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TABLE III-4. BODY WEIGHT AND ORGAN WEIGHT DATA FOR PEROMYSCUS POLIONOTUS FROM A CONTROL SITE. DATA FOR PREGNANT FEMALES AND FOR MICE WITH TOTAL BODY WEIGHTS LESS THAN 10 GRAMS ARE NOT LISTED.

YEAR COLLECTED	SEX	BODY WEIGHT (Gms)	ORGAN WEIGHTS (Mg)				
			HEART	LUNGS	LIVER	SPLEEN	KIDNEY
1973	M*	12.86	70	---**	660	---	---
1973	M	11.90	70	---	750	---	---
1973	M	12.30	70	---	880	---	---
1973	M	10.44	100	---	540	---	---
1974	M	14.65	108	119	811	17	226
1974	M	12.62	93	68	778	12	183
1974	F	11.61	77	99	642	26	171
1974	M	12.66	113	108	524	21	199
1974	F	12.55	85	164	688	16	223
1974	M	12.59	96	112	495	14	207
1974	F	10.23	84	88	679	25	170
1974	M	10.44	84	94	580	16	174
1974	M	11.70	130	92	537	16	195
1974	M	12.75	105	102	530	20	174
1974	M	11.72	90	100	726	15	211
1974	M	11.45	100	96	548	20	171
1974	M	11.05	90	87	549	4	203
1974	M	10.55	97	107	643	30	161
1974	F	12.67	121	106	704	20	225

*M = Male, F = Female
**Data not collected

TABLE III-5. BODY WEIGHT AND ORGAN WEIGHT DATA FOR PEROMYSCUS POLIONOTUS FROM TEST SITE. DATA FOR PREGNANT FEMALES AND FOR MICE WITH TOTAL BODY WEIGHTS LESS THAN 10 GRAMS ARE NOT LISTED.

YEAR COLLECTED	SEX	BODY WEIGHT (Gms)	ORGAN WEIGHTS (Mg)				
			HEART	LUNGS	LIVER	SPLEEN	KIDNEY
1973	M*	12.59	100	---**	450	---	---
1973	F	14.20	80	---	1150	---	---
1973	M	11.50	30	---	---	---	---
1973	M	11.36	110	---	---	---	---
1973	F	15.43	70	---	1300	---	---
1973	M	13.72	90	---	850	---	---
1973	M	10.70	90	---	940	---	---
1973	M	13.81	100	---	1300	---	---
1973	F	14.59	80	---	1290	---	---
1973	F	16.01	100	---	1450	---	---
1973	M	10.48	70	---	760	---	---
1973	M	12.16	90	---	570	---	---
1973	M	13.50	---	---	---	---	---
1973	F	10.00	80	---	560	---	---
1973	F	10.79	100	---	1140	---	---
1973	M	12.43	100	---	1150	---	---
1973	F	13.93	80	---	1450	---	---
1973	F	11.30	70	---	580	---	---
1973	M	11.28	80	---	800	---	---
1973	M	12.45	80	---	930	---	---

*M = Male, F = Female
**Data not collected

TABLE III-5. BODY WEIGHT AND ORGAN WEIGHT DATA FOR PEROMYSCUS POLIONOTUS FROM TEST SITE. DATA FOR PREGNANT FEMALES AND FOR MICE WITH TOTAL BODY WEIGHTS LESS THAN 10 GRAMS ARE NOT LISTED. (CONCLUDED)

YEAR COLLECTED	SEX	BODY WEIGHT (Gms)	ORGAN WEIGHTS (Mg)				
			HEART	LUNGS	LIVER	SPLEEN	KIDNEY
1974	M	10.06	73	80	529	14	187
1974	M	13.63	97	112	696	11	196
1974	M	11.49	113	103	824	29	201
1974	M	12.25	97	124	696	16	234
1974	M	11.26	112	92	419	10	179
1974	F	15.57	111	90	926	17	216
1974	F	16.32	108	82	1044	55	241
1974	M	10.05	149	124	436	12	204
1974	F	12.25	114	121	737	11	197
1974	M	11.74	70	85	797	45	191
1974	M	11.09	84	81	635	9	174
1974	M	11.63	82	84	750	35	204
1974	M	10.61	102	151	645	17	174
1974	F	12.05	85	91	734	16	252
1974	M	12.07	92	96	902	28	232
1974	M	11.30	85	89	587	25	171
1974	M	12.21	75	80	847	58	173
1974	M	11.46	84	98	544	14	189

RELATIVE VARIATION VS ABSOLUTE VARIATION IN THE STUDY OF TREATMENT EFFECTS

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FOREWORD

This report was prepared by Colorado State University, Fort Collins, Colorado, under Contract No. F0561174-90182.

Dr. George M. Angleton, Associate Professor of Radiation Biology and Biostatistics, Colorado State University (CSU) was program manager at CSU for this research program.

Dr. Alvin L. Young was senior scientist and final program manager for the United States Air Force (USAF) for this contract. Dr. John W. Watters was the original program manager for the USAF. Dr. Louis F. Wailly was responsible for initiating the collaborative effort between CSU and the USAF.

ABSTRACT

A fallacy of using the ratio of two response variables to study the effect of some treatment when measurements for both responses are taken on the same subject for the same time is disclosed. An alternative to the use of the ratio is proposed, namely to use one of the terms as an independent variable and take into account covariation through a regression relationship,

RELATIVE VARIATION VS ABSOLUTE VARIATION IN THE STUDY OF TREATMENT EFFECTS

The effects of a treatment are frequently studied in terms of a dependent variable which is the ratio of two responses. In the event that the two responses represent two different measurements made on one subject at a given time, their ratio may be an insensitive statistic relative to the detecting of treatment effects. The principal reason for this is that if both responses were affected proportionally then their ratio would not change. In many studies it would be more appropriate to treat one of the variables in the ratio as a dependent variable and the second variable as an independent variable.

Such situations frequently occur when the weight data obtained during a necropsy are analyzed. For example, in the case of a subject previously receiving some treatment (T) such as an exposure to ionizing radiation or an exposure to some chemical substance, the endpoints of interest might be the lung weight (L) and the total body weight (B) with the dependent variable being defined as the ratio (R) of the lung weight to the body weight. Thus,

$$R = L/B.$$

The first order dependence of R on T is given by the linear relationship

$$R = \alpha_1 + \alpha_2 T$$

where α_1 is the expected value of R for T equal to zero and α_2 is the expected change in R per unit change in T. Alternately,

$$L/B = \alpha_1 + \alpha_2 T.$$

Least squares estimation techniques can be used to obtain estimates of the parameters α_1 and α_2 and hence of the regression line for R.

$$\hat{R} = (\hat{L/B})$$
$$= \hat{\alpha}_1 + \hat{\alpha}_2 T$$

If the R_i, that is the ratio L_i/B_i for the i-th observation set L_i and B_i corresponding to T_i, can be assumed to be somewhat normally distributed with constant variance about the expected values of R_i as estimated by the values of $\hat{R}_i$, then the hypothesis that α_2 is equal to zero can be tested

using analysis of variance techniques.

However, it is both interesting and important to note that this is not a complete test of the simple hypothesis of no effect due to treatment. The hypothesis being tested is that the response variables L and B on a proportional scale are not affected differently by the treatment. In essence, then it can be shown that the test of the hypothesis that α_2 is equal to zero is a test of no body-weight and treatment, BT, interaction given that the response variable of principal interest is the lung weight L.

If the equation for R is rewritten in terms of L and B and then solved for L, then the fact that testing the hypothesis that α_2 is equal to zero is the same as testing the hypothesis that there is no BT interaction becomes immediately clear.

$$L/B = R$$
$$= \alpha_1 + \alpha_2 T;$$

so that

$$L = \alpha_1[B] + \alpha_2[BT].$$

The equation in this latter form states that lung weight is directly proportional to body weight when the treatment level is zero, the proportionality constant being α_1. However, for non-zero values of T, the lung weight is also linear dependent on BT, the interactive term whose coefficient is α_2. Hence, as the level of treatment increases the lung weight changes proportionately providing there is no effect of treatment on body weight. However, if the treatment were to lead to a change in the body weight, as might be expected in many cases, then the effect due to treatment alone could not be estimated since the only term involving T is the interactive term BT.

A more meaningful approach to the analysis would be to postulate a model whereby the terms of its equation would not impose the restrictions of the previous model. One such equation is as follows:

$$L = \alpha_1 + \alpha_2(B) + \alpha_3(T) + \alpha_4(BT)$$

In this equation both body weight and level of treatment are considered to be independent variables. The hypothesis of no significant effect due to a body-weight with level of treatment interaction could be performed by testing the hypothesis that α_4 is equal to zero. The hypothesis of no effect due to treatment

could also be tested by testing the joint hypothesis that α_3 and α_4 are both equal to zero.

Summary

The use of the ratio of two different response measurements in testing the null hypothesis of no effects due to treatment can be an insensitive and a meaningless test when the treatment affects both responses in a proportionate manner. When this is the case a more meaningful approach may be to treat one of the responses, say R_2, as an independent variable and to formulate a four term linear model, expressing the dependence of the other response, say R_1, on R_2 and the level of treatment T. Thus,

$$R_1 = \alpha_1 + \alpha_2(R_2) + \alpha_3(T) + \alpha_4(TR_2).$$

Null hypotheses concerning any of the parameters could be tested. A particular hypothesis of interest would be to test that α_1 is equal to zero for the data whereby T is equal to zero. Such a test as can be seen would test the basic plausibility of using ratio statistics as considered initially.

TABLE II

ANALYSIS OF VARIANCE TABLE FOR TESTING HYPOTHESES OF NO EFFECTS DUE TO TCDD

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	Test Statistic F_s	Significance Level $P\{F>F_s\}$
Observations	22	22.2374			
Group I	10	14.0716			
Group II	12	8.1658			
Hypothesis-1 ($\mu_1=0 \cap \mu_2=0$)	2	2.7370	1.3685	1.40	0.26
Hypothesis-2 ($\mu_1=\mu_2$)	1	2.1080	2.1080	2.16	0.16
Hypothesis-3 ($\mu_1+\mu_2=0$)	1	0.6290	0.6290	0.65	0.43
Error	20	19.5004	0.9750		
Group I	9	13.7826	1.9500	3.75	0.04*
Group II	11	5.7178	0.5198		

* Two tail

III-14

TABLE III-6. BODY WEIGHTS AND ORGAN WEIGHTS FOR PEROMYSCUS POLIONOTUS DUSTED WITH ALUMINA GEL CONTAINING NO TCDD (CONTROL GROUP) OR ALUMINA GEL CONTAINING 2.5 PPB OF TCDD (TEST GROUP)

TREATMENT	SEX	BODY WEIGHT (Gms)	ORGAN WEIGHTS (Mg) HEART	LUNG	LIVER	SPLEEN	KIDNEY	GONADS	THYMUS	ADRENALS
C*	F**	17.55	156	112	951	26	258	---***	15	41
C	F	16.80	112	106	980	24	255	---	54	49
C	F	11.43	92	80	606	14	201	---	19	46
C	M	12.60	115	95	577	10	199	88	19	26
C	F	14.23	132	95	825	20	230	---	11	28
C	M	12.72	75	95	610	10	186	93	18	22
C	M	14.38	81	125	686	13	207	127	12	26
C	M	13.10	130	79	645	20	197	96	12	30
C	M	13.26	100	101	698	19	118	100	18	43
C	M	12.97	~~110~~ 158	~~118~~ 118	~~14~~ 718	~~190~~ 14	~~87~~ 190	~~10~~ 87	~~27~~ 18	-- ~~27~~ 27
T	F	12.07	98	~~114~~ 84	~~17~~ 714	~~195~~ 17	—195	~~87~~ ---	~~30~~ 11	-- ~~30~~ 30
T	M	15.72	144	107	953	37	226	556	33	25
T	M	12.77	122	90	542	20	189	93	20	32
T	M	18.02	156	123	790	25	225	109	21	42
T	M	13.65	105	88	805	19	246	105	15	34
T	M	13.20	119	92	713	24	202	99	13	39
T	M	15.57	127	90	723	33	214	83	27	59
T	F	11.78	117	80	593	17	196	---	14	20

*C = Control Site, T = Test Grid

**F = Female, M = Male

**Data not collected

DUSTING STUDY - TEST ANIMALS

IIMAL #	SPECIMEN #	EM #	SEX	MATURITY	STARTING Body Wt Grams	FINAL Body Wt Grams	HEART mg	LUNG mg	LIVER mg	SPLEEN mg	KIDNEY mg	GONADS mg	THYMUS mg	ADRENAL mg	REMARKS: Only Thoracic thymus removed on female animals, ovaries not weighe
2	111	224	F	M		12.07	98	84	714 *	17	195		11	30	
4	112	996	M	M		15.72	144	107	953	37	226	556	33	25	*White spots on liver, section ta to include spots.
5	113	528	M	M		12.77	122	90	542	20	189	93	20	32	
6	114	221	M	M		18.02	156	123	790	25	225	109	21	42	
7	115	446	M	M		13.65	105	88	805	19	246	105	15	34	
9	116	296	M	M		13.20	119	92	713	24	202	99	13	39 *	
10	117	742	M	M		15.57	127	90	723	33	214	83	27	59 *	*Excess fat around adrenals.
16	118	444	F	M		11.78	117	80	593	17	196		14	20	*Adrenals in three pieces.
18	119	073	F	M		12.61	101	112	751	14	219		15	28	
20	120	641	F	M		14.99	126	113	912	14	279		10	35	
21	121	054	F	M		13.77	123	88	832	9	243		13	31	
23	122	372	M	M		14.12	116	109	779	22	226	118	11	27	

DUSTING STUDY - CONTROL ANIMALS

MAL	SPECIMEN #	EM #	SEX	MATURITY	STARTING BODY WT GRAMS	FINAL BODY WT GRAMS	HEART mg	LUNG mg	LIVER mg	SPLEEN mg	KIDNEY mg	GONADS mg	THYMUS mg	ADRENALS mg	REMARKS: Only thoracic thymus removed on female animals ovaries not weighed
1	101	696	F	M		17.55	156	112	951 **	26	258		15 *	41 *	
3	102	112	F	M		16.80	112	106	980	24	255		54	49	*OBSES (excess fat on thymus and adrenals. **Fatty liver.
8	103	591	F	M		11.43	92	80	606	14	201		19	46	
12	104	655	M	M		12.60	115	95	577	10	199	88	19	26	
13	105	274	F	M		14.23	132	95	825	20	230		11	28	
14	106	626	M	M		12.72	75	95	610	10	186	93	18	22	
15	107	323	M	M		14.38	81	125	686	13	207	127	12	26	
17	108	669	M	M		13.10	130	79	645	20	197	96	12	30	
19	109	628	M	M		13.26	100	101	698	19	118	100	18	43 *	
21	110	069	M	M		12.97	158	118	718	14	190	87	18	27	*One adrenal macerated.

Statistical analyses were performed on field animals captured ~~in 19~~ in consecutive years (1973-1974). Table III-4 and Table III-5 present data on year of collection, sex of specimen, total body weight, and individual organ weights for heart, lungs, liver, spleen and kidney for control and test animals respectively. ~~Animals~~ Data for pregnant females were excluded since pregnancy may alter organ and body mass. In addition animals with a total body weight of less than 10 grams were also excluded since histological examination confirmed that animal

of less than 10 grams body weight were general immature. Therefore, the number of animals included for statistical analysis were 19 mature control animals and 38 mature animals from the test grid

The following linear statistical model was applied to all data[1] -----

$$R_1 = \alpha_1 + \alpha_2(R_2) + \alpha_3(T) + \alpha_4(TR_2)$$

where: R_1 is the dependent variable (e.g., lung weight) while both R_2 (body weight) and level of treatment (control or test) (T) are considered to be independent

1. Statistical analyses were performed by Dr. George Anderton, College of Veterinary [illegible] Biomedical Sciences, Colorado State University, Fort Collins, Colorado 80523

variables. The analysis of variances for the data are presented in Tables III-6 (Body weight), III-7 (Liver weights), III-8 (heart weight), III-9 (lung weights), III-10 (kidney weights) III-11 (Spleen weights)

The analysis of variance table, Table III-6, was used to test the hypothesis of no effect of treatment (Animals from control or test Area) on total body weight. There does not appear to exist any significant effect due to treatment. However, as might be expected,

mice normal weight more than male mice).

In the case of analysis of liver weight data as given in Table III-7, the effect due to treatment is significant at the 0.08 level of significance but not at the 0.05 level. Hence, the hypothesis of no effect due to treatment is accepted, but with a slight degree of reservation. It is interesting to note the significant effects due to body weight, sex and year were simultaneously noted with the levels of significance for these tests being less than 0.001. In 1973 the test area received more than 20 inches above normal rain fall. That year

abundant vegetation (and seeds) were available. However, in 1974 an exceptionally dry year occurred. So severe was this dry period that many plant species produced only minimal amounts of seed

LAB STUDY

STATISTICAL

DATA

TABLE III- . ANALYSIS OF VARIANCE TABLE FOR THE ANALYSIS OF FINAL BODY WEIGHT DATA FOR PEROMYSCUS POLIONOTUS DUSTED WITH ALUMINA GEL CONTAINING 2.5 PPB OF TCDD

SOURCE OF VARIATION	dF	SS	MS	TEST STATISTIC -F-	LEVEL OF SIGNIFICANCE P F F
OBSERVATIONS	22	4,361.4335			
MODEL	3	4,292.8250			
INTERCEPT	1	4,292.7016			
SEX (S)	1	0.0447	0.0447	0.012	0.914
BODY WEIGHT	1	0.0786	0.0782	0.022	0.884
ERROR	19				

Model $B = \alpha_1 + \alpha_2 S + \alpha_3 T$

Sequential Conditional Hypotheses

H_{01}: $\alpha_3 = 0$, no effect due to treatment, accepted at the 0.05 level of significance

H_{02}: $\alpha_2 = 0$, no effect due to sex, accepted at the 0.0t level of significance.

TABLE III- . ANALYSIS OF VARIANCE TABLE FOR THE ANALYSIS OF LIVER WEIGHT DATA FOR PEROMYSCUS POLIONOTUS DUSTED WITH ALUMINA GEL CONTAINING 2.5 PPB OF TCDD

SOURCE OF VARIATION	dF	SS	MS	TEST STATISTIC -F-	LEVEL OF SIGNIFICANCE P F F
OBSERVATIONS	22	12,568,491.			
MODEL	5	12,465,795.			
INTERCEPT	1	12,229.927.			
BODY WEIGHT (B)	1	188,584.	188,584	31.22	0.001
SEX (S)	1	43,212.	43,212	7.15	0.016
TREATMENT (T)	1	2,532.	2,532	0.42	0.526
INTERACTION (BT)	1	1,538.	1,538	0.25	0.623
ERROR	17	102,695.	6,040		

Model: $L = \alpha_1 + \alpha_2 B + \alpha_3 S + \alpha_4 T + \alpha_5 BT$

Sequential Conditional Hypotheses

H_{01}: $\alpha_5 = 0$; no effect due to body-weight with treatment interaction, accepted at the 0.05 level of significance

H_{02}: $\alpha_4 = 0$; no effect due to treatment, accepted at the 0.05 level of significance

H_{03}: $\alpha_3 = 0$; no effect due to sex, rejected at the 0.016 level of significance

H_{04}: $\alpha_4 = 0$; no effect due to body weight, rejected at the 0.001 level of significance

TABLE III- . ANALYSIS OF VARIANCE TABLE FOR THE ANALYSIS OF ADRENAL WEIGHT DATA FOR PEROMYSCUS POLIONOTUS DUSTED WITH ALUMINA GEL CONTAINING 2.5 PPB OF TCDD

SOURCE OF VARIATION	dF	SS	MS	TEST STATISTIC -F-	LEVEL OF SIGNIFICANCE P F F
OBSERVATIONS	22	26,866.00			
MODEL	5	25,334.71			
INTERCEPT	1	24,890.90			
BODY WEIGHT (B)	1	393.32	393.32	4.37	0.052
SEX (S)	1	7.80	7.80	0.09	0.768
TREATMENT (T)	1	1.99	1.99	0.02	0.889
INTERACTION (BT)	1	40.68	40.68	0.45	0.511
ERROR	17	1,531.28	90.07		

Model: $A = \alpha_1 + \alpha_2 B + \alpha_3 S + \alpha_4 T + \alpha_5 BT$

Sequential Conditional Hypotheses

H_{01}: $\alpha_5 = 0$; no effect due to body-weight with treatment interaction, accepted at the 0.05 level of significance

H_{02}: $\alpha_4 = 0$; no effect due to treatment, accepted at the 0.05 level of significance

H_{03}: $\alpha_3 = 0$; no effect due to sex, accepted at the 0.05 level of significance

H_{04}: $\alpha_2 = 0$; no effect due to body weight, accepted at the 0.052 level of significance

TABLE III- . ANALYSIS OF VARIANCE TABLE FOR THE ANALYSIS OF LUNG WEIGHT DATA FOR PEROMYSCUS POLIONOTUS DUSTED WITH ALUMINA GEL CONTAINING 2.5 PPB OF TCDD

SOURCE OF VARIATION	dF	SS	MS	TEST STATISTIC -F-	LEVEL OF SIGNIFICANCE P F F
OBSERVATIONS	22	220,626.0000			
MODEL	5	218,023.2542			
INTERCEPT	1	216,414.7273			
BODY WEIGHT (B)	1	1,476.9833	1,476.9833	0.65	0.006
SEX (S)	1	78.1148	78.1148	0.51	0.485
TREATMENT (T)	1	51.8922	51.8922	0.34	0.567
INTERACTION (BT)	1	1.5366	1.5366	0.01	0.922
ERROR	17	2,602.7458	153.1027		

Model: $L = \alpha_1 + \alpha_2 B + \alpha_3 S + \alpha_4 T + \alpha_5 BT$

Sequential Conditional Hypotheses

H_{01}: $\alpha_5 = 0$; there exists no significant effect due to body-weight and treatment interaction: Accepted, at the 0.05 level of significance

H_{02}: $\alpha_4 = 0$; there exists no significant effect due to treatment: Accepted, at the 0.05 level of significance

H_{03}: $\alpha_3 = 0$; there exists no significant effect due to sex differences: Accepted, at the 0.05 level of significance

H_{04}: $\alpha_2 = 0$; there exists no significant effect due to body weight: Rejected at the 0.01 level of significance

TABLE III- . ANALYSIS OF VARIANCE TABLE FOR THE ANALYSIS OF HEART WEIGHT FOR *PEROMYSCUS POLIONOTUS* DUSTED WITH ALUMINA GEL CONTAINING 2.5 PPB OF TCDD

SOURCE OF VARIATION	dF	SS	MS	TEST STATISTIC -F-	LEVEL OF SIGNIFICANCE P F F
OBSERVATIONS	22	319,269.00			
MODEL	5	311,988.42			
INTERCEPT	1	308,455.68			
BODY WEIGHT (B)	1	3,301.26	3.301.26	7.708	0.013
SEX (S)	1	5.29	5.29	0.012	0.914
TREATMENT (T)	1	151.30	151.30	0.353	0.560
INTERACTION (BT)	1	74.89	74.89	0.174	0.681
ERROR	17	7,280.58	428.20		

Model: $H = \alpha_1 + \alpha_2 B + \alpha_3 S + \alpha_4 T + \alpha_5 BT$

Sequential Conditional Hypotheses

H_{01}: $\alpha_5 = 0$; no effect due to body-weight with treatment interaction, accepted at the 0.05 level of significance

H_{02}: $\alpha_4 = 0$; no effect due to treatment, accepted at the 0.05 level of significance

H_{03}: $\alpha_3 = 0$; no effect due to sex, accepted at the 0.05 level of significance

H_{04}: $\alpha_2 = 0$; no effect due to body weight, rejected at the 0.013 level of significance

TABLE III- . ANALYSIS OF VARIANCE TABLE FOR THE ANALYSIS OF SPLEEN WEIGHT DATA FOR PEROMYSCUS POLIONOTUS DUSTED WITH ALUMINA GEL CONTAINING 2.5 PPB OF TCDD

SOURCE OF VARIATION	dF	SS	MS	TEST STATISTIC -F-	LEVEL OF SIGNIFICANCE P F F
OBSERVATIONS	22	9,129.00			
MODEL	5	8,578.22			
INTERCEPT	1	8,056.41			
BODY WEIGHT (B)	1	386.11	386.11	11.92	0.003
SEX (S)	1	48.60	48.60	1.50	0.237
TREATMENT (T)	1	74.33	74.33	2.29	0.149
INTERACTION (BT)	1	12.79	12.79	0.39	0.541
ERROR	17	550.78	32.40		

Model: $S = \alpha_1 + \alpha_2 B + \alpha_3 S + \alpha_4 T + \alpha_5 BT$

Sequential Conditional Hypotheses

H_{01}: $\alpha_5 = 0$; no effect due to body-weight with treatment interaction, accepted at the 0.05 level of significance

H_{02}: $\alpha_4 = 0$; no effect due to treatment, accepted at the 0.05 level of significance

H_{03}: $\alpha_3 = 0$; no effect due to sex, accepted at the 0.05 level of significance

H_{04}: $\alpha_2 = 0$: no effect due to body weight, rejected at the 0.003 level of significance

TABLE III- . ANALYSIS OF VARIANCE TABLE FOR THE ANALYSIS OF KIDNEY WEIGHT DATA FOR PEROMYSCUS POLIONOTUS DUSTED WITH ALUMINA GEL CONTAINING 2.5 PPB OF TCDD

SOURCE OF VARIATION	dF	SS	MS	TEST STATISTIC -F-	LEVEL OF SIGNIFICANCE P F F
OBSERVATIONS	22	1,027,675.00			
MODEL	5	1,017,622.43			
INTERCEPT	1	1,004,518.23			
BODY WEIGHT (B)	1	7,046.30	7,046.30	11.916	0.003
SEX (S)	1	4,685.37	4,685.37	7.923	0.012
TREATMENT (T)	1	1,371.75	1,371.75	2.320	0.146
INTERACTION (BT)	1	0.78	0.78	0.001	0.975
ERROR	17	10,052.57	591.33		

Model: $K = \alpha_1 + \alpha_2 B + \alpha_3 S + \alpha_4 T + \alpha_5 BT$

Sequential Conditional Hypotheses

H_{01}: $\alpha_5 = 0$; no effect due to body-weight with treatment interaction, accepted at the 0.05 level of significance

H_{02}: $\alpha_4 = 0$; no effect due to treatment, accepted at the 0.05 level of significance

H_{03}: $\alpha_3 = 0$; no effect due to sex, rejected at the 0.012 level of significance

H_{04}: $\alpha_2 = 0$; no effect due to body weight, rejected at the 0.003 level of significance

TABLE III- . ANALYSIS OF VARIANCE TABLE FOR THE ANALYSIS OF GONAD WEIGHT DATA FOR PEROMYSCUS POLIONOTUS DUSTED WITH ALUMINA GEL CONTAINING 2.5 PPB OF TCDD

SOURCE OF VARIATION	dF	SS	MS	TEST STATISTIC -F-	LEVEL OF SIGNIFICANCE P F F
OBSERVATIONS	13	430,612.00			
MODEL	4	263,353.38			
INTERCEPT	1	236,655.08			
BODY WEIGHT (B)	1	24,274.02	24,274.02	1.31	0.282
TREATMENT (T)	1	2,423.08	2,423.08	0.13	0.727
INTERACTION (BT)	1	1.61	1.61	0.00^{+}	0.993
ERROR	9	167,258.21	18,584.25		

Model: $G = \alpha_1 + \alpha_2 B + \alpha_3 T + \alpha_4 BT$

Sequential Conditional Hypotheses

H_{01}: $\alpha_4 = 0$; no effect due to body-weight with treatment interaction, accepted at the 0.05 level of significance

H_{02}: $\alpha_3 = 0$; no effect due to treatment, accepted at the 0.05 level of significance

H_{03}: $\alpha_2 = 0$; no effecut due to body weight, accepted at the 0.05 level of significance

TABLE III- . ANALYSIS OF VARIANCE TABLE FOR THE ANALYSIS OF THYMUS WEIGHT FOR *PEROMYSCUS POLIONOTUS* DUSTED WITH ALUMINA GEL CONTAINING 2.5 PPB OF TCDD

SOURCE OF VARIATION	dF	SS	MS	TEST STATISTIC -F-	LEVEL OF SIGNIFICANCE P F F
OBSERVATIONS	22	9,229.0000			
MODEL	5	7,670.9750			
INTERCEPT	1	7,236.4090			
BODY WEIGHT (B)	1	378.6052	378.6052	4.13	0.058
SEX (S)	1	0.0013	0.0013	0.01	0.922
TREATMENT (T)	1	47.8972	47.8972	0.52	0.481
INTERACTION (BT)	1	8.0623	8.0623	0.09	0.768
ERROR	17	1,558.0250	91.6485		

Model: $T = \alpha_1 + \alpha_2 B + \alpha_3 S + \alpha_4 T + \alpha_5 BT$

Sequential Conditional Hypotheses

H_{01}: $\alpha_5 = 0$; no effect due to body-weight with treatment interaction, accepted at the 0.05 level of significance

H_{02}: $\alpha_4 = 0$; no effect due to treatment, accepted at the 0.05 level of significance

H_{03}: $\alpha_3 = 0$; no effect due to sex, accepted at the 0.05 level of significance

H_{04}: $\alpha_2 = 0$; no effect due to body weight, accepted at the 0.05 level of significance

TABLE III-6. ANALYSIS OF VARIANCE TABLE FOR TOTAL BODY WEIGHTS OF PEROMYSCUS POLIONOTUS COLLECTED IN 1973 AND 1974 FROM THE CONTROL AND TEST GRID. DATA FOR PREGNANT FEMALES AND FOR MICE WITH TOTAL BODY WEIGHTS LESS THAN 10 GRAMS EXCLUDED FROM THE ANALYSIS

SOURCE OF VARIATION	dF	SS	MS	TEST STATISTIC -F-	LEVEL OF SIGNIFICANCE P F F
OBSERVATIONS	58	8,742.1315			
MODEL	4	8,630.5108			
MEAN	1	8,610.5303			
YEAR	1	2.3668	2.3668	1.1450	0.289
SEX	1	17.2892	17.2892	8.3642	0.006
TREATMENT	1	0.3246	0.3246	0.1470	0.694
ERROR	54	111.6207	2.0671		

TABLE III-7. ANALYSIS OF VARIANCE TABLE FOR LIVER WEIGHTS OF PEROMYSCUS POLIONTUS COLLECTED IN 1973 AND 1974 FROM THE CONTROL AND TEST GRID. DATA FOR PREGNANT FEMALES AND FOR MICE WITH TOTAL BODY WEIGHTS LESS THAN 10 GRAMS EXLUDED FROM THE ANALYSIS

SOURCE OF VARIATION	dF	SS	MS	TEST STATISTIC -F-	LEVEL OF SIGNIFICANCE P F F
OBSERVATIONS	52	34,592,585.			
MODEL	5	33,279,682.			
MEAN	1	31,125,642.			
YEAR	1	845,190.	845,190.	30.256	0.001
SEX	1	483,959.	483,959.	17.325	0.001
BODY WEIGHT	1	734,901.	734,901.	26.308	0.001
TREATMENT	1	89,989.	89,988	3.22	0.0792
ERROR	47	1,312,903.	27,934		

TABLE III-8. ANALYSIS OF VARIANCE TABLE FOR HEART WEIGHTS OF PEROMYSCUS POLIONOTUS COLLECTED IN 1973 AND 1974 FROM THE CONTROL AND TEST GRID. DATA FOR PREGNANT FEMALES AND FOR MICE WITH TOTAL BODY WEIGHTS LESS THAN 10 GRAMS EXLUDED FROM THE ANALYSIS

SOURCE OF VARIATION	dF	SS	MS	TEST STATISTIC -F-	LEVEL OF SIGNIFICANCE P F F
OBSERVATIONS	56	486,160.0000			
MODEL	5	470,417.3081			
MEAN	1	467,383.1424			
YEAR	1	2,697.6582			
SEX	1	1.0493	1.0493	0.003	0.957
BODY WEIGHT	1	334.7756	1.0845	1.085	0.304
TREATMENT	1	0.6821	0.6821	0.002	0.963
ERROR	51	15,742.6919	308.68		

TABLE III-9. ANALYSIS OF VARIANCE TABLE FOR LUNG WEIGHTS OF PEROMYSCUS POLIONOTUS COLLECTED IN 1973 AND 1974 FROM THE CONTROL AND TEST GRID. DATA FOR PREGNANT FEMALES AND FOR MICE WITH TOTAL BODY WEIGHTS LESS THAN 10 GRAMS EXCLUDED FROM THE ANALYSIS

SOURCE OF VARIATION	dF	SS	MS	TEST STATISTIC -F-	LEVEL OF SIGNIFICANCE P F F
OBSERVATIONS	33	350,007.00			
MODEL	4	337,384.13			
MEAN	1	337,037.12			
SEX	1	174.44	174.44	0.40	0.532
BODY WEIGHT	1	38.14	38.14	0.09	0.766
TREATMENT	1	134.43	134.43	0.31	0.582
ERROR	29	12,622.87	435.27		

TABLE III-10. ANALYSIS OF VARIANCE TABLE FOR KIDNEY WEIGHTS OF PEROMYSCUS POLIONOTUS COLLECTED IN 1973 AND 1974 FROM THE CONTROL AND TEST GRID. DATA FOR PREGNANT FEMALES AND FOR MICE WITH TOTAL BODY WEIGHTS LESS THAN 10 GRAMS EXCLUDED FROM THE ANALYSIS

SOURCE OF VARIATION	dF	SS	MS	TEST STATISTIC -F-	LEVEL OF SIGNIFICANCE P F F
OBSERVATIONS	33	1,594.832.			
MODEL	4	1,582,099.			
MEAN	1	1,571,782.			
SEX	1	3,010.	3,010	6.85	0.014
BODY WEIGHT	1	5,998.	5,998	13.66	0.001
TREATMENT	1	1,309.	1,309	2.98	0.095
ERROR	29	12,732.	439		

TABLE III-11. ANALYSIS OF VARIANCE TABLE FOR SPLEEN WEIGHTS OF PEROMYSCUS POLIONOTUS COLLECTED IN 1973 AND 1974 FROM THE CONTROL AND TEST GRID. DATA FOR PREGNANT FEMALES AND FOR MICE WITH TOTAL BODY WEIGHTS LESS THAN 10 GRAMS EXCLUDED FROM THE ANALYSIS

SOURCE OF VARIATION	dF	SS	MS	TEST STATISTIC -F-	LEVEL OF SIGNIFICANCE P F F
OBERVATIONS	33	19,418.00			
MODEL	4	15,123.36			
MEAN	1	14,595.00			
SEX	1	52.03	52.03	0.35	0.559
BODY WEIGHT	1	262.61	262.61	1.77	0.195
TREATMENT	1	213.69	213.69	1.44	0.241
ERROR	27	4,294.64	148.09		

C. Statistical Methods [1]

The effects of a treatment are frequently studied in terms of a dependent variable which is the ratio of two responses. In the event that the two responses represent two different measurements made on one subject at a given time, their ratio may be an insensitive statistic relative to the determination of treatment effects. The principal reason for this is that if both responses were affected proportionally then their ratio would not change. When this is the case a more meaningful approach may be to treat one of the responses, R_2, as an independent variable and to formulate a four term linear model, expressing the dependence of the other response, R_1, on R_2 and the level of treatment, T. Thus:

$$R_1 = \alpha_1 + \alpha_2(R_2) + \alpha_3(T) + \alpha_4(TR_2).$$

R_1 is the dependent variable (e.g., lung weight,

In this equation, while both R_2 (e.g., body weight)

and level of treatment (T) are considered to be independent variables. The hypothesis of no significant effect on lung weight due to body weight with level of treatment interaction could be performed by testing the hypothesis that α_4 is equal to ZERO. The hypothesis of no effect due to treatment could also be tested by testing the joint hypothesis that α_3 and α_4 were both equal to ZERO.

The above model was applied to all data collected on the beachmouse. It should be noted that Histopathologic studies indicated that the designation of some mice as immature at necropsy was incorrect as judged from microscopic appearance of the uterus and ovaries and the production of sperm in the testicles. Therefore, statistical analyses were performed only on animals having a total body weight of 10 grams or greater (i.e., animals considered as mature). Moreover, data from pregnant females were also excluded since pregnancy may alter [illegible] organs and body mass.

TABLE III -

ANALYSIS OF VARIANCE TABLE FOR TOTAL BODY WEIGHTS OF PEROMYSCUS ~~FOR FIELD BEACHMOUSE DATA~~. DATA FOR PREGNANT FEMALES AND FOR MICE WITH TOTAL BODY WEIGHTS LESS THAN 10 GRAMS EXCLUDED FROM THE ANALYSIS

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	Test Statistic $-F_s-$	Level of Significance $P\{F>F_s\}$
Observations	58	8,742.1315			
Model	4	8,630.5108			
Mean	1	8,610.5303			
Year	1	2.3668	2.3668	1.1450	0.289
Sex	1	17.2892	17.2892	8.3642	0.006
Treatment	1	0.3246	0.3246	0.1570	0.694
Error	54	111.6207	2.0671		

TABLE III -

ANALYSIS OF VARIANCE TABLE FOR LIVER WEIGHTS ~~FOR FIELD BEACHMOUSE DATA~~. DATA FOR PREGNANT FEMALES AND FOR MICE WITH TOTAL BODY WEIGHTS LESS THAN 10 GRAMS EXCLUDED FROM THE ANALYSIS

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	Test Statistic $-F_s-$	Level of Significance $P\{F>F_s\}$
Observations	52	34,592,585.			
Model	5	33,279,682.			
Mean	1	31,125,642.			
Year	1	845,190.	845,190.	30.256	<0.001
Sex	1	483,959.	483,959.	17.325	<0.001
Body Weight	1	734,901.	734,901.	26.308	<0.001
Treatment	1	89,989.	89,988	3.22	0.0792
Error	47	1,312,903.	27,934		

1973

Males 193.48 ÷ 16 = 12.0925
Females 106.25 ÷ 8 = 13.28125

Control males 47.5 ÷ 4 = 11.875
Control Females 0

Test males 145.98 ÷ 12 = 12.165
Test Females 106.25 ÷ 8 = 13.28125

1974

Males 293.03 ÷ 25 = 11.7212

Females 103.25 ÷ 8 = 12.90625

Control Males 132.18 ÷ 11 = 12.01
control Females 47.06 ÷ 4 = 11.765

Test Males 160.85 ÷ 14 = 11.489285
Test female 3 56.19 ÷ 4 = 14.0475

TABLE [redacted]

[redacted] TABLE FOR THE ANALYSIS OF LIVER WEIGHT DATA FOR [redacted] DUSTED WITH ALUMINA GEL CONTAINING [redacted] PPB OF TCDD

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	Test Statistic $-F_s-$	Level of Significance $P\{F>F_s\}$
Observations	22	12,568,491.			
Model	5	12,465,795.			
Intercept	1	12,229,927.			
Body Weight (B)	1	188,584.	188,584	31.22	<0.001
Sex (S)	1	43,212.	43,212	7.15	0.016
Treatment (T)	1	2,532.	2,532	0.42	0.526
Interaction (BT)	1	1,538.	1,538	0.25	0.623
Error	17	102,695.	6,040		

~~TABLE 9~~

TABLE II - • ~~ANOVA~~ TABLE FOR THE ANALYSIS OF THYMUS WEIGHT FOR [redacted] DUSTED WITH ALUMINA GEL CONTAINING [redacted] PPB OF TCDD

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	Test Statistic $-F_s-$	Level of Significance $P\{F>F_s\}$
Observations	22	9,229.0000			
Model	5	7,670.9750			
Intercept	1	7,236.4090			
Body Weight (B)	1	378.6052	378.6052	4.13	0.058
Sex (S)	1	0.0013	0.0013	<0.01	0.922
Treatment (T)	1	47.8972	48.8972	0.52	0.481
Interaction (BT)	1	8.0623	8.0623	0.09	0.768
Error	17	1,558.0250	91.6485		

TABLE III - ANOVA TABLE FOR THE ANALYSIS OF GONAD WEIGHT DATA FOR MALE DUSTED WITH ALUMINA GEL CONTAINING PPB OF TCDD

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	Test Statistic $-F_s-$	Level of Significance $P\{F>F_s\}$
Observations	13	430,612.00			
Model	4	263,353.38			
Intercept	1	236,655.08			
Body Weight (B)	1	24,274.02	24,274.02	1.31	0.282
Treatment (T)	1	2,423.08	2,423.08	0.13	0.727
Interaction (BT)	1	1.61	1.61	0.00^{+}	0.993
Error	9	167,258.21	18,584.25		

TABLE I - ANOVA TABLE FOR THE ANALYSIS OF SPLEEN WEIGHT DATA FOR MICE DUSTED WITH ALUMINA GEL CONTAINING 2 PPB OF TCDD

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	Test Statistic $-F_s-$	Level of Significance $P\{F>F_s\}$
Observations	22	1,027,675.00			
Model	5	1,017,622.43			
Intercept	1	1,004,518.23			
Body Weight (B)	1	7,046.30	7,046.30	11.916	0.003
Sex (S)	1	4,685.37	4,685.37	7.923	0.012
Treatment (T)	1	1,371.75	1,371.75	2.320	0.146
Interaction (BT)	1	0.78	0.78	0.001	0.975
Error	17	10,052.57	591.33		

TABLE III. ANOVA TABLE FOR THE ANALYSIS OF SPLEEN WEIGHT DATA FOR [redacted] DUSTED WITH ALUMINA GEL CONTAINING [redacted] PPB OF TCDD

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	Test Statistic $-F_s-$	Level of Significance $P\{F>F_s\}$
Observations	22	9,129.00			
Model	5	8,578.22			
Intercept	1	8,056.41			
Body Weight (B)	1	386.11	386.11	11.92	0.003
Sex (S)	1	48.60	48.60	1.50	0.237
Treatment (T)	1	74.33	74.33	2.29	0.149
Interaction (BT)	1	12.79	12.79	0.39	0.541
Error	17	550.78	32.40		

TABLE III -

ANALYSIS OF VARIANCE TABLE FOR THE ANALYSIS OF HEART WEIGHT FOR MICE DUSTED WITH ALUMINA GEL CONTAINING 2.5 PPB OF TCDD

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	Test Statistic $-F_s-$	Level of Significance $P\{F>F_s\}$
Observations	22	319,269.00			
Model	5	311,988.42			
Intercept	1	308,455.68			
Body Weight (B)	1	3,301.26	3.301.26	7.708	0.013
Sex (S)	1	5.29	5.29	0.012	0.914
Treatment (T)	1	151.30	151.30	0.353	0.560
Interaction (BT)	1	74.89	74.89	0.174	0.681
Error	17	7,280.58	428.20		

TABLE 21 –

ANOVA TABLE FOR THE ANALYSIS OF FINAL BODY WEIGHT DATA FOR ~~MICE~~ DUSTED WITH ALUMINA GEL CONTAINING ~~24~~ 2.8 PPB OF TCDD

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	Test Statistic $-F_s-$	Level of Significance $P\{F>F_s\}$
Observations	22	4,361.4335			
Model	3	4,292.8250			
Intercept	1	4,292.7016			
Sex (S)	1	0.0447	0.0447	0.012	0.914
Body Weight (B)	1	0.0786	0.0782	0.022	0.884
Error	19				

[redacted]

TABLE III-3. ANALYSIS OF VARIANCE TABLE FOR HEART WEIGHTS OF PEROMYSCUS POLIONOTUS COLLECTED IN 1973 AND 1974 FROM THE CONTROL GRID. ~~FOR FIELD BEACHMOUSE DATA.~~ DATA FOR PREGNANT FEMALES AND FOR MICE WITH TOTAL BODY WEIGHTS LESS THAN 10 GRAMS EXCLUDED FROM THE ANALYSIS

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	Test Statistic $-F_s-$	Level of Significance $P\{F>F_s\}$
Observations	56	486,160.0000			
Model	5	470,417.3081			
Mean	1	467,383.1424			
Year	1	2,697.6582			
Sex	1	1.0493	1.0493	0.003	0.957
Body Wt.	1	334.7756	1.0845	1.085	0.304
Treatment	1	0.6821	0.6821	0.002	0.963
Error	51	15,742.6919	308.68		

TABLE III-4. ANALYSIS OF VARIANCE TABLE FOR LUNG WEIGHTS ~~FOR FIELD BEACHMOUSE DATA~~. DATA FOR PREGNANT FEMALES AND FOR MICE WITH TOTAL BODY WEIGHTS LESS THAN 10 GRAMS EXCLUDED FROM THE ANALYSIS

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	Test Statistic $-F_s-$	Level of Significance $P\{F>F_s\}$
Observations	33	350,007.00			
Model	4	337,384.13			
Mean	1	337,037.12			
Sex	1	174.44	174.44	0.40	0.532
Body Weight	1	38.14	38.14	0.09	0.766
Treatment	1	134.43	134.43	0.31	0.582
Error	29	12,622.87	435.27		

TABLE III –

ANALYSIS OF VARIANCE TABLE FOR KIDNEY WEIGHTS ~~FOR FIELD BEACHMOUSE DATA~~.
DATA FOR PREGNANT FEMALES AND FOR MICE WITH TOTAL BODY WEIGHTS LESS THAN
10 GRAMS EXCLUDED FROM THE ANALYSIS

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	Test Statistic $-F_s-$	Level of Significance $P\{F>F_s\}$
Observations	33	1,594.832.			
Model	4	1,582,099.			
Mean	1	1,571,782.			
Sex	1	3,010.	3,010	6.85	0.014
Body Weight	1	5,998.	5,998	13.66	<0.001
Treatment	1	1,309.	1,309	2.98	0.095
Error	29	12,732.	439		

TABLE IV –

ANALYSIS OF VARIANCE TABLE FOR SPLEEN WEIGHTS ~~FOR FIELD BEACHMOUSE DATA~~.
DATA FOR PREGNANT FEMALES AND FOR MICE WITH TOTAL BODY WEIGHTS LESS THAN
10 GRAMS EXCLUDED FROM THE ANALYSIS

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	Test Statistic $-F_s-$	Level of Significance $P\{F>F_s\}$
Observations	33	19,418.00			
Model	4	15,123.36			
Mean	1	14,595.00			
Sex	1	52.03	52.03	0.35	0.559
Body Weight	1	262.61	262.61	1.77	0.195
Treatment	1	213.69	213.69	1.44	0.241
Error	27	4,294.64	148.09		

TABLE III –

ANALYSIS OF VARIANCE TABLE FOR KIDNEY WEIGHTS ~~FOR FIELD BEACHMOUSE DATA~~.
DATA FOR PREGNANT FEMALES AND FOR MICE WITH TOTAL BODY WEIGHTS LESS THAN
10 GRAMS EXCLUDED FROM THE ANALYSIS

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	Test Statistic $-F_s-$	Level of Significance $P\{F>F_s\}$
Observations	33	1,594.832.			
Model	4	1,582,099.			
Mean	1	1,571,782.			
Sex	1	3,010.	3,010	6.85	0.014
Body Weight	1	5,998.	5,998	13.66	<0.001
Treatment	1	1,309.	1,309	2.98	0.095
Error	29	12,732.	439		

TABLE IV –

ANALYSIS OF VARIANCE TABLE FOR SPLEEN WEIGHTS ~~FOR FIELD BEACHMOUSE DATA~~.
DATA FOR PREGNANT FEMALES AND FOR MICE WITH TOTAL BODY WEIGHTS LESS THAN
10 GRAMS EXCLUDED FROM THE ANALYSIS

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	Test Statistic $-F_s-$	Level of Significance $P\{F>F_s\}$
Observations	33	19,418.00			
Model	4	15,123.36			
Mean	1	14,595.00			
Sex	1	52.03	52.03	0.35	0.559
Body Weight	1	262.61	262.61	1.77	0.195
Treatment	1	213.69	213.69	1.44	0.241
Error	27	4,294.64	148.09		

TABLE III- BODY WEIGHTS AND ORGAN WEIGHTS FOR [redacted] SUBJECTS DUSTED WITH ALUMINA GEL CONTAINING NO TCDD (CONTROL GROUP) OR ALUMINA GEL CONTAINING 2.5 PPB OF TCDD (TEST GROUP)

Treatment	Sex	Body Weight -gms-	Organ Weights (mg)							
			Heart	Lung	Liver	Spleen	Kidney	Gonads	Thymus	Adrenals
C*	F**	17.55	156	112	951	26	258	---	15	41
C	F	16.80	112	106	980	24	255	---	54	49
C	F	11.43	92	80	606	14	201	---	19	46
C	M	12.60	115	95	577	10	199	88	19	26
C	F	14.23	132	95	825	20	230	---	11	28
C	M	12.72	75	95	610	10	186	93	18	22
C	M	14.38	81	125	686	13	207	127	12	26
C	M	13.10	130	79	645	20	197	96	12	30
C	M	13.26	100	101	698	19	118	100	18	43
C	M	12.97	158	118	718	14	190	87	18	27
T	F	12.07	98	84	714	17	195	---	11	30
T	M	15.72	144	107	953	37	226	556	33	25
T	M	12.77	122	90	542	20	189	93	20	32
T	M	18.02	156	123	790	25	225	109	21	42
T	M	13.65	105	88	805	19	246	105	15	34
T	M	13.20	119	92	713	24	202	99	13	39
T	M	15.57	127	90	723	33	214	83	27	59
T	F	11.78	117	80	593	17	196	---	14	20

* C= CONTROL RATS, T= TEST GROUP
** F = FEMALE, M= MALE

*** DATA NOT COLLECTED

TABLE I, Pg. 2

Treat-ment	Sex	Body Weight -gms-	Heart	Lung	Liver	Spleen	Kidney	Gonads	Thymus	Adrenals
T	F	12.61	101	112	751	14	219	---	15	28
T	F	14.99	126	113	912	14	279	---	10	35
T	F	13.77	123	88	832	9	243	---	13	31
T	M	14.12	116	109	779	22	226	118	11	27

TABLE 7

ANOVA TABLE FOR THE ANALYSIS OF KIDNEY WEIGHT DATA FOR MICE DUSTED WITH ALUMINA GEL CONTAINING 2.24 PPB OF TCDD

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	Test Statistic $-F_s-$	Level of Significance $P\{F>F_s\}$
Observations	22	1,027,675.00			
Model	5	1,017,622.43			
Intercept	1	1,004,518.23			
Body Weight (B)	1	7,046.30	7,046.30	11.916	0.003
Sex (S)	1	4,685.37	4,685.37	7.923	0.012
Treatment (T)	1	1,371.75	1,371.75	2.320	0.146
Interaction (BT)	1	0.78	0.78	0.001	0.975
Error	17	10,052.57	591.33		

Model: $K = \alpha_1 + \alpha_2 B + \alpha_3 S + \alpha_4 T + \alpha_5 BT$

Sequential Conditional Hypotheses

H_{01}: $\alpha_5 = 0$; no effect due to body-weight with treatment interaction, accepted at the 0.05 level of significance

H_{02}: $\alpha_4 = 0$; no effect due to treatment, accepted at the 0.05 level of significance

H_{03}: $\alpha_3 = 0$; no effect due to sex, rejected at the 0.012 level of significance

H_{04}: $\alpha_2 = 0$; no effect due to body weight, rejected at the 0.003 level of significance