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The small African weaver finch commonly known as Quelea (*Quelea quelea*) has been reported (Crook and Ward, 1968) to be one of the most numerous and destructive birds in the world and is found extensively throughout Africa (DeGrazio, 1974). Quelea have been associated with damage to many agricultural crops including millet, grain sorghum, rice, and wheat. Because current population control programs in Africa have not reduced damage except in a few local areas (Crook and Ward, 1968), more effective damage control methods need to be investigated. One promising method, protection of the agricultural crop with a chemical repellent, methiocarb, has been demonstrated to be highly effective (Guarino, 1972). Small scale efficacy demonstrations in Tanzania (DeGrazio, 1974) with three pounds of methiocarb per acre to protect maturing rice and wheat have reduced Quelea damage by about 90 percent.

Methiocarb is thought to produce a post-ingestional effect in the affected birds (Guarino, 1972). Rogers (1974) has presented some evidence that methiocarb, unlike a highly bitter-tasting compound (sucrose octaacetate), affects feeding activity of Red-winged Blackbirds (*Ageliaus phoenlceus*), but some time delay is required for affectation and subsequent feeding aversion.

The development of the repellent (or aversion) response for methiocarb was similar to the aversive response shown to lithium chloride (LiCl), a salt that has been traditionally used to study conditioned aversion in rats (Nachman, 1963). This aversion effect is then thought to become quickly associated with the taste of methiocarb or treated food material (Crase and DeHaven, 1976). Schafer, Brunton, and Lockyer (1977) observed that most of the seven bird species they tested [Robins (*Turdus migratorius)*, Brown-headed Cowbirds (*Molothrus* ater), White-crowned Sparrows (*zonotrichia leucophrys*). House Sparrows (*Passer* domesticus), Starlings *(sturnus vulgaris),* Grackles (*Quiscalus qaiscula*), and Red-winged Blackbirds] displayed more food aversion and longer-lasting conditioning to methiocarb when compared with thiram (TMTD), a taste repellent. Both repellent materials were placed on food particles at levels slightly lower than the R-50 for Red-winged Blackbirds (Schafer and Brunton, 1971).

To more effectively predict field application rates for protecting cereal grains from Quelea damage in Africa, we felt it necessary to compare the sensitivity of Quelea to methiocarb with sensitivities reported for other bird species (Schafer and Brunton, 1971). In addition, we wanted to determine the relative importance of taste versus visual feeding cues that could become associated with methiocarb exposure in Quelea. Knowledge gained from these studies could lead to an improved application method that would enhance the long-term repellent action of methiocarb with low level methiocarb treatments in conjunction with other stimuli. Aversive cues could also be used to alter food-searching behavior (Crase and DeHaven, 1976) so that Quelea repelled from agricultural crops would more quickly seek alternate natural foods such as grass or weed seeds and insects.

PROCEDURES

Quelea. Quelea were obtained from Senegal and flown to the Denver Wildlife Research Center. All birds were held under quarantine for 90 days in compliance with USDA requirements. The birds were allowed free access to water, grit, and a mixture of whole millet seed, whole grain sorghum, and Purina Game Bird Chow in a 8 x 8 x 12 foot aviary. A 12:12 forward light-to-dark schedule with 15 minute "dawn" and "dusk" periods (low light level) interposed on either end of the 12 hour light cycle were used to simulate the normal tropical daylight pattern.

R-50 Measurement. The procedures outlined by Schafer and Brunton (1971) were followed with minor modifications. Twenty male Quelea were housed in a communal 21 x 10 x 15 inch cage for two weeks before testing and were allowed free access to water, grit, and their normal mixed feed. Each bird was then transferred to individual 6 x 9 x 6 inch cages and and was offered 37 hulled proso millet seeds for 18 hours. Average weight of these seeds was 6 mg. Only Quelea that ate all 37 seeds were used for the R-50 determination. Five individually caged birds were then offered 37 millet seeds treated with a 0.1% (w/w) concentration of methiocarb for 18 hours. Birds that ate 18 or fewer seeds (one-half or less than the number of seeds offered) were considered repelled. If three or more of the five birds were repelled, the methiocarb concentration was reduced by one-half of a logarithmic step; and this procedure was essentially continued until fewer than 3 out of 5 were repelled. Then, one final group of birds was tested at a concentration one-quarter logarithmic step above the lowest concentration to further refine the R-50 determination. Methiocarb concentrations of 0.10, 0.032, 0.018, and 0.01 percent w/w were used for the R-50 measurement.

Sensory Stimuli and Methiocarb Effects. A separate group of 32 Quelea were randomly assigned to four groups of eight birds. Each group consisted of two males, two females, and four birds of undetermined sex. Each of the four groups was housed in a separate 21 x 10 x 15 inch communal cage for two weeks before testing. The following is a general description of the preference test choices allowed each of the four groups:

(a) Control Group: given a choice between 4 g of hulled proso millet in a food cup labeled "A" versus 4 g of the same food in another cup labeled "B."
(b) Color Group: given a choice between 4 g of red-colored millet and 4 g of green-colored millet. We used 3 drops of Durkee's food coloring per 50 g millet.
(c) Taste Group: given a choice between 4 g of sweetened millet (1.4×10^{-4} mol/g of sucrose) and 4 g of sour millet ($1.4 \times 10^{-4*}$ mol/g of citric acid).
(d) Color - Taste Group: given a choice between 4 g of millet treated with the above levels of red coloring and sucrose versus 4 g of millet treated with the above levels of green coloring and citric acid (i.e., red-sweet vs. sour-green millet).

The following preference testing schedule was adhered to for all four groups:

I. Pre-exposure preference (week 1)

Birds in each group were in the two-choice situation for 18 hours, every other day from 3:30 PM until 9:30 AM, three times during the week. All birds were moved back into their respective communal cages between test days.

II. Exposure to methiocarb (week 2)

Each of the birds in all four groups was then exposed to 37 millet seeds treated with a level of methiocarb well above the R-50 value (0.0182% w/w). The 18-hour exposure periods during this week were scheduled every other day as was done during week 1. No alternate choice to the 37 methiocarb-treated seeds was allowed. Control group birds were exposed to the methiocarb on hulled proso millet. The other three groups were offered 37 methiocarb-treated seeds of the color or taste most preferred in the two-choice tests (week 1). Color group birds were exposed to red-colored millet treated with methiocarb. Taste group birds were presented with the methiocarb exposure on sucrose-treated millet and the Color - Taste group was presented with the methiocarb on sweet-red millet.

III. Post-exposure Preference Tests (weeks 3 to 7)

This series of test periods (three 18-hour choice periods each week) were identical to the pre-exposure period. The rationale behind this sequence of choice presentations was that Quelea would learn to associate methiocarb effects with either millet by itself, sweet-tasting millet, red-colored millet, or sweet-red millet. All data were converted to percentage preference for the type of millet corresponding to methiocarb exposure. For example,

$$\text{\% preference for red milet} = \frac{\text{red millet consumed (g)}}{\text{red + green millet consumed (g)}} \times 100$$

Both percentage preference and consumption data were used in the final tabulations and analyses of results.

RESULTS AND DISCUSSION

R-50 Measurement. When the birds were offered methiocarb treatment levels of 0.10 - 0.018%, four out of five Quelea in each group ate 18 or fewer seeds of the 37. At the lowest concentration (0.01%), all birds ate from 23 to 33 seeds. These concentrations and percentages of birds repelled were used to calculate the R-50 value of 0.015% (with 95% C.L. of 0.011 - 0.021%). The moving average interpolation methods of Thompson and Weil (1952) and Weil (1952) were used for these calculations. In comparing these values to R-50s for other bird species, Quelea were about six times more sensitive than Red-winged Blackbirds (R-50 = 0.0893l), three times more sensitive than House Sparrows (R-50 = 0.0422), and about equal to Tricolored Blackbirds (R-50 - 0.022%) (Schafer and Brunton, 1971). These laboratory comparisons indicate that methiocarb should have high potential for reducing agricultural crop damage caused by Quelea at application rates near or below the levels used for domestic avian species.

Sensory Stimuli and Conditioning Effects. Results of the conditioning experiment are shown in Table 1. The data for the first week (pre-exposure) indicated that birds in the Taste group and Color - Taste group showed much more preference over the alternate food than the other two groups. Although analysis of covariance could be used to adjust for these initial preference differences, an even more restrictive feature can be seen in the unstable preference behavior of the control group birds. Both the Control group birds and the Color group birds ate appreciable amounts of the alternate available foods. However, the Taste group and the Color - Taste group ate very little (< 0.20 g/bird) of the millet treated with citric acid. Thus, for these last two groups, the alternate food was apparently quite unpalatable. The preference data in Table 1 do not properly reflect this low consumption of the citric-acid-treated millet, but the data do reflect some changes in preference toward sweet-tasting millet after methiocarb exposure. The Control and Color groups showed no sharp changes in preference after methiocarb exposure. Some changes were observed in consumption of the previously-treated seed type, but these were not significant for either group using a rank-sum test. In contrast, the Taste group and Color - Taste group both showed preference changes after methiocarb exposure. Separate rank-sum tests applied to the consumption data for these two groups revealed significant ($P < 0.05$) depressions during the first 2 post-exposure weeks. Another depression ($P < 0.05$) at week 6 in the Color -Taste group was also shown.

Taste stimuli appeared to become readily associated cues to previous methiocarb effects. Unfortunately, the groups in this test cannot be directly compared due to unequal and unstable baseline preference values and unequally palatable alternate foods. However, the taste effect is quite strong, because little citric-acid-treated millet was consumed due to this unpalatability. Thus, the first two groups (Control and Color) had a palatable food as an alternate choice, whereas, the last two groups (Taste and Color - Taste) had only an unpalatable food as an alternate choice. Despite this, the latter two groups, under more severe food deprivation, showed reliable conditioning effects for two weeks after three exposures to methiocarb.

These data are in agreement with those (Brett, et al., 1976) for buteo hawks (Buteo *jamaicensis)* in which mouse color, serving as a cue to LiC1 expsoure, produced less feeding aversion than taste stimuli placed on mice, but are in contrast with the mo narch butterfly (*Danaus plexippus*) and Blue Jay (*cyanocitta cristata*) data (Brower et al., 1968) for mimicry phenomena, and the Bobwhite Quail (*colinus vizginanus*) data comparing taste and color cues associated with LiC1 effects (Wilcoxson, et al., 1971). Of course, our results could have changed drastically if alternate choices had been equally palatable and if preference levels were better stabilized among the groups. More research is needed to confirm or refute our findings. However, we believe these taste cue association effects for methiocarb could have potential control application, especially in high damage situations. The addition of taste stimuli with methiocarb treatment may enhance the long-termed repellency effects and more quickly direct the birds toward alternate, non-crop foods.

LITERATURE CITED

Brett, L.P., W.G. Hankins, and J. Garcia. 1976. Prey-lithium aversions. III; buteo hawks. Behav. Biol. 17: 87-98.

Brower, L.P., Ryerson, W.N., Coppinger, L.L. and S.C. Glazier. 1968. Ecological chemistry and the palatability spectrum. Science. 161: 1349-1351.

Crase, F.T. and R.W. DeHaven. 1976. Methiocarb: its current status as a bird repellent. Proc. Vertebrate Pest Conf. 7: 46-56.

Crook, J.H. and P. Ward. 1968. The quelea problem in Africa, pp. 211-230. In Murton, R.K. and E.N. Wright (eds.), The problems of birds as pests. Academic Press, New York.

DeGrazio, J.W. 1974. Vertebrate Damage Control Research. Quelea bird problems in African agriculture. Unpublished Trip Report. Jan. 11 - Feb. 25, Denver Wildlife Research Center. 25 pp.

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Guarino, J.L. 1972. Methiocarb, a chemical bird repellent: A review of its effectiveness on crops. Proc. Vertebrate Pest Conf. 5: 108-111.

Nachman, M. 1963. Learned aversion to the taste of lithium chloride and generalization to other salts. J. Comp. Physiol. Psychol. 56: 343-349.

Rogers, J.G. 1974. Responses of caged red-winged blackbirds to two types of repellents. J. Wildl. Manage. 38: 418-423.

Schafer, E.W. and R.B. Brunton. 1971. Chemicals as bird repellents: two promising agents. J. Wildl. Manage. 35: 569-572.

Schafer, E.W., Brunton, R.B and N.F. Lockyer (1977). Learned aversion in birds: a method for testing comparative acute and long-term repellency. Symposium on Test Methods for Vertebrate Pest Control and Management Materials. Amer. Soc. Test. Mat. Conf., Monterey,
Calif., March 8, 1976. 16 pp.

Thompson, W.R. and C.S. Weil. 1952. On the construction of tables for moving-average interpolation. Biometrics 8: 51-54.

Weil, C.S. 1952. Tables for convenient calculation of median-effective dose (LD_{50} or ED_{50}) and instructions in their use. Biometrics 8: 249-263.

Wilcoxon, H.C., Dragoin, W.B. and P.A. Kral. 1971. Illness-induced aversions in rat and quail: relative salience of visual and gustatory cues. Science. 171: 826-828.

Table 1. Mean ± S. E. percent preference and consumption for four groups of quelea before and after exposure to methiocarb.

Test Group (Percentage Preference)

Test Period	Control ("A" cup millet)	Color (red millet)	Taste (sweet millet)	Color - Taste (red-sweet millet)
Pre-exposure week 1	40.6 ± 10.2	54.5 ± 16.4	80.0 ± 13.7	90.8 ± 10.0
Exposure week 2	----------	----------	----------	----------
Post-exposure week 3	60.8 ± 12.2	67.6 ± 16.7	25.0 ± 15.0	65.7 ± 20.1
week 4	37.2 ± 14.4	44.9 ± 24.4	47.7 ± 16.5	74.4 ± 17.7
week 5	74.1 ± 11.4	66.3 ± 16.0	46.8 ± 22.2	90.4 ± 13.1
week 6	43.8 ± 11.2	70.4 ± 15.0	65.0 ± 17.7	99.8 ± 0.2
week 7	56.6 ± 15.6	61.1 ± 16.1	75.7 ± 15.1	99.9 ± 0.1

Test Group (Consumption in grams)

Test Period	Control	Color	Taste	Color - Taste
Pre-exposure week 1	1.0 ± .3	1.6 ± .6	2.2 ± .5	2.7 ± .4
Exposure week 2	.09± .01	.08± .01	.10± .02	.09± .02
Post-exposure week 3	.6 ± .2	1.3 ± .5	.0 ± .0**	1.3 ± .5**
week 4	.8 ± .3	1.3 ± .5	.6 ± .3*	1.5 ± .5*
week 5	1.6 ± .3	1.7 ± .5	1.3 ± .5	1.9 ± .4
week 6	1.0 ± .3	1.7 ± .4	1.0 ± .4	1.8 ± .2*
week 7	.9 ± .3	1.2 ± .4	1.2 ± .4	1.9 ± .2

* Significantly depressed from week 1 ($P < 0.05$).

** Significantly depressed from week 1 ($P < 0.01$).