# DATA EVALUATION RECORD

1. CHEMICAL: Brodifacoum

2. FORMULATION:

3. CITATION: Savarie, Peter J. and LaVoie, G. Keith, (1979). Secondary Toxicity Hazards of the Anticoagulent Brodifacoum to American Kestrels (Falco sparverius) Cooperative agreement between ICI and Denver Wildlife Research Center (FWS) Acc #245704

4. REVIEWED BY: Russel Farringer
   Wildlife Biologist
   EEB/HED

5. DATE REVIEWED: 11/13/81

6. TEST TYPE: Secondary Toxicity

   A. Test Species: American Kestrel (Falco sparverius)

7. REPORTED RESULTS:

   a) Chronic three day $LC_{50}$ (95% C.L.) of brodifacoum to voles was 1.4 (0.77-2.0) ppm, slope ± standard error of the slope = 4.1 ± 1.2 Acute oral $LD_{50}$ (95% C.L.) of brodifacoum to voles: 0.20 (0.11-0.32 mg/kg; slope ± S.E. of slope = 1.8 ± 0.4. entered in Database

   b) 4 out of 10 kestrels that feed for 6 days upon brodifacoum-treated voles died. No mortalities in kestrels that fed for 2 days upon brodifacoum - treated voles.

   c) At 71 days postreatment the mean prothrombin time in kestrels that consumed brodifacoum-treated voles for either 2 or 6 days was higher than the control group. At 100 days posttreatment 2 kestrels that fed upon brodifacoum-treated voles for 2 days had prothrombin times of greater than 300 seconds each, and 1 kestrel that fed upon brodifacoum-treated voles for 6 days had a prothrombin time of greater than 600 seconds. Statistical analysis of this data has not been completed.

8. Reviewer's Conclusions: EEB calculations of the $LD_{50}$ and $LC_{50}$ for voles was close to identical to those of the registrants. This study with kestrels indicates that mortality to these birds could occur if the birds fed on Brodifacoum killed voles for more than two days. However, this mortality data may not reflect the actual mortality pattern. The bird were administered a diet containing menadione sodium bisulfite complex (Vitamin K type compound) which could of biased the results.

## Materials/Methods

### Test Procedure

The $LC_{50}$ and $LD_{50}$ for voles was determined. Six dose levels and a control was use in each test. The $LD_{50}$ dose levels ranged from 0.045 to 1.0 mg/kg. The $LC_{50}$ dose levels ranged from 1 to 50 ppm. PEG 400 was use as the carrier in the $LD_{50}$ study at a rate of 0.1 ml/20g body weight. Controls received an equivalent amount of PEG 400. The $LC_{50}$ voles were given 40 g of treated bait in a no choice situation for 3 days, then observed for 21 days or until death. No control mortality occurred in either test.

American kestrels were live trapped in Sacromento, CA and shipped to Denver, CO. They were individually caged in outdoor pens for a minimum of 30 days before testing. They had free access to water and were fed daily (except Sunday). Twenty-one days before treatment and 21 days posttreatment each kestrel was fed approximately 75g of 25% Zu Preem Birds of Prey diet and 75% horsemeat. Kestrels were then maintained on a ration of approximately 45g. of horsement. Two groups of 10 kestrels were used for the treatment groups. Control birds were indicated but the number of control birds was not given. One group of treatment birds was exposed for two days and the other group for 6 days. Vole used for exposure to the kestrels were offered 30 grams of ICI Brodifacoum (Talon) 3/16 inch pelletized bait containing 50 ppm brodifacoum for days. After 3 feeding days the voles were killed by cervical dislocation, and kept frozen until fed to the kestrels. Ten voles were randomly selected for whole body residue analysis (not with this report), and sent to ICI, Labs. Teh amount of brodifacoum consumed by each vole was calculated and there was a stratified randomization of each vole to the kestrels. That is, voles consuming the highest amount of brodifacoum were fed to the heaviest kestrels. Each of the birds in the 2-day treatment group was offered one treated vole a day for two days and the 6-day treatment group was offered one treated vole per day for 6 days.

### Statistical Analysis

The $LC_{50}$ and $LD_{50}$ for the voles was estimated by the probit analysis described by Finney as programed for the computer by Daum and Killcreas.

## Discussion/Results

A) 3-day Chronic $LC_{50}$ for voles = 1.4 (0.77-2.0) ppm

B) $LD_{50}$ for voles = 0.20 (0.11-0.32) mg/kg

C) There were no mortalities in kestrels that fed for 2 days upon brodifacoum-treated voles or in the kestrels that fed upon untreated voles. Four of ten kestrels that fed for 6-days upon brodifacoum-trated voles died.

D) See attached tables (#'s 3+4) form report.

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Reviewer's Conclusion

A. Test Procedure

The test procedure raised a major question. The kestrels were being tested to see what effects brodifacoum had on then as a potential secondary hazard. The supplemental feed contained vitamin k-like compound (menadione sodium bisulfite complex). Vitamin k is antidotal to the toxicant. Thus, a masking of the effects of the compound could have occurred. For this type of test, the kestrels should of been maintained on voles pre-and post treatment.

B. Statistical Analysis

Our probit analysis of the vole data confirmed the $LC_{50}$ and $LD_{50}$ values reported by the reseacher. (See attached analysis)

Conclusions

Category: Invalid

Rationale: See that procedure in coclusions.

Repairability: None at this time subject to data showing that the use of a Vitamin K complex is not antidotal.

VOLES. LC50

| CONC. | NUMBER EXPOSED | NUMBER DEAD | PERCENT DEAD | BINOMIAL PROB. (PERCENT) |
|---|---|---|---|---|
| 50 | 10 | 10 | 100 | 0.09765625 |
| 30 | 10 | 10 | 100 | 0.09765625 |
| 15 | 10 | 10 | 100 | 0.09765625 |
| 5 | 10 | 10 | 100 | 0.09765625 |
| 3 | 10 | 9 | 90 | 1.074219 |
| 1 | 10 | 3 | 30 | 17.1875 |

THE BINOMIAL TEST SHOWS THAT 0.045 AND 3 CAN BE USED AS STATISTICALLY SOUND CONSERVATIVE 95 PERCENT CONFIDENCE LIMITS, BECAUSE THE ACTUAL CONFIDENCE LEVEL ASSOCIATED WITH THESE LIMITS IS GREATER THAN 95 PERCENT.

AN APPROXIMATE $LC_{50}$ FOR THIS SET OF DATA IS 1.409166

RESULTS CALCULATED USING THE MOVING AVERAGE METHOD

| SPAN | G | LC50 | 95 PERCENT CONFIDENCE LIMITS | |
|---|---|---|---|---|
| 1 | 0.509802 | 1.409166 | 0.6021472 | 2.147129 |

RESULTS CALCULATED USING THE PROBIT METHOD

| ITERATINS | G | H | GOODNESS OF FIT PROBABILITY |
|---|---|---|---|
| 7 | 0.3564675 | 1 | 0.9968676 |

SLOPE = 4.09327
95 PERCENT CONFIDENCE LIMITS + 1.649387 AND 6.537153

LC50 = 1.360264
95 PERCENT CONFIDENCE LIMITS = 0.772308 AND 1.990645

LC10 = 0.6658213
95 PERCENT CONFIDENCE LIMITS = 0.1608374 AND 1.037864

VOLES. LD50

| CONC. | NUMBER EXPOSED | NUMBER DEAD | PERCENT DEAD | BINOMIAL PROB. (PERCENT) |
|---|---|---|---|---|
| 1 | 10 | 9 | 90 | 1.074219 |
| 0.75 | 10 | 8 | 80 | 5.46875 |
| 0.37 | 10 | 8 | 80 | 5.46875 |
| 0.18 | 10 | 4 | 40 | 37.69531 |
| 0.09 | 10 | 2 | 20 | 5.46875 |
| 0.045 | 10 | 1 | 10 | 1.074219 |

THE BINOMIAL TEST SHOWS THAT 0.045 AND 1 CAN BE USED AS STATISTICALLY SOUND CONSERVATIVE 95 PERCENT CONFIDENCE LIMITS, BECAUSE THE ACTUAL CONFIDENCE LEVEL ASSOCIATED WITH THESE LIMITS IS GREATER THAN 95 PERCENT.

AN APPROXIMATE LC50 FOR THIS SET OF DATA IS 0.214014

RESULTS CALCULATED USING THE MOVING AVERAGE METHOD

| SPAN | G | LC50 | 95 PERCENT CONFIDENCE LIMITS | |
|---|---|---|---|---|
| 5 | 0.189172 | 0.2129989 | 0.1193247 | 0.3420593 |

RESULTS CALCULATED USING THE PROBIT METHOD

| ITERATIONS | G | H | GOODNESS OF FIT PROBABILITY |
|---|---|---|---|
| 4 | 0.1901451 | 1 | 0.900969 |

SLOPE = 1.956266
95 PERCENT CONFIDENCE LIMITS = 1.103224 AND 2.809308

LC50 = 0.2158203
95 PERCENT CONFIDENCE LIMITS = 0.129784 AND 0.3428208

LC10 =
95 PERCENT CONFIDENCE LIMITS = 0.01245027 AND 0.08909829

Table 4. Data on Kestrels Dying After Eating Voles Treated with Brodifacoum. Kestrels fed upon voles for 6 days.

| Kestrel No. | Sex | Theoretical maximum mg/kg brodifacoum consumed | Initial wt (g) | Dead wt (g) | Days to death* |
|---|---|---|---|---|---|
| 43 | M | 27.9 | 122 | 122 | 5 |
| 54 | F | 43.2 | 147 | 129 | 8 |
| 65 | F | 26.2 | 120 | 123 | 11 |
| 29 | M | 19.9 | 113 | *** | 83 |
| | | 29.3 ± 9.9** | 125.5 ± 14.8 | 124.7 ± 3.8 | 26.8± 37.6 |

* After initial feeding on voles

** Mean ± standard deviation

*** Dead weight not obtained

Table 3. Theoretical Maximum Consumption of Brodifacoum by Kestrels Feeding upon Voles

| Kestrel No. | Sex | Wt (g) | Amount of 50 ppm bait eaten by voles (g) | mg Brodifacoum eaten by voles | Theoretical maximum mg/kg brodifacoum consumed |
|---|---|---|---|---|---|
| | | | 2-day feeding of voles to kestrels | | |
| 53 | M | 119 | 23 | 1.15 | 9.7 |
| 58 | M | 118 | 18 | 0.9 | 7.6 |
| 50 | M | 115 | 15 | 0.75 | 6.5 |
| 67 | M | 102 | 11 | 0.55 | 5.4 |
| 62 | F | 144 | 39 | 1.95 | 13.5 |
| 64 | F | 134 | 32 | 1.6 | 11.9 |
| 68 | F | 133 | 29 | 1.45 | 10.9 |
| 69 | F | 130 | 28 | 1.4 | 10.8 |
| 60 | F | 127 | 26 | 1.3 | 10.2 |
| 51 | F | 113 | 22 | 1.1 | 9.7 |
| | | 123.5 ± 12.3* | 24.3 ± 8.3 | 1.2 ± 0.4 | 9.6 ± 2.5 |
| | | | 6-day feeding of voles to kestrels | | |
| 43 | M | 122 | 74 | 3.4 | 27.9** |
| 38 | M | 116 | 69 | 2.8 | 24.1 |
| 29 | M | 113 | 61 | 2.25 | 19.9** |
| 37 | M | 107 | 52 | 1.5 | 14.0 |
| 54 | F | 147 | 129 | 6.35 | 43.2** |
| 78 | F | 139 | 106 | 5.0 | 36.0 |
| 40 | F | 132 | 96 | 4.55 | 34.5 |
| 66 | F | 132 | 87 | 4.05 | 30.7 |
| 70 | F | 128 | 79 | 3.90 | 30.5 |
| 65 | F | 120 | 72 | 3.15 | 26.2** |
| | | 125.6 ± 12.3 | 82.5 ± 22.8 | 3.7 ± 1.4 | 28.7 ± 8.3 |

* Mean ± standard deviation

** Died - see Table 4