

THE EFFECT OF COLORED LIGHTS AND OTHER FACTORS ON THE NUMBERS OF *CULEX PIPIENS QUINQUEFASCIATUS*, *C. TARSALIS*, AND *AEDES SIERRENSIS* ENTERING LIGHT TRAPS

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ABSTRACT. When the effect of differently colored lamps was tested in a New Jersey light trap in a 12½ x 22½ x 11 foot room against male and female *Culex pipiens quinquefasciatus* Say, *C. tarsalis* Coquillett and also against male *Aedes sierrensis* (Ludlow), a red 7½-watt incandescent light was more attractive to males of the three species than green, blue, orange, or white lights and also more attractive than a 4-watt ultraviolet light. However, more females than males were always caught. The red-lighted trap was the most attractive to female *C. tarsalis* and the green

to female *C. p. quinquefasciatus*, but the differences in the numbers caught with the different colored lamps were small. Males and females from 11 to 22 hours old entered traps in much lower numbers than older adults. A red 7½-watt light was significantly more attractive to males of the three species than a 40-watt light. A one-fourth-inch mesh screen placed vertically around the struts of a New Jersey trap in front of the light did not reduce the catch of males or females of these species.

Suppression and elimination of an island population of *Culex pipiens quinquefasciatus* Say was proved possible through the release of sterile males by Patterson *et al.* (1970). This success encouraged consideration of the suggestion of Knipling *et al.* (1968) that light or bait traps containing chemosterilants might be used as a method of sterilizing mosquitoes. A CDC light trap, Sudia and Chamberlain (1962), was therefore modified by Grant *et al.* (1970) to produce a chemosterilant trap. However, the effectiveness of such chemosterilizing traps would be increased if provisions for more effective attractants for males could be incorporated in the trap. The responses of male and female *Culex p. quinquefasciatus* and *C. tarsalis* Coquillett and of male *Aedes sierrensis* (Ludlow) to traps equipped with different colored lights are reported here. Information concerning the effect of light intensity and vertical trap screens is also presented.

MATERIALS AND METHODS. The effects of the colored lights in a standard New Jersey trap on the three species were tested in a 12½ x 22½ x 11-foot windowless room in which the relative humidity ranged from 45 to 50 percent and the temperature from 78 to 86° F. The walls and the ceilings of the room were a light green. Light was provided by six cool, white,

4-foot neon tubes in unshaded reflectors. The room was empty except for two small tables and five dismantled table tops that were leaning against one wall.

The trap was operated in the center of the room from 10 p.m. to 5 a.m. with the test light at a height of 5 feet. Room lights were turned off during this period. Trapped mosquitoes were collected in a net tied around the bottom of the cylinder. The top 30-inch section of the net was made of cotton cloth, and the bottom 12-inch section was of fine net material. A weight released by a time clock at 5 a.m. closed the net with a draw string.

Mosquitoes used in the tests were taken from laboratory colonies reared in an 8-hours dark, 16-hours light cycle (10 p.m. to 6 a.m. dark). Fifty adults of each sex of *C. tarsalis* and *C. p. quinquefasciatus* and 50 male *A. sierrensis* were released in the room for each test. After each test, the mosquitoes remaining in the room were destroyed by heat. Then a new population was released for the next test. The mosquitoes used in most tests were from 2 to 8 days old, but in other tests, adults 11 to 22 hours old were used.

In the color tests, ceramic-dipped red, green, blue, orange, and white incandescent lamps were used. Also, one 4-watt ultraviolet light was also tested. Informa-

tion concerning light intensity and infrared was obtained with red $7\frac{1}{2}$ - and 40-watt ceramic-dipped lamps. In addition, a $7\frac{1}{2}$ -watt white ceramic-dipped lamp was compared with an inside frosted soft white light and a general purpose inside frosted 40-watt lamp. All lamps were Sylvania¹ lamps except the ultraviolet light which was a General Electric.

Finally, a test was made to determine if the numbers of mosquitoes captured would be reduced if the traps were arranged to exclude large insects by placing one-quarter inch wire mesh around the struts of the trap at the light level so that all access was closed except through the screen. A blue $7\frac{1}{2}$ -watt light was used in the trap, and 50 adults of each sex of *C. tarsalis* and *C. p. quinquefasciatus* and 50 male *A. sierrensis* were released in the room for each test. This trap was operated with and without the screen on alternate days from 10 p.m. to 6 a.m.

RESULTS AND DISCUSSION. *Effect of Lamp Color.* In the color comparison tests, the largest numbers of males of all three species were caught in a trap with a $7\frac{1}{2}$ -watt red lamp (Fig. 1). The descending order of attraction for *C. tarsalis* was red, ultraviolet, orange, green, blue, and white; a trap with no light caught the lowest numbers of this species. The descending order for *C. p. quinquefasciatus* was red, green, no light, orange, blue, ultraviolet, and white. For *A. sierrensis* the descending order was red, green, orange, white, blue, and ultraviolet; and the trap with no light caught the lowest numbers. The results show that traps equipped with red lamps attract the largest numbers of males of these three species. However, additional tests will be necessary to determine the effectiveness of this light under field conditions.

Also, the red-lighted trap was the most attractive to female *C. tarsalis*, and the

green-lighted trap was the most attractive to female *C. p. quinquefasciatus* (Table 1); but no large differences were apparent in the responses of the females to any colors. However, the females of these species were caught in larger numbers than the males; in a few instances all 50 of the released females were captured in the traps with the red and green lamps. Therefore, a shorter trapping period might have resulted in slightly greater differences between the numbers attracted to these and other less attractive lamps.

Effect of Age. Males that were less than 22 hours old were attracted to a trap with a green light in smaller numbers than were older males (Table 1): of the 250 young males of each species that were released in the room, only 14, 79, and 19 respectively, of the *C. p. quinquefasciatus*, *C. tarsalis*, and *A. sierrensis* were taken in the trap compared with 152, 148, and 93, respectively, of 250 older males. Female attraction to the green-lighted trap was also low at 11 to 22 hours after emergence: a total of 11 and 84, respectively, of the female *C. p. quinquefasciatus* and *C. tarsalis* entered the trap compared with 238 and 213, respectively, of the older females. These figures indicate that approximately half the normal catch of male *C. tarsalis* and one-third the catch of females would enter traps and be sterilized before they mated. However, mating of *Culex* species in nature may not occur within the first 24-hour period after emergence. Lea and Edman (1972) in a release and recovery investigation of marked *Culex p. quinquefasciatus* and *C. nigripalpus* Theobald found that most of the females were not inseminated until the second or third night. Normal numbers of unmated adults could be expected to enter traps and be sterilized during this 2- or 3-day period before mating occurs.

Effect of Females on Male Trap Captures. As noted in the tests with colored lights (Table 1), both male and female *C. p. quinquefasciatus* and *C. tarsalis* were released together, but only male *A. sierrensis* were released. A series of tests were

¹Mention of a commercial or a proprietary product in this paper does not constitute an endorsement of this product by the USDA.

therefore made with males of all three species to check on any effect the presence of *C. p. quinquefasciatus* and *C. tarsalis* females might have on the larger captures of the males. In the tests with red- and green-lighted traps, only small differences were apparent in the number of males captured in the presence or absence of females (Table 1), though the green lamp attracted somewhat larger numbers of

C. tarsalis and *A. sierrensis* than the red lamp. However, red remained the most attractive color to the males of these species on the basis of the combined figures for these and earlier tests.

Effect of Light Intensity on Catch. When the attraction of different intensities of red and white lights to males was investigated, a 55 foot-candle, 7½-watt red light was significantly more attractive to

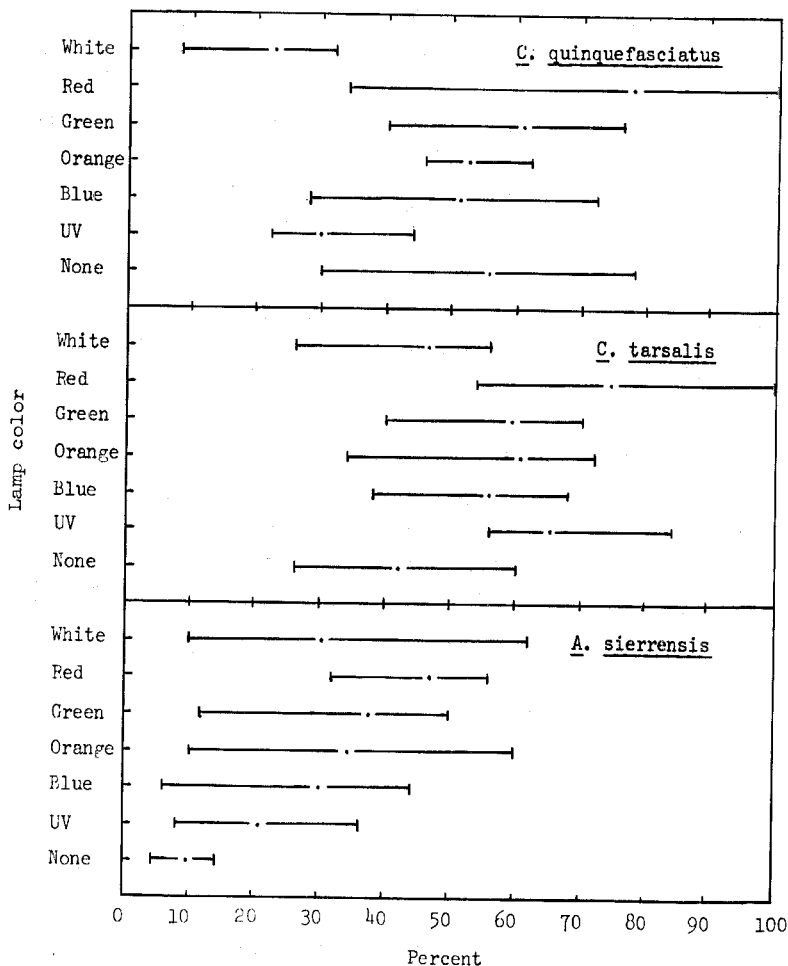


FIG. 1.—Responses of male *Culex tarsalis*, *C. quinquefasciatus*, and *Aedes sierrensis* to one 4-watt ultraviolet and five 7½-watt colored lamps in a New Jersey trap as indicated by percent caught and the range of captures in five replicated tests.

TABLE 1.—Numbers of male and female *Culex p. quinquefasciatus* and *C. tarsalis* and male *A. sierrensis* captured in a New Jersey trap equipped with lamps of different colors.^a

Light		No. collected of 250 released ^b				
		<i>C. p. quinquefasciatus</i>		<i>C. tarsalis</i>		<i>A. sierrensis</i>
Color	Ft.-candles	♀	♂	♀	♂	♂
Males and females 2 to 8 days old						
Red	55	223	194	223	186	118
Green	65	238	152	213	148	93
Orange	440	233	131	202	151	86
No light	..	196	139	146	105	24
Blue	110	228	128	201	140	75
UV	260	207	74	207	161	52
White	370	225	56	214	117	76
Males and females 11 to 22 hours old						
Green	65	11	14	84	79	19
Males only, 2 to 8 days old						
Red	55	..	190	..	107	81
Green	65	..	159	..	137	90

^a Five 7½-watt incandescent and one 4-watt ultraviolet.

^b Five replications of 50 each.

males of all three species than a 1400 foot-candle, 40-watt light. A 7½-watt white light was also more attractive to males of these species than white light lamps of higher wattages. Considerable differences existed in the numbers caught at the different intensities, but analysis of variance did not indicate significance (Table 2).

Effect of Wire Screens on Catch. Vertical screens for excluding large insects from trap collections were suggested by Mulhern (1953). When the New Jersey trap was

operated with a 7½-watt blue light with the screen in place and with the screen removed on alternate nights, the numbers of mosquitoes collected showed only small differences; thus, it was concluded that no reduction in the capture of the three mosquito species would result from the use of the screens (Table 3).

More males per trap night were caught in the present study compared with the numbers of females than are usually caught in field traps. This may have resulted partially or entirely from a shorter

TABLE 2.—Effect of different light intensities on catches of male mosquitoes.

Light		Numbers collected of 250 released ^a		
Watts	Ft.-candles	<i>C. p. quinquefasciatus</i>	<i>C. tarsalis</i>	<i>A. sierrensis</i>
Red lights				
7½	55	194 ^{**}	186 [*]	118 [*]
40	1400	57	117	70
White lights				
7½	370	56	117	76
25	1750	34	115	67
40	3000	33	101	37

^a Five replications of 50 each.

^{*} Significant at 0.05 probability level.

^{**} Significant at 0.01 probability level.

TABLE 3.—The effect of a one-fourth-inch mesh screen placed vertically around the struts of a New Jersey trap to exclude large insects.

Species	Screen	Numbers collected of 250 released ^a	
		Females	Males
<i>C. tarsalis</i>	Present	232	202
<i>C. tarsalis</i>	Absent	237	209
<i>C. p. quinquefasciatus</i>	Present	237	213
<i>C. p. quinquefasciatus</i>	Absent	246	196
<i>A. sierrensis</i>	Present	...	63
<i>A. sierrensis</i>	Absent	...	53

^a Five replications of 50 each.

male lifespan of this species. The maximum lifespan for male and female *Culex erythrothorax* Dyar in the laboratory was reported to be 9 and 13 weeks, respectively, by Chapman (1962); and Beeuwkes *et al.* (1933) had similar results with *Aedes aegypti* (L.) i.e., the average length of life for this species was 40–61 days for males and 70–116 days for females. Also, Gjullin *et al.* (1950) found that in three breeding places where only one spring emergence had occurred, the combined male population of *Aedes vexans* (Meigen) and *A. sticticus* (Meigen) taken in net collections fell from 40 percent of the total of both sexes on the twentieth day after emergence to 9 percent on the eightieth day.

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Literature Cited

- Beeuwkes, H., Kerr, J. A., Weatherbee, A. A. and Taylor, A. W. 1933. Observations on the bionomics and comparative prevalence of the vectors of yellow fever and other domestic mosquitoes of West Africa, and the epidemiological significance of seasonal variations. *Trans. R. Soc. Trop. Med. Hyg.* 26(5):425–447. 5 fig., 5 refs.
- Chapman, H. C. 1962. The bio-ecology of *Culex erythrothorax* Dyar. *Mosq. News* 22(2):130–134.
- Gjullin, C. M., Yates, W. W. and Stage, H. H. 1950. Studies on *Aedes vexans* (Meig.) and *Aedes sticticus* (Meig.), flood-water mosquitoes, in the lower Columbia River Valley. *Ann. Entomol. Soc. Am.* 43(2):262–275.
- Grant, G. G., Carmichael, A. G., Smith, C. N. and Brown, A. W. A. 1970. Autochemosterilization of the southern house mosquito by means of a modified light trap. *J. Econ. Entomol.* 63(2):648–650.
- Knipling, E. F., Laven, H., Craig, G. B., Pal, R., Kitzmiller, J. B., Smith, C. N. and Brown, A. W. A. 1968. Genetic control of insects of public health importance. *Bull. Wld. Hlth. Org.* 38:421–438.
- Lea, A. O. and Edman, J. D. 1972. Sexual behavior of mosquitoes. Age dependence of insemination of *Culex nigripalpus* and *C. pipiens quinquefasciatus* in nature. *Ann. Entomol. Soc. Am.* 65(2):290–293.
- Mulhern, T. D. 1953. The use of mechanical traps in measuring mosquito populations. *Proc. Calif. Mosquito Contr. Assoc.* 21:64–66.
- Patterson, R. A., Weidhaas, D. E., Ford, H. R. and Lofgren, C. S. 1970. Suppression and elimination of an island population of *Culex pipiens quinquefasciatus* with sterile males. *Science* 1968:1368–1369.
- Sudia, W. D. and Chamberlain, R. W. 1962. Battery-operated light trap, an improved model. *Mosq. News* 22:126–129.

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