ARTICLES

SOME MARKING AND RECOVERY TECHNIQUES IN *CULEX TARSALIS* COQ. FLIGHT STUDIES *

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INTRODUCTION. Flight range studies of Diptera and other insects always have posed common problems. These problems are very familiar to workers in this field of research. The first difficulty is collecting or rearing large numbers of adults of a uniform physiological age for marking. The second problem is the availability of a marking chemical or substance which can be applied readily, be nontoxic, persist throughout the life of the individual, and one which can easily be discerned in small amounts among large numbers of specimens. Lastly, the extensive dilution of marked individuals with the wild population makes it necessary to collect a tremendous volume of material and employ many man hours to recover a significant number.

Reviews summarizing previous works n the dispersion and flight range of mosuitoes as well as methods of marking ave been published elsewhere (Eyles, 944; Reeves *et al.*, 1948; Boyd, 1949). riefly, the methods of marking have inluded aniline dyes applied as a spray, halk, and metallic powders dusted exrnally, vital stains fed to the larvae Weathersbee and Hasell, 1938) and more ecently spraying (Aarons *et al.*, 1951; Smith *et al.*, 1956) and dusting with fluorescent powders and feeding the same in sugar solution (Reeves, *et al.*, 1959), and rearing in water containing radioisotopes (Thurman and Husbands, 1951; Provost, 1957). We believe some of the materials and methods we have employed using water-soluble fluorescent dyes to mark the feces, and the use of the zinc sulfide fluorescent powders externally, are useful modifications in such work with mosquitoes. The materials and methods are described below.

In 1959, Dr. E. M. Stafford of the Department of Entomology, University of California, Davis, suggested the possibility of using zinc sulfide ("Helecon" products, United States Radium Corporation) fluorescent powders for external marking. He had previously employed these powders in studying oil spray deposits and in marking Drosophila (unpublished notes). Johansson (1959) has used the "Helecon" pigments in tracking honey bees and undoubtedly there are other instances in biological science where such pigments have been employed.

The senior author made inquiry of the police concerning the materials used in criminology for marking money, etc., and discovered that the same type of extremely fine fluorescent powders was employed for this purpose. Preliminary laboratory tests with mosquitoes showed these powders to be superior to bronzing powders and colored inert pigments in the majority of cases. In addition, the botanists, notably Dr. H. B. Currier, at this university and Dr. R. H. Garber, plant pathologist of the Agricultural Research Service, United States Department of Agriculture, have employed water soluble fluorescent dyes in studying the translocation of chemicals in plants. We made use of these experiences and screened the materials listed in the table below. An ultra violet "Stroblite" (with a Westinghouse 100W,

* This research was done under grant E2831 of the USPHS, initiated in 1959 by the late Dr. Stanley B. Freeborn, and covers the 1960 and 1961 seasons' work. The major part of the work was done in Yolo County, California.

CH_4, projector spot bulb and a purple-blue filter) giving an Ängstrom unit range of 3,500 to 3,900 were used in this work.

Prior to marking *Culex tarsalis* Coq. for the release experiments, samples of various fluorescent powders were collected and tested under the ultra violet light. Table 1 lists these products and their fluorescent nature.

The most promising water soluble dyes for our use were oxypyren, more tech-

TABLE 1.—Characteristics of fluorescent products *

Material (or product)	Mfr.	Fluorescence	
		Dry	*Wet (in tap water)*
Rhodamine B	Coleman & Bell Co. Norwood, Ohio	Very slight	Slight. Pink
Rhodamine 6G	Coleman & Bell Co. Norwood, Ohio	Very slight	Slight. Orange
Rhodamine B, Xtra S	General Aniline and Film Corp.	Faint (after dilution)	Excellent. Faint orange to pink.
Acriflavine hydrochloride	Coleman & Bell Co. Norwood, Ohio	Very slight	Slight. Yellow
Rose bengal, 3B concen., N. Xtra B	Coleman & Bell Co. Norwood, Ohio	No	Good. Crimson to red
Phosphine	Coleman & Bell Co. Norwood, Ohio	No	Slight. Brown
Primuline	Coleman & Bell Co. Norwood, Ohio	Faint	No (not soluble)
Auramine O	Coleman & Bell Co. Norwood, Ohio	Faint	Slight. Yellowish green when ingested
Clayton yellow range 12.1–14.0	Coleman & Bell Co. Norwood, Ohio	Faint	Very faint. Yellow
Acid Alizarine Blue, 2B	Coleman & Bell Co. Norwood, Ohio	No	No. Bluish green when ingested
Berberine Sulfate	Farbenfabriken Bayer, Leverkusen	Faint	Bright yellow
Brilliant Sulpho Flavine, FFA	General Aniline and Film Corp.	Orange	Yellow-orange
Pyrene (94%)	Eastman Organic Chem. Rochester, New York	Good	Excellent. Blue (poor solubility)
Acridin Yellow R	Hartman-Leddon Co. Philadelphia, Pa.	No	No
Thioflavine S	Hartman-Leddon Co. Philadelphia, Pa.	Very faint	Very faint. Blue.
Oxypyren (pyramine)	Bayer (Pollack Luminescent Corp. 640 S. Federal Chicago 5, Ill.)	No	Excellent. Bright yellow
Uranine, WSS	General Aniline and Film Corp.	No	Excellent. Bright yellow

* Technical characteristics are to be found in Gurr, Edward: "A Practical Manual of Medical and Biological Staining Techniques," Inter. Sc. Pub., Inc., N. Y. 1953. 320 pp.

nically known as 3-oxypyren-5,8,10 trisulfosaures natrium, Rhodamine B, extra S, and Uranine WSS. Other pigments tested as dusts only are listed in Table 2.

TABLE 2.—"Helecon" fluorescent pigments, U. S. Radium Corp., Morristown, N. J.

Pigment	Color under U.V.	Relative brightness	Particle size (microns)	Chemical base
1953	Green	100	2	Zn S
1955	Blue-green	85	2	Zn S
2200	Blue-white	80	3.5	Zn S
3336	Copper-orange	25	2	Zn S

To date the zinc sulfide dusts have proven the most satisfactory for external marking. Adults dusted so heavily that the powder could be seen with the naked eye appeared to be unharmed and reacted normally. Over a period of two weeks, when held in cages in the laboratory and fed sugar solution, they lost some of the dust, but the adhesiveness of the particles was adequate without the addition of gum arabic (Zukel, 1945) or other stickers.

Mention also should be made of colored, inert, non-fluorescent pigments which we used in powdered form for external marking. Four pigments were obtained from E. I. duPont de Nemours under the names of Toluidine Red, Benzidine Yellow, "Ramapo" Blue, and "Monastral" Green. The dusting quality of these powders was inferior to the zinc sulfide powders but the adhesiveness and ease with which the red pigment particles could be seen under lower magnification (9x to 10x) justifies further use, particularly where it is not possible to use ultra violet lamps. However, contamination of all equipment and containers occurs readily with this powder. Also, examining large numbers of adults for the presence of this type of dust cannot be done as rapidly as with fluorescent powders with U.V.

REARING LARVAE IN DYES. Larvae of *C. tarsalis* were reared in solutions of oxypyren, Rhodamine B extra S., Oil red O, Evans Blue, and Giemsa. As observed by other workers (Eyles review, 1944; Chang, 1946; Reeves *et al.*, 1948), the results were not very satisfactory. The degree of staining or marking of the emerged adults (see Table 3) was insufficient to be readily seen under low magnification (without dissection) or under U.V. The time consumed in rearing and the inability to quickly recognize marked individuals when diluted with a large daily volume of field collections makes this method impractical.

STUDY OF MARKED FECES. Following up the possibility of internally marking the mosquitoes by tissue staining, we experimented with feeding the adults soluble dyes and fluorescent compounds in sugar solution (Reeves *et al.*, 1948). Auramine O; Acid alizarine Blue, BB; Rhodamine B, Xtra S, and 6G; Acridin Yellow R and Rose Bengal were tested at various dilutions. All these dyes were taken up by the adults when fed on cotton pads. The results were as follows: saturated solutions usually produced mortality; Rose Bengal fluoresced poorly. With the exception of Rhodamine B Xtra S, these compounds produced green, blue and Yellow R and Rose Bengal were tested those sometimes found to be naturally fluorescent in field-collected specimens. This method produced colored, engorged adults which could be readily recognized and furthermore, resulted in colored and/or fluorescent feces being deposited. A long series of laboratory experiments with *Culex tarsalis* at room temperature resulted in detailed observations on the fecal deposits and their varying visible characteristics throughout the feeding cycle. These observations may be of value to other research workers in this field.

The meconium is grey-green to blue and varies considerably in color. From three to seven such drops are deposited in the first two days depending on availability of food. Following the passage of the meconium, on a diet of water only, the fecal drops turn brown to yellowish and remain thin. When a five percent sugar solution is fed, several clear drops are deposited following the meconium, then there is a continuing deposition of pale brownish yellow drops with a slight glazed appearance (on white bond paper). Newly emerged, mated and unmated females will live as long as three weeks on the sugar solution only. When raisins and water are employed as food, the fecal drops in about 48 hours become shiny brown and shellac-like upon drying. On this diet, longevity is increased to a maximum of six weeks.

After a blood meal there is a definite pattern and sequence of fecal drops as follows: if the meconium has previously been passed, 15 to 40 tan-colored solid, round, doughnut-like drops are passed over a two- to three-day period. Usually on the third day (45 and up to 60 hours), black, shiny, irregular, asphalt-like drops are deposited. In some individuals digestion is slower and it is 72 to 96 hours before the blood is digested. Following the black feces, several brown, thinner drops are laid down and if a diet of water only is available, some of the thin drops assume a greenish color similar to the meconium. In such a feeding cycle about eighty fecal drops per individual are deposited. The maximum of drops produced by one female living thirty days was 302. The results of the feeding experiments with dyes are summarized in Table 4.

The obvious advantage in employing the fecal marking techniques—by placing white paper in resting stations—is that the presence of marked individuals can be determined even though they are not captured or seen. In nature we have not seen feces marked with bright yellow, orange, brilliant blue, or dark red. Various shades of yellow, green, blue, brown, pink and even some with a faint fluorescence are to be found in field-collected mosquitoes. C. T. Brues (1944) has pointed out that many plants contain fluorescent alkaloids which can stain insect tissues. Therefore, red food coloring (by Schilling*) which is non-fluorescent, oxypyren, rhodamine, and uranine were used in these experiments. Individual adults of known age were isolated in shell vials or small cartons and fed the dye solutions with 5 percent sugar. Plain white filing cards (3 by 5 inches) or discs of bond paper were used to collect the feces. These could be numbered, fluoresced, and filed conveniently. The diverticulae appear to become the principal reservoir of the dyed sugar solutions upon engorgement. Some coloration extends into the coxae, thorax, "neck" and wing bases.

The rate and amount of "absorption," as well as length of retention varies in individuals. The uranine appeared to cause some internal irritation as nearly twice as many fecal drops were deposited from this dye as with other materials. However, it did not cause a higher rate of mortality than a diet of sugar and water only. Oil red O was difficult to get into solution, the mosquitoes appeared to dislike it, and a high mortality resulted when it was ingested. Oxypyren is highly water soluble and as a result appeared to be eliminated more rapidly. When freshly deposited the feces fluoresced most brilliantly. As the amount of solids increased the fluorescence became less distinct. Dried droplets, heavily glazed, as from a diet of raisins, reacted poorly under U.V. light. The feces colored with food coloring are readily seen with the unaided eye, but, in great dilution or several days after the adults are removed from the diet, are not discernible as are the fluorescent-dyed feces. The colored droplets on the cards did not fade in five months. An-

* A commercial mixture of U.S.F.D. and C. colors Red #1, Ponceau 3R and #2, Amaranth, 2.5 percent in a water propylene glycol solution.

TABLE 3.—Summary of larval rearing experiments with dye solutions

Dye	Dilution	Relative toxicity	Remarks
Rhodamine B, extra S (powder)	1 gr/10,000 ml H_2O	Low	Adults not marked (meconium not marked).
Giemsa (solution)	1 part/250 ml H_2O	Low	Adults show some marking in "neck." Darker coloration of adults occurred when early 4th instar larvae were placed in the dye rather than rearing larvae through all stages in the dye.
Evans Blue (powder)	0.1 gm/500 ml H_2O	Very low	Blue color is readily visible in the larval gut but evidently is all passed before pupation. Adults show no color from dye.
Oil Red O (powder)	0.1% in a solution of equal parts acetone and 70% alcohol (food pellets were soaked in the solution for several hours).	Moderate	Adults not marked.
Oxypren (powder)	0.5% solution	Low	Adults not marked.
Uranine WSS (powder)	1 gr/10,000 ml H_2O	Moderate	Adults not marked (meconium not marked).

TABLE 4.—Fluorescence of *Culex tarsalis* adults fed with dyes

Dye	Dilution	Adults marked		Feces marked		Maximum time (days) marked after one feeding	
		Visibly	U.V.	Visibly	U.V.	Adults	Feces
Rhodamine B, Xtra S	1 gm/10,000 ml water plus 5% sugar	Yes	Yes	Yes	Yes	2 to 3 (15 max.)*	14 max. avg.4
Rhodamine B, Xtra S	1 gm/100,000 ml H_2O plus 5% sugar	Very faint	Yes	No	Yes	..	1
Oxypyren	1 gm/10,000 ml water plus 5% sugar	Yes	Yes	Yes	Yes	1	4
Oxypyren	1/100,000 ml H_2O	No	Yes	No	Yes	..	2
Uranine	1 gm/100 ml water	Yes	Yes	Yes	Yes	7*	7
Uranine	1:10,000	Yes	Yes	Yes	Yes	4	5
Uranine	1:100,000	No	Yes	No	Yes	..	1
Food coloring	2% in water plus 5% sugar	Yes	No	Yes	No	2	2 to 3 (6 max.)

* When exposed continuously on dye solution for two weeks.

other point to mention is that females thus engorged still seek and take blood.

In the field, a "self-feeding station" was set up by placing a 5 percent sugar solution with red food coloring added at the rate of 15 ml. to one liter on cotton pads in dishes. These dishes were placed on a box in a willow thicket on the bank of a canal in the rice fields. This location had previously been found to be a choice daytime resting area for large numbers of adults. On the one evening this solution was available, adult *tarsalis* were observed to feed on this dye solution in small numbers. During the following three nights several hundred bright red fecal drops were deposited on papers placed in the weeds and bushes within ten feet of the feeding location.

A second experiment was conducted using dry ice in an attempt to attract larger numbers to the food. About five pounds of dry ice was suspended in a metal can over a large pan of the marking solution placed four feet above the ground near the willow thicket. A half-inch rubber tube directed the CO_2 vapor from the bottom of the can to the surface of the saturated cotton in the pan. This station was established at sundown and several hundred adults were observed to feed. White paper was placed in forty of the cubic-foot-square red boxes used as resting stations in the rice fields. The maximum distance boxes were located from the station was about 200 yards. The food was exposed for one evening only and the papers left in the resting stations for four nights thereafter. Scattered red fecal drops were found on the papers in 6 of the 40 boxes at varying distances up to 75 yards in the north, east and south quadrants. This method can be improved and, even though its usefulness is limited, it is described here should others wish to use it.

CHICKENS DYED. Further, in an attempt to have the adults mark themselves in a "natural" manner we hoped to introduce dye into the bloodstream of chickens and feed *tarsalis* on the marked fowl. Oxypyren was put in the birds' water receptacle (2 gm. to a liter). In twenty-four hours only the feces fluoresced. However, when the chickens were fed grain soaked in an oxypyren solution (20 gm. oxypyren, 20 ml. 70 percent alcohol, 70 ml. water) at the rate of 5 gm. oxypyren to 1 kg. of grain, the feces fluoresced in about four hours and the entire bird fluoresced after feeding on the marked grain for two days. The fluorescence gradually disappeared in a period of four days after the chicken was taken off the marked grain diet.

Rhodamine B, extra S, also was used to dye chicken feed by dissolving it first in 95 percent alcohol (0.5 gm. to 10 cc. alcohol) and then adding water at the same rate to the grain. The chicken fluoresced in nineteen hours. To speed up the marking process the chickens were force-fed capsules of 0.2 gm. of the rhodamine dye. The feces and the entire bird fluoresced in one hour with this method. The beak, feet, and pin feathers showed a deposition of the dye as well as the flesh. The whole, coagulated, or dried blood drawn from these chickens the following day did not fluoresce.

An autopsy of the bird fed oxypyren showed the dye to be deposited in the subcutaneous fatty tissue. The feces passed 26 hours after the chicken had been force-fed with the dye, ceased to fluoresce. However, the rhodamine still was seen under U.V. in the pin feathers and beak up to eleven days afterwards. The vital stain, Evans Blue, was also fed in a capsule in the same amount. The feces were visibly blue and the flesh assumed a blotchy appearance. When injected intravenously with physiological salt solution with two gm./1. of oxypyren, the entire bird glowed in two to three minutes. All parts of the body, including the eyes, feet, and beak, except the feathers, fluoresced. In five minutes the feces were bright yellow. In ten hours the chicken had lost its fluorescence.

The mosquitoes fed on these dyed chickens did not fluoresce significantly

ıor did their feces. The dyes are apparntly eliminated from the blood too rapidly o be useful for this purpose.

OTHER TESTS. A test was run to see f the fluorescence of the dye was masked ›y the blood. Rhodamine B Xtra S was ıised in four different solutions at 1 gr./10,000 ml. in each. Whole horse ›lood, horse blood serum, 5 percent sugar, ınd 15 percent sugar solutions were used. Cotton pads were soaked with the four olutions and the mosquitoes allowed to eed on them. All four pads showed ıniform fluorescence except that with the vhole blood, which gave slightly less fluoescence. Feces from mosquitoes which ed on these solutions all showed fluoescence under U.V. but varied as to degree of brilliance. The following tabulaion shows the results of examining the hodamine marked feces under U.V. light:

Solution	Relative fluorescence	
	Dry	Smeared with water
Iorse blood serum + 5% sugar	Very good	No change
% sugar solution	Good	No change
Iorse whole blood	Fair	No change
5% sugar solution	Poor	No change

Re-examination after three months howed no change in the fluorescence of hese feces retained on file cards.

If time does not permit the detailed xamination of all collections made durng the summer, it is well to know the legree of retention of fluorescence of the lried specimens. Table 5 shows the reults of re-examining "marked" mosquioes recaptured from releases after varyng lengths of time.

Adults marked internally should be exmined while fresh after recapture to obain the most positive proof of fluoresence. Those dusted externally may be xamined many months later and if adequately marked will fluoresce very well.

Dried raisins (punctured) were soaked in the rhodamine and oxypyren solutions and exposed to caged mosquitoes. The engorged specimens and their feces fluoresced clearly, but the brilliance was considerably masked in the feces. The next step was to feed the dyes in sugar solutions on cotton pads. A five percent sugar solution proved very satisfactory; ten and fifteen percent solutions tend to mask the fluorescence of the feces.

ARTIFICIAL RESTING UNIT. Artificial resting units (A.R.U.) as originated by Goodwin (1942), and employed by Hayes *et al.* (1958) and Loomis and Sherman (1959) were used in rice fields and nearby communities. These were pine boxes, one cubic foot square with one side open, painted red. Some were roughened in the interior by sprinkling sawdust on the wet paint to increase the attractiveness of the resting surface. After all the boxes became dirty with continuous use, there was no difference in effectiveness. Boxes facing east, adjacent to or on dry ground, unshaded or in a drafty place, attracted few mosquitoes.

Temperature readings inside the top of the box where the majority of mosquitoes rested were made to determine the maximum *C. tarsalis* would tolerate before relocating. When the temperature of the inner top surface reached 88° to 90° F., the adults began moving about and flew out of the box. This relocation was usually completed between 11 a.m. and 1 p.m. during the summer months. In the week of July 7 to 14, 1960, the maximum was 102° F. and the minimum 59° F. in one box placed in a patch of *Baccharis* plants at the edge of an irrigation canal. By moving the boxes about, the best locations generally were found to be facing in the arc south to northeast in the rice field area. When the boxes were placed in pairs a better representative catch was made. Once a good location was found, the boxes were not moved for the remainder of the season.

Collections or counts should be made before about 9 a.m. to record the maxi-

TABLE 5.—Retention of fluorescence of marked specimens

Fluorescent material used	Examination under U.V. light		Time elapse since 1st r captured treated ar examined
	Dry	Wet (crushed)	
Rhodamine B, Xtra S (fed to adults)	Poor	Fair	2 months
Uranine WSS (fed to adults)	Not detectable	Poor	3 months
Rhodamine B, Xtra S (sprayed on adults) in laboratory	Good	No improvement	1 year
Oxypyren (sprayed on adults) in laboratory	Not detectable	Good	1 year
Helecon 1953 dusted on adults	Good	No improvement	2 months
Helecon 2200 dusted on adults	Good	No improvement	2 months

mum number. A Plexiglas sheet 18 inches square to which a handle was bolted was placed over the open end. Chloroform was introduced by an atomizer through a half-inch hole in the plate. The asphyxiated mosquitoes were then easily picked out of the box and put in cartons for later examination. Vertical baffles about two inches apart suspended from the top to create more resting surfaces did not appear to increase total catch per box. As pointed out elsewhere, this method samples a rather small segment of the population but is most useful and properly supplements the CO_2 and light traps. Details on the 1960 and 1961 catches in these artificial stations, light traps, etc. will be presented in another report.

DRY ICE TRAPS. The dry ice (CO_2) traps, following the basic method of Bellamy and Reeves (1952) (originated by Headlee, Huffaker and associates, 1942) were employed extensively in this study. They were used to collect female *tarsalis* of a uniform physiological state for marking and for recapture following releases. They were also used to sample the field population movement in all types of ecological environments in and surrounding the rice study area in th lower, central Sacramento Valley.

Four gallon mayonnaise cans (12.75 10") were modified by soldering fly-tr type screen cones in each end; the o in the cover and the other fixed in t bottom end. A wire hook for suspensi parallel to the ground was soldered on the side. Two wire struts were solder to the inside beneath the hook for holdi the package of dry ice on the top (i side) of the trap when in place. The b results were obtained by placing the tra about five feet above ground (Burge and Haufe, 1960) along a southea northeast axis so the prevailing eveni breeze passed through the screen. T cans were suspended on metal fence po which could easily be driven into t ground wherever needed. The posts we placed in selected locations before ea experiment. At sundown, the previous wrapped packets of about three poun of dry ice in a double thickness of new paper and one layer of aluminum f were transported in an ice chest a placed in the cans just before they we hung in position. Several holes we punched in the wrapping material befo

lacement to direct the CO_2 vapor to the nter of the trap. Such a package connued to emit CO_2 vapor (visibly) for out six hours. On cool nights when ie temperature ranged from about 65° own to 49° F. the ice did not all vapore (and also very few mosquitoes were ying). Other observers (Bellamy and eeves, 1952) were correct in their asmption that the majority of *tarsalis* males were attracted to these artificial it traps in early evening.

During July to September, 1961, no O_2 trap, even when placed in the most favorable and/or isolated location failed capture *C. tarsalis* females. Three genalizations can be made from hundreds "trap hours": (1) in dense foliage in ie center of residential areas the numbers ught were small, (2) the farther away om the major breeding source, i.e., rice elds, the fewer the numbers captured id (3) in areas where there was very ttle air circulation ("dead spots") or on ill evenings, the catches were markedly duced. A maximum of 2,600 mosquitoes as caught in one rice-field trap in one ening.

The catches were picked up each morng, returned to the laboratory, chilled at ° F. and then shaken into quart cyanide rs via a large tin funnel. They were ien scanned in a dark room with the .V. lamp and the marked specimens reoved. Mosquitoes captured for marking, owever, were transferred into a holding ge by slowly sinking the CO_2 trap in drum of water and thereby forcing out ie adults, via a cloth sleeve placed over ie open end in a manner used by others. he adults which were marked with rhoamine-sugar solution were fed in the olding cages by placing cotton pads satuted with the dye on the top of the cage. he longer they were held, the higher ie mortality before release. About 4,000 lults per cage (18 x 18 x 26") appeared to the maximum to handle readily, to asre 85 to 100 percent being engorged with ie dye, and to keep the mortality to a inimum. In hot weather two days is the aximum the mosquitoes should be kept before release. The lower the humidity the higher percentage of feeding and consequent marking. A low temperature (70° F.) reduced the rate of feeding; about 80° F. and 40 to 50 percent relative humidity appeared to be the best conditions to induce feeding.

The releases that were dusted were treated by placing a box over the cage and blowing the dust inside through small holes with a small rubber bulb such as that used by pest control operators. Both internal and external marking of the same mosquitoes did not appear to affect them when released. When released in a slight breeze many individuals rise and travel with the breeze a short distance and then seem to reorient. Some individuals fly directly into the breeze when rising from the cage. When there is no wind, dispersal is nearly equal in all directions, at least in the vicinity of the release point. The marked mosquitoes were released just after sundown (Provost, 1957) to obtain the maximum flight.

Unusually high catches of *Anopheles freeborni* have been made in these traps. As many as 460 females were taken in one trap, and on one occasion 29 percent of a total catch (2,223) in one trap night was this species.

SUMMARY. For external marking in flight studies of *Culex tarsalis* in the rice-growing area of the lower Sacramento Valley, California, the "Helecon" (zinc sulfide) fluorescent pigments were most satisfactory. Larvae reared in various stains and dyes did not produce adequately marked adults for mass scanning of field collections. Colored feces produced by adults fed dyed sugar solution offer an additional method of tracing the presence of marked mosquitoes by placing papers in resting stations. The digestion cycle produces visible changes in the feces; blood meals and a raisin diet mask the fluorescence. Marked feces were produced for a maximum of fourteen days following engorgement with rhodamine, 1 gram to 10,000 ml. of 5 percent sugar solution. A self-feeding station using food coloring as a marker was satisfactory in prelimi-

nary experiments resulting in marked feces on papers in resting stations up to 75 yards distant. Chickens dyed with oxypyren and rhodamine by feeding and injection did not retain the dye in the blood for sufficient time (or in a sufficient amount) for adult mosquitoes to pick up the dye by feeding. Dried raisins punctured and soaked in the dyes provide a useful method of marking mosquitoes. Slight modifications of previously used CO_2 traps are described. These dry ice traps caught a surprisingly large number of *Anopheles freeborni*. Baffles inserted in the red boxes (A.R.U.) did not increase the catch.

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FROM LETTERS TO THE EDITOR:

"It was not pleasant to hear that once again suggestions were being made to chang the name of *Mosquito News*. Here's a vote against it. The name is unique and fail to see why it's not sufficiently dignified. True, it's a narrow and limited moniker— nevertheless universally satisfactory and good. I'm certainly not adverse to includin articles on related vectors but for a long time to come, mosquito control activities wil need a periodical of their very own. That we now have and, I hope, will keep. 'What change the name of Mosquito News? Hell's fire, no, never ! !'"—H. H. STAGE.

"I think the name 'Journal of the American Mosquito Control Association' i pomposity compounded. Let's keep the simple, catchy name: MOSQUITO NEWS."— J. A. KERR.