infestation render cockroaches terribly noxious pests.

The cockroach management problem represents a major manpower and fiscal expenditure to the Army, where pest control personnel devote approximately 75% of their time to cockroach control (Smith, pers. com.). Through scheduled repeated treatments, the Army dispenses tons of cockroach baits and dusts and thousands of gallons of pesticide sprays yearly in an effort to control these insects. The magnitude of expenditure for cockroach control warrants development and adoption of procedures which will insure optimum efficiency of manpower and pesticides. A need exists for a simple, efficient, inexpensive cockroach surveillance device

which will provide a population index to be used in establishing the need for and proper timing of control procedures, thereby reducing manpower and pesticide usage.

B. PURPOSE.

Army regulations 40-5 (Health and Environment) and 420-76 (Pest Control Services) require surveillance for cockroaches as a prerequisite to initiation of control procedures. Present surveillance procedures consist of flushing cockroaches from their harborages with pyrethrin sprays and making population estimates by visual observation. The procedure is time consuming, highly subjective, and provides only the crudest estimate of the population.

A study was initiated to evaluate four currently marketed cockroach traps to identify surveillance devices to replace the "flush and count" procedure and to provide guidelines for their use.

II. METHODS AND MATERIALS

TEST AREA:

All tests were conducted in a specially prepared test room located at Fort Detrick, Maryland. Three walls and the floor of the room were tile, and one wall and the door were plywood. A translucent window was present in one tiled wall. All cracks within the test area were caulked, and the floor drain was sealed. A cockroach barrier, of masking tape and Tack Trap(R), was placed on all walls 1.3 M from the floor. The size of the test area was 3.25 x 2.1 x 1.3 M. A cardboard test chamber 45.7 x 45.7 x 35.6 cm was placed in the test area to simulate a cupboard or enclosed area under a sink. Cockroaches could easily exit and reenter the test chamber. A temperature of 21 $\pm$ 2° C was maintained in the test area using a 1500 watt electric space heater having a fan and thermostat. The humidity was monitored during the tests with a hygrometer positioned on the wall 1.4 M above the floor.

TRAPS:

Four cockroach traps were selected for evaluation as surveillance devices, The Detector (R), the Mr. Sticky(R), the Roatel(R), and the Shock"M"All(R).

Tack Trap(R) - Animal Repellants, Inc., Griffin, GA.

The Detector(R) - Zoecon Corp., 975 California Ave., Palo Alto, CA 94304.

Mr. Sticky(R) - Mitsuboshi Boeki Inc., 587 Industrial Rd., Carlstadt NJ 07072.

Roatel(R) - Fumakilla Limited, Tokyo, Japan.

Shock"M"All(R) - Hinez Corp., 121 W. Chestnut Hill Ave., Philadelphia, PA 19118

(1) The Detector is a ready-to-use, disposable, rectangular, cardboard box, 4.5 x 12.5 x 7.0 cm, with three 2 cm adhesive bands around the trap's inner surface. A burnt caramel odoriferous bait is incorporated into one of the adhesive bands. The ends of the box are open with internally directed flaps. The traps are received wrapped in pairs in cellophane and require no preparation. They do not fold for transport. Black traps were used in these tests, but different colors are available.

(2) The Mr. Sticky is a cardboard trap which comes collapsed to 9 x 18 cm. When assembled, it is a tube18 cm long, triangular in cross section, 9 cm wide and 5 cm high. To make operational, the tops of the trap are unfolded, a protective paper sheet over the adhesive, which covers the entire inner surface of the base, is removed, and the contents of a packet of roach bait (84.5% chrysalis powder, 15.0% precipitated calcium carbonate, and 0.5% sodium benzoate) is sprinkled over the adhesive. The sides of the trap are then interlocked to form a tube.

(3) The Roatel is a clear plastic, non-disposable, two stage trap which requires baiting (Fumakilla Roatel Bait). The trap operates by allowing cockroaches, in search of food, to enter the bottom of the trap by means of one-way aluminum toothed-edge trap doors. From there, finding further progress to the bait blocked, they enter the upper bait holding level also through trap doors. The upper level is removable for periodic collection and for cleaning.

(4) The Shock"M"All is designed for permanent installation on wall baseboards. The system consists of specially designed plastic baseboard

sections which contain electric contacts that electrocute insects. The 3 ft. long sections operate on 110 or 220 volt, 50 or 60 cycle, household current. A power pack converts the household current to 850 volts and reduces the amperage to 0.9 milliamperes. A capacitance/discharge system electrocutes any insects which enter the baseboard unit. The units require periodic cleaning with a vacuum cleaner. According to Army regulations, an electrician must install the units.

TESTS:

Three comparative tests were conducted. One involved testing the traps individually in a confined space, another involved testing three of the traps simultaneously, using the entire room, and a third involved testing two of the traps under operational conditions. Twenty-four hours prior to each test replicate, cockroaches were isolated. For each replicate of the first test, 40 each 2nd and 4th instar nymphs and 20 each adult males and females (Blatella germanica)* were collected and five each of the same instar were placed in a clean, dry 37 ml plastic vial containing a small piece of moist filter paper. These vials were held overnight, and dead cockroaches were removed and replaced the following morning. The cockroaches were then placed in three pint mason jars for

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*The specimens used were from a mixed colony consisting of individuals from the US Dept. of Agriculture, Beltsville, MD; The US Army Environmental Hygiene Agency, Fort Meade, MD; and from the stock colony maintained by the Pest Management Systems Branch, USAMBRDL.

introduction to the test site. For the second test, 150 2nd instar nymphs, 120 4th instar nymphs, and 90 each adult male and female cockroaches were similarly introduced to the test site and used for three consecutive nights.

(1) TEST ONE.

The first test was designed to determine the effectiveness of each trap in sampling a population of known density and instar composition within a confined space. Each trap was tested on four different nights. The test area was inspected for any previously uncaptured cockroaches and those found were removed. On the day of the test, food, water and harborage (six pieces of 10.2 x 10.2 x 0.3 cm masonite separated by two 4.5 x 1.3 x 0.3 cm spacers) were placed under the cardboard test chamber. The test chamber was positioned 10.2 cm from the wall, and a trap was placed between the chamber and the wall. If the test involved the Shock"M"All, the trap was thoroughly vacuumed and inspected for short circuits. Fresh bait was used in traps requiring bait. The overhead lights were turned off, and the test chamber was set aside. The tops of the cockroach holding jars were removed, and the jars were placed near the harborage and the test chamber then replaced. The door to the test area was locked and sealed with masking tape. At the end of 24 hrs the following data were recorded: temperature; relative humidity; number of cockroaches in the floor, walls, tack trap, harborage, in the trap, and the number missing by instar and sex; the time required to set, check and remove the trap and cockroaches; and the nature of any malfunctions.

(2) TEST TWO.

In the second test the comparative trapping capabilities of The Detector, the Roatel and the Mr. Sticky traps were tested. Four of each of the three traps were used for three consecutive nights. The twelve traps were arranged in a 75 cm radius circle an equal distance apart with the position of each trap being determined randomly and with their positions rerandomized daily. Freshly baited, clean traps were used each night. The traps were tested against an initial number of 450 cockroaches (150 2nd instar nymphs, 120 4th instar nymphs and 90 each adult males and females) released near the harborage which was positioned, with water and food, in the center of the circle. The water, food, and harborage were then covered with the cardboard test chamber. The test area was then sealed as previously described and after 24 hrs the following data were recorded: room temperature, relative humidity, trap type, replicate, position, number of cockroaches collected by instar and sex. Cockroaches trapped from the original test evaluation were not replaced.

(3) OPERATIONAL TEST.

The Mr. Sticky(R) and The Detector(R) traps were tested as part of an operational cockroach control program in two dining facilities at Fort Detrick. These tests were designed to demonstrate the usefulness of these traps in determining cockroach infestations and as an aid in locating harborages.

III. RESULTS AND DISCUSSION.

All traps evaluated could be used as survey devices for cockroaches with varying degrees of utility. It should be noted here that the traps did not noticeably decrease cockroach population levels in the operational test. Tables 1-3 show the effectiveness of the four traps when they were tested individually. The Shock"M"All trap had the most consistent capture rates between stages and between replication although the average percent catch was only slightly higher than the lowest value (Mr. Sticky). None of the traps produced statistically consistent results. The highest average catch was obtained with The Detector followed in order by the Roatel, Shock"M"All, and Mr. Sticky. All traps demonstrated a low proficiency in capturing 2nd instar nymphs (Table 1). Although, with the exception of the Mr. Sticky, the capture rate was essentially identical for all traps. Similarly, with the exception of the high rate of capturing 4th instar nymphs by The Detector, the capture rate for the other traps was surprisingly similar (Table 2). It is interesting to note that the capture rate of adults for the Roatel trap was nearly twice that for the other traps (Table 3). The Roatel is the only trap which will allow for collection of live cockroaches to be used for colonization and/or resistance testing. An analysis of the adult male-female capture ratio indicated The Detector and Roatel were more successful in capturing males while the Mr. Sticky and

and Shock"M"All were more successful in capturing females in these tests (Table 4). This reveals a balanced split between the attractiveness of the adhesive traps and non-adhesive traps.

Table 1. Catch Per Replicate, Total Catch, and Percent of Total (All Replicates) Caught of 40, 2nd Instar Blatella germanica Nymphs Per Replicate, By Cockroach Traps Individually Tested.

Trap	Catch/Replicate 1	2	3	4	Total Catch	Percent of Total (All Replicates) Caught
Detector	19	1	11	7	38	23.75
Mr. Sticky	6	1	3	2	12	7.50
Roatel	3	9	9	13	34	21.25
Shock"M"All	9	11	9	9	38	23.75

Table 2. Catch Per Replicate, Total Catch, and Percent of Total (All Replicates) Caught of 40, 4th Instar Blatella germanica Nymphs Per Replicate, By Cockroach Traps Individually Tested.

Trap	Catch/Replicate 1	2	3	4	Total Catch	Percent of Total (All Replicates) Caught
Detector	27	11	15	18	71	44.38
Mr. Sticky	3	4	15	20	42	26.25
Roatel	13	15	7	10	45	28.13
Shock"M"All	6	16	5	10	37	23.13

Table 3. Catch Per Replicate, Total Catch, and Percent of Total (All Replicates) Caught of 40 Adult Blatella germanica Per Replicate, By Cockroach Traps Individually Tested.

Trap	Catch/Replicate 1	2	3	4	Total Catch	Percent of Total (All Replicates) Caught
Detector	18	8	11	18	55	25.0
Mr. Sticky	4	9	19	12	44	27.5
Roatel	23	30	23	7	83	51.9
Shock"M"All	7	14	13	10	44	27.5

Table 4. Male/Female Cockroaches Caught by Cockroach Traps Individually Tested.

Trap	Male/Female Catch/Replicate 1	2	3	4	Male/Female Total
Detector	9/9	3/5	3/8	8/10	23/32
Mr. Sticky	4/0	3/6	10/9	7/5	24/20
Roatel	10/13	14/16	9/14	2/5	35/48
Shock"M"All	4/3	8/6	5/8	8/2	25/19

The second test was comprised of four replicates of three of each of the attractant-containing traps for three consecutive nights to determine their relative attractivenss (Table 5). Results of these tests indicated no significant difference between traps. The Roatel caught the greatest number of cockroaches, averaging nearly six per night while The Detector caught the fewest number (average three per night).

Table 5. Relative Attractiveness of Three Cockroach Traps When Tested Together in Random Order Against A Population of Blatella germanica Comprised of 150 - 2nd Instar Nymphs, 120-4th Instar Nymphs, and 90 Each Adult Males and Females Over Three Consecutive Nights.

Trap	Catch/Replicate For 3 Nights					Replicate Means/Night				$\bar{X}$ =	$\bar{X}$ S_D
	1	2	3	4	Total	1	2	3	4	$\bar{X}$	All Replicates
Detector	8	4	8	17	37	2.67	1.33	2.67	5.67	3.17	1.27
Mr. Sticky	12	13	16	9	50	4.00	4.33	5.33	3.00	4.17	1.07
Roatel	21	14	23	13	71	7.00	4.67	7.67	4.33	5.92	1.60

The operational tests involved use of The Detector and Mr. Sticky traps in two dining facilities. An ultra low volume (ULV) application and residual spray program using the traps as surveillance devices was initiated. By using the same traps two consecutive days, a relatively consistent and determinable level of cockroach infestation was found. Prior to this surveillance program, control was initiated in response to user requests which frequently resulted in weekly pesticide applications. The two dining facilities used in this study accounted for a time expenditure of 27 hrs. per quarter for pest control personnel. Following spraying and utilization of the surveillance traps, user requests and frequency of residual spraying were reduced significantly. One facility has averaged monthly spraying and the other has averaged quarterly treatments since inception of the surveillance program. The total manpower requirement for pesticide applications and surveillance has now been reduced by nearly one-half to 14 hrs per quarter and pesticide usage has been reduced by two-thirds.

A cost-benefit analysis was performed to determine the best possible cockroach trap for use in an Army-wide surveillance program (Table 6). Seven categories or factors were identified as being valid in evaluation of the four traps. In order to make the values dimensionless and normalized, the largest value for each factor was divided into all the values for that factor. Since all of the factors are not necessarily of equal importance their relative values and rankings were subjectively arrived at by three professional entomologists considering test results and objectives of a good cockroach control program. The highest benefit value was for consistency of count, which allowed for actual estimates of cockroach populations, followed by operational considerations. Obviously, since the traps are to be used for surveys, their effectiveness is important, and if resistance testing is to be part of a surveillance program the ability to collect live specimens acquires a high benefit value. Since surveillance must be performed with a minimum manpower expenditure, portability to and from the survey areas was given a high benefit value. Trap set-up time was given an intermediate benefit value. This factor involves both the manpower expended in set-up and the disruption caused within the surveyed activity. Of lesser benefit values were the annoying appearance of the traps and requirements for their daily maintenance. The Roatel trap had the highest sum of benefit values followed in order by The Detector and Mr. Sticky which were very close, and the Shock"M"All. The weekly (52 wks/yr) trap cost was lowest for The Detector followed by the Mr. Sticky, the Roatel, and the Shock"M"All. The Detector and Mr. Sticky

Table 6. Cost-Benefit Analysis of Four Cockroach Traps

Factor	Value	Trap			
		Detector	Mr. Sticky	Roatel	Shock"M"All
Portability	10	140	200	70	1
	Normalized	0.70	1.00	0.35	0.005
	Benefit	7.00	10.00	3.50	0.050
Annoying Appearance	1	12	11	10	1
	Normalized	1.000	0.917	0.833	0.083
	Benefit	1.000	0.917	0.833	0.083
Set-Up Time	5	100	75	50	1
	Normalized	1.000	.750	0.500	0.010
	Benefit	5.000	3.750	2.500	0.050
Effectiveness For Survey	10	5	50	25	1
	Normalized	0.100	1.000	0.50	0.020
	Benefit	1.000	10.000	5.00	0.200
Effectiveness For Colonization	10	2	2	20	1
	Normalized	0.100	0.100	1.000	0.050
	Benefit	1.000	1.000	10.00	0.500
Consistency of Count	15	5	1	10	20
	Normalized	0.250	0.050	0.500	1.000
	Benefit	3.75	0.750	7.500	15.00
Maintenance Required	1	100	90	50	1
	Normalized	1.000	0.900	0.500	0.010
	Benefit	1.000	0.900	0.500	0.010
Summary of Benefit Values		19.75	18.317	29.833	15.893
Trap Cost/26 uses/Yr		$5.20	$7.54	$7.80	$400.00
Trap Cost/52 uses/Yr		$10.40	$15.08	$15.60	$400.00
Benefit-Cost Ratio 26 Weeks		3.79	2.43	3.82	0.039
Benefit-Cost Ratio 52 Weeks		1.89	1.22	1.91	0.039

are throw-aways and therefore have no capital investment while the Roatel and Shock"M"All have capital investments of $5.00 and $1200 per trap respectively. Life expectancy is one year for the Roatel trap and three years for the Shock"M"All. The lowest benefit-cost ratio was for the Shock"M"All trap. This point coupled with the trap's maintenance and installation requirements, the permanancy of installation, and the real potential for electrical shock render the Shock"M"All trap ineffectual for Army use as a cockroach surveillance device. The highest benefit-cost ratio was obtained with the Roatel trap which was followed very closely by The Detector and in third place in the benefit-cost ratio ranking was the Mr. Sticky. The unique positive feature of the Roatel trap is the capability of capturing live specimens for colonization and resistance testing as previously mentioned. The negative features of the Roatel are the time necessary to remove and kill the captured cockroaches, time to clean the trap with alcohol, time to discard and replace the old bait, and the inordinate amount of care exercised to insure against dropping the delicate trap.

IV. RECOMMENDATIONS.

A. Cockroach surveillance techniques should become an integral part of all Army pest control procedures to be in compliance with pertinent Army regulations and to reduce expenditures for cockroach control.

B. For routine surveillance The Detector is the trap of choice, followed closely by the Mr. Sticky.

C. Use of The Detector or Mr. Sticky traps should involve a minimum of two consecutive nights, using the same trap, to dampen the inconsistency of sampling.

D. If colonization is the primary function of the survey, the Roatel trap should be used.

E. The Shock"M"All trap should not be used for either control or surveillance due to electrical hazard potential and low cost-benefit.

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