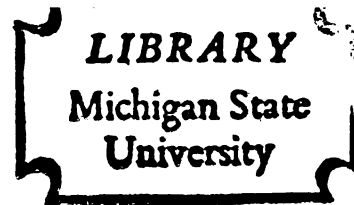


THE PHYSIOLOGICAL EFFECTS RESULTING
FROM DIFFERING TYPES OF TRAINING
ON THE ORGAN WEIGHTS
OF THE ADULT RAT

Thesis for the Degree of M. A.
MICHIGAN STATE UNIVERSITY
William Lee Clark
1962

THESIS



ABSTRACT

THE PHYSIOLOGICAL EFFECTS RESULTING FROM DIFFERING TYPES OF TRAINING OF THE ORGAN WEIGHTS OF THE ADULT RAT

by William Lee Clark

The objective of this study was to compare the effects on the organ weights of adult male rats, that two different types of training would bring about. Differing degrees of forced exercise were used on the training groups. The animals assigned to group I represent the underdistance method of training. Those animals in group II were trained by the overdistance method. The third group was the control group which were kept sedentary.

Twelve animals were selected randomly for each group. The overdistance group swam for a relatively extended period of time with a light amount of weight. The time limit being set at one hour. The procedure for training the animals in the underdistance group was done by allowing the animals to swim twenty repetitions or bouts of one minute each with a rest period of one minute in between each bout. The maximum number of bouts were limited to twenty. The sedentary group received no exercise. The amount of weight used on each animal was derived at by taking a certain percent of his body

weight and adding weight accordingly so that all the animals would have a equal burden in respect to his group. The weight was added by applying lead sinkers strung on a piece of wire and held in place by waterproof adhesive tape wrapped around the animals tail.

The experimental period lasted for twelve weeks with four specific testing sessions. The animals in the two experimental groups were trained every weekday with the exceptions of the testing days. Each test period three animals from each group were selected at random to be tested. The animals chosen were then sacrificed and their organs weighed. These organs included the adrenals, liver, testes, spleen, kidneys and heart. Next the carcass was weighed both in and out of water to determine the specific gravity. After this process the organs were weighed by the use of a Mettler weighing device and recorded on the data sheets to the nearest hundredth gram.

The analysis of variance results indicated that there was some significance at the five percent level. The main conclusion being that the effects of training performed in this study seemed to be in general a decrease in organ weight. Recommendation is made that this study be repeated using pathogen free animals and a larger number of subjects in each group.

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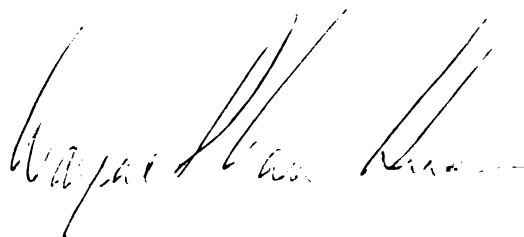
A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF ARTS

Department of Health, Physical Education, and Recreation

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The author is also indebted and grateful to Dr. Henry J. Montoye, David Anderson and Janos Nevai who gave willingly of their time and effort.

DEDICATION

This thesis is respectfully dedicated to my parents, Dorothy and Earl Clark, who have given me with patience and understanding, sustained encouragement throughout my education.

CHAPTER I

INTRODUCTION AND STATEMENT OF THE PROBLEM

Introduction

The purpose of a training or exercise program may be considered as a means to render the body capable of performing various tasks. Such a training program would bring about physiological changes within the body specific to the type of program administered. These changes are of interest to those concerned with the field of physical education because more information is needed concerning the specific effects of training programs if advances in training techniques are to be made.

In the current study rats were used to present a study of the effects of high intensity with low duration training and low intensity with high duration training on the body organs.

Statement of the Problem

The purpose of this study was to record, examine and compare any physiological differences in development occurring in the organs of these groups studied.

Importance of the Problem

It is hoped that this study will help to enlighten the

field of physical education by denoting the physiological changes of body organs which occur in different methods of training. Although there has been research on the effects of exercise on organ weights; considerable confusion concerning the results that various methods of training produce on these organs still exists.

This particular study is not meant to be an end in itself, but a means to an end. It is a study to compile scientific data of this type or contribute to other available data which could be used for other such related studies.

Limitations of the Study

The subjects for this experiment, were male albino rats. Many people have the tendency to reject the findings on lower animals no matter how significant the results may be.

The primary limitation of this study was one of which we were completely unaware of prior to the first testing period. The colony from which the male albino rats used in the study were obtained had chronic murine pneumonia. The stress of training tended to further consolidate the pneumonia. The degree of the disease varied, but yet was present in all of the animals studied. This of course would render effects upon their training and probably indirectly

upon the development of their organs. There is little question but that the pathology present in the animals clouds the results.

Definition of Terms Used

Organ Development. Organ development in this study is interpreted as the amount of change taking place in the organs concerned as determined by weight.

Training. Training is any process or method employed in preparing the subjects to perform a specific task.

Experimental Group--1. Group 1 refers to the experimental group of subjects which were given a specific type of training. The procedure used for this group was one of high intensity and low duration. The purpose of this group was to demonstrate the degree of changes in organ weight as compared to the organs of the other groups studied.

Experimental Group--2. Group 2 refers to the experimental group of subjects which were given a specific type of training. The procedure used for this group was one of low intensity and high duration. Group 2 would thus demonstrate a further comparison of organ development in relationship to the other groups.

Control Group--3. Group 3 refers to that group of subjects which were given no specific type of training.

This group of subjects remained completely sedentary throughout the experimental period and were used in this study as a basis for comparison.

CHAPTER II

REVIEW OF THE LITERATURE

Research on the effects of exercise on organ weights began as early as 1911. At this time Donaldson (2) studied the effect of exercise on the central nervous system of albino rats. No statistical treatment was used however Donaldson indicated a deviation of plus 2.7 per cent for the brain, and plus 0.25 per cent for the spinal cord.

Secher (6) in 1921, studied the musculature and heart in regard to the effect forced exercise would have on their weight. He reported that the musculature increased 5 per cent and the heart increased 21 per cent in weight.

In 1930, Borovansky (1) again studied the effects of forced exercise on organ weight. In this study however Borovansky studied more organs than had been studied before. He reported increases in weight for the testes, kidneys, heart and adrenals in the males; and increases in the kidneys, heart, spleen, adrenals and thyroid in the females. The liver showed a minus deviation in both sexes.

Donaldson (3) in 1932, performed a study which involved the effects of exercise carried through seven

generations of rats. In both sexes of the albino rats, exercise causes most of the organs to become larger. These increases in weight are largest in the heart, kidneys, adrenals and testes. The thyroid and liver show minus deviations. Donaldson states that organ weight changes depend largely on changes in the size of formed cells and follicles, rather than on changes in cell numbers. He further concluded that there was no cumulative effect of exercise in seven generations. Donaldson (4) next, studied the effects of exercise beginning at different ages on the weight of several organs. He concluded that older rats responded in the same ways to exercise as did those which were younger. Secondly, he states that exercise produces changes in the organ weights whether the rat begins to exercise at 25 days or at 200 days. He further concludes percentage of deviations are in proportion to exercise.

The effects of training on animals was discussed by Steinhaus (7) in 1933. He concluded that most literature in this area shows an increase in heart weight and also in the ratio of heart weight to body weight due to training.

In 1935, Donaldson (5) studied the influence of

prolonged rest following exercise on organ weights. In this study he exercised his rats for 90 days with controls, then placed some of the animals in sedentary cages for 125 days. Within this lapse of time the organ weights in the resting group returned to nearer the size of the control group. Donaldson explains this by saying that during the interval of rest the organs of this group were growing less rapidly than the organs of the control group. Donaldson also suggests that if this rest period had been extended the organs of the exercised group may have returned to the weight of the control group.

Macnab (8) in 1959 performed a study in which one phase was to determine the correlation between spontaneous activity and organ weights. He reported that heart weight was positively correlated with spontaneous activity. All other coefficients, of spontaneous activity with organ weights were insignificant.

CHAPTER III

EXPERIMENTAL METHOD

Design of the Experiment

This was a study to show the physiological effects on body organs of rats resulting from two different types of training. The various methods of training used were low intensity with high duration and high intensity with low duration. The control group used was kept completely sedentary and experienced no abnormal exercise, except for swimming them once a week with no additional weight added. Also, the control group was handled everyday and allowed normal life in their cages. Swimming once a week was done for the purpose of letting each animal get use to being handled by humans and to acquaint them to the water so that in the phases of the experiment in which this group was tested, these experiences would not be completely new to them.

The animals which were assigned to experimental group 2 were trained by the overdistance method. This group swam for a relatively extended period of time with a light amount of weight. For practical reasons, the time limit was set at one hour. The amount of weight used on each animal was

derived at by taking three per cent of his body weight and adding weight accordingly so that all the animals would have a relatively equal burden. This was used as a base and if the animal failed to reach the hour time limit, the weight was decreased by gradation of one-half per cent of the body weight. The same procedure in reverse was used for those animals which swam over the one hour time limit. This above procedure was done in an effort to keep most of the animals swimming near the time set to make an overdistance process present. The weight was added by applying lead sinkers strung on a piece of wire and held in place by waterproof adhesive tape wrapped around the animal's tail. A special effort was made to wrap the weight on the tail near the body and in approximately the same place on each animal. The procedure for swimming this group was performed by allowing the animal's to swim as a group in a large sink, being timed by means of a Kodak timer. Subjective judgement was used to determine whether an animal was able to swim for the entire sixty minute period. If certain animals were unable to do so they were removed from the water and their time recorded on the data sheets to the nearest whole minute that the animal swam. After the swimming period each animal was dried off to prevent colds or

other diseases from occurring and placed back in their respective cages.

The animals which were assigned to experimental group 1 were trained by the process of high intensity with low duration. These animals were required to swim for short periods of time with a larger amount of weight, than used on group 2. The procedure for swimming this group was done by allowing the animals to swim twenty repetitions or bouts of one minute each with a rest period of one minute in between each bout. The maximum number of bouts, for reasons of practicability, were limited to twenty. The weight was applied in the same manner as had previously been done to group 2. At first weight was added according to per cent of his body weight and then the weights were increased by one-half per cent, when and if the animal completed his twenty repetitions. Again the amount of weight was adjusted in order to try and have each animal come as close as possible to completing his twenty repetitions. Subjective judgement was used also in determining when the subjects would be removed from the water. If the animal was unable to complete the twenty repetitions he was removed from the water, the number of repetitions recorded on the data sheet and the animals were then dried as before

and put back into their respective cages. The times for this group were recorded as the number of complete repetitions which each animal swam unless it was within ten seconds of completing another repetition when it was removed from the water.

In order to make sure each animal was submerged into the water and removed from the water at the same time a wire basket was used which fit into the sink and could be raised or lowered by rope which was attached on each side of the basket. After each animal was weighed they were put as a group into the basket and lowered for each bout into the sink. The basket was made of porous light weight wire and fit snugly into the sink. The basket lowered deep enough as to not allow any extra support for the animals and the rope used for lowering and raising sank to the bottom. At the end of each bout the basket was raised by means of the rope to the level of the water and each animal was allowed to rest for one minute before the basket would be lowered to start his next bout. This procedure was repeated for the twenty repetitions or until each animal had been removed from the water.

Subjects and Equipment

The animals used as subjects in this experiment were of

the Sprague-Dawley strain. These male albino rats were all of the same age, but were not of the same litter. These animals were fifteen weeks old when they arrived at the laboratory and a period of three weeks was set aside before the actual experiment began. During this three week period these animals were handled each day and swam to assure that this would not be a new experience for them upon the beginning of the experimental period. The animals were also grouped and marked during the pre-experiment period. The grouping was done by using a table of random numbers. Each animal was subjectively given a number and then by the use of the table, randomly assigned to their respective groups. The marking was accomplished by using a series of holes, triangular cuts and red ink for which a code was set up. The holes were made by the use of a ordinary paper punch and the triangular cuts by the use of scissors. These marks of identification were placed in the ears of each animal. There was evidence of very little pain or bleeding resulting from this particular method. Further marks of identification included the use of a red ink placed on the tail of the animal to identify the particular group. The red ink mark was placed on the tail nearer the body for group E_1 and nearer the end of the tail for group E_2 . Group C_1 was free

from any marking on the tail. The markings on the ears remained clear throughout the entire experiment while the ink markings were redone several times to make clarity certain.

During the entire experiment the animals were housed in individual cages, measuring 10 inches long, 8 inches wide and 7 inches high. These cages were marked to correspond with the group and number of each subject to make sure the animals remained in his specific cage throughout the experiment. Each animal had his own water and food to assure that there would be no transferring of germs between the individual animals. The water was obtained from a bottle which hung inverted on the cage with a piece of bent metal tubing leading to the cage. The food consisted of Wayne Lab Blox. Special care was taken to assure each animal had an ample supply of food and water at all times.

During the actual experimental period the animals swam in a sink measuring 24 inches wide, 24 inches long and 18 inches high. An extension was added to raise the height of the sink to 27 inches in order to prevent the animals from scampering over the edge of the sink. The water in which these animals swam was maintained between 35 and 37 degrees Centigrade. The room temperature was kept at 80-3 degrees Fahrenheit. This was done to prevent the

animals from getting colds or pneumonia which would affect the results or cause a loss of animals.

The basket used for the repetition swimming of group 1 fit snugly into the sink. Several layers of tape ran along the outer edges to alleviate the problems of injury to the animals upon exit from the water. The material used for the basket was light weight wire mesh which allowed it to be maneuvered with ease. The times were recorded by the use of a Kodak timer and as the animals were removed from the water the time was recorded on a tally sheet concurrently, as the subjects were placed in numbered cages. Then as they were taken in order and dried in towels to prevent the chance of cold and pneumonia the time was checked on the tally sheet corresponding with the number as the animals had been taken out of the water. This data was then recorded on the data sheet.

The Testing Sessions

The experimental period lasted for twelve weeks with four specific testing sessions. These fell on the weekends of the weeks 3, 6, 9, and 12. The animals in the two experimental groups were trained every weekday with the exceptions of the testing days. On the testing days three animals from

each group were selected at random to be tested.

The testing sessions were divided into two specific phases. The first phase related to another study which was being done concurrently with mine. This phase consisted of an all out swim for each animal to measure their endurance in relation to the different training programs administered. The second phase of the testing sessions was the sacrifice of the animals and weighing of their organs. Before being sacrificed, the animals were anesthetized by placing them in an airtight container filled with ether. The animals were then shaved with an electric animal clipper to make the dissection easier and neater. Following this the animals were dissected and the organs to be weighed removed. The organs included the adrenals, liver, testes, spleen, kidneys and heart. The dissection was performed an experienced animal surgeon, who was amazingly skillful in performing this operation without injury to the organs. After the removal of the organs from the animals the organs were cleaned of any excess fatty tissue. Next the carcass was weighed both in and out of water to determine the specific gravity. After this process the organs were taken and weighed by the use of a Metter weighing device and recorded on the data sheets to the nearest hundredth gram.

CHAPTER IV

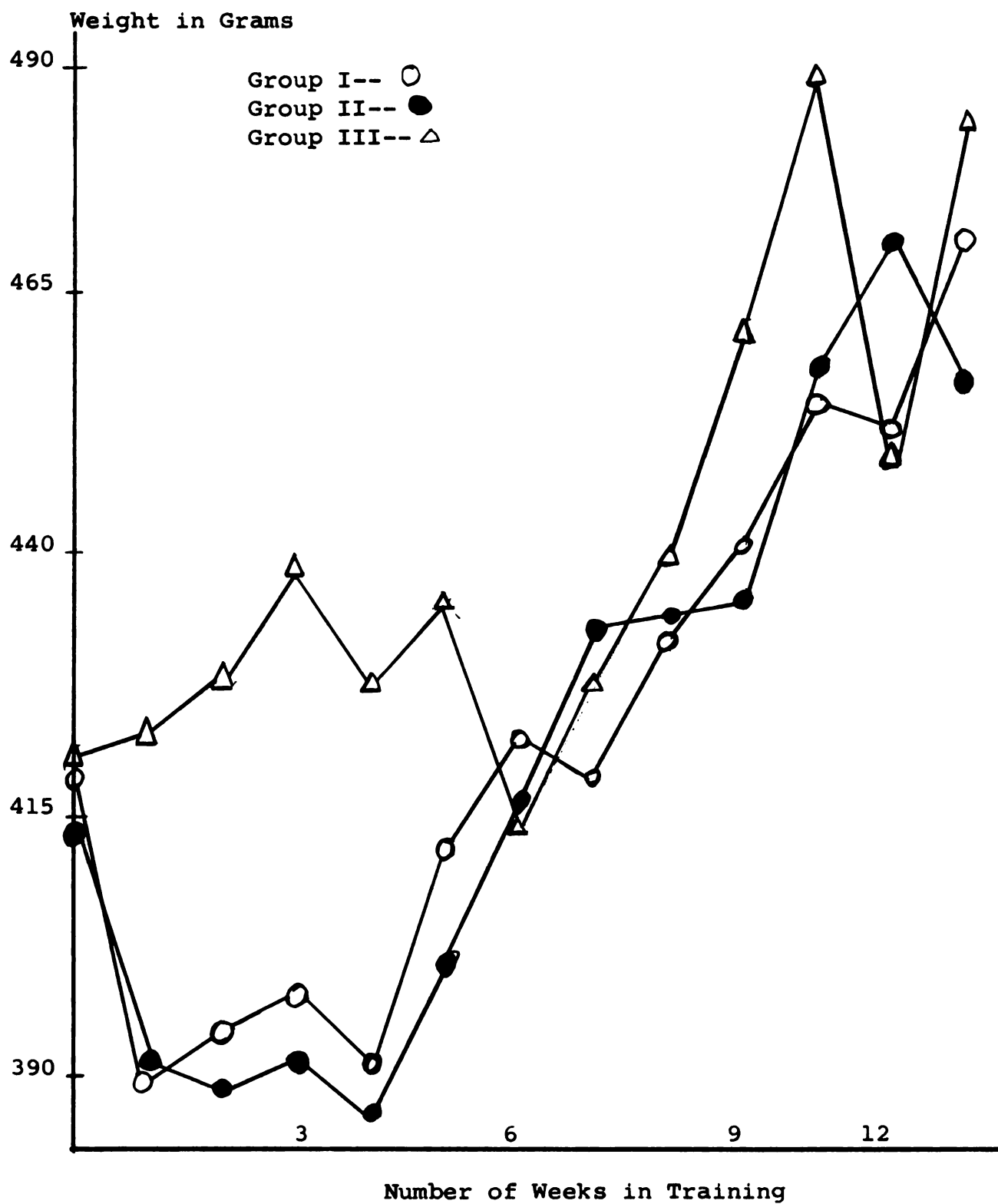
RESULTS

The objective of this study was to compare the effects on the organ weights of adult male rats, that two different types of training would bring about. Differing degrees of forced exercise was used on the training groups. The animals assigned to group 1 represent the underdistance method of training. Those animals in group 2 were trained by the overdistance method. The third group was the control group which were kept sedentary.

Results were taken by the collection of data at the end of the four testing periods. These four periods were the third, sixth, ninth and twelfth weeks. During each of these testing periods three animals from each group were sacrificed and their organs weighed. The results from these testing sessions are presented graphically and have been statistically analyzed using the variance technique. The level of significance accepted is the five per cent level.

Chart I representing weekly changes in average body weight shows, that at the beginning of the experiment as well as at the end, the average body weights of the three groups were very close. It is interesting to observe however,

Chart 1. Weekly Changes in Average Body Weight



that the two exercised groups lose weight for the first four weeks of the experiment while the sedentary group gains weight. By the sixth week all three groups are back to about their starting weights and thus proceed to gradually gain weight throughout the remainder of the experiment.

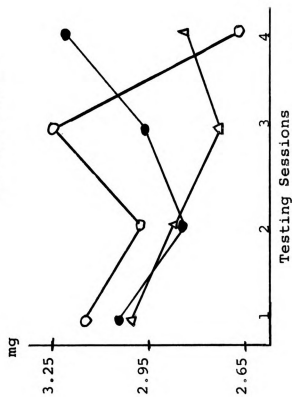
Chart 2 and Table I represent the data and results for the heart. The F ratios obtained were not statistically significant. No interpretation of the data is warranted.

The data and results for the adrenals are shown in Chart 3 and Table II. There is a significant decrease in the size of the adrenals across the testing periods. This decrease is much more prevalent in the training groups than in the sedentary group. The interaction is also significant but not interpretable between the training groups and testing periods.

Chart 4 and Table III show the data and results for the kidney. The F ratios obtained for the kidneys were not significant. No interpretation is warranted.

The data and results for the testes are illustrated in Chart 5 and Table IV. Significance was found for the testes as indicated by the F ratio for groups. While the testes for the underdistance and sedentary group decreased in size while the testes of the overdistance group remained relatively large.

Chart 2. Heart Weight Divided
by Body Weight



Group I --- ○
Group II --- ●
Group III --- △

Chart 3. Adrenal Weight Divided
by Body Weight

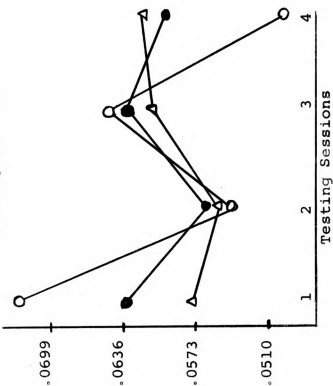
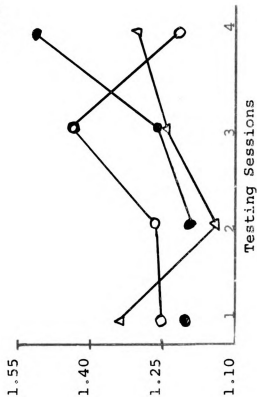
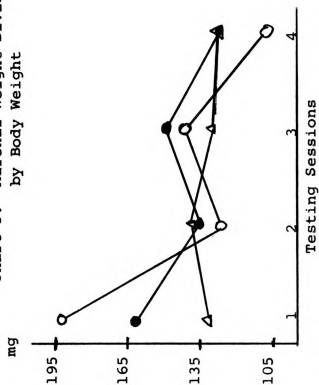


TABLE I

HEART WEIGHT DATA

Source of Variance	<u>Analysis of Variance</u>		$\bar{x}$ square	F
	Sum of Squares	df		
Groups	21.79	2	10.89	1.99
Test Period	21.71	3	7.23	1.32
Interaction	75.44	6	12.57	2.30
Within Groups	131	24	5.45	
Total	249.94	35		

TABLE II

ADRENAL WEIGHT DATA

Source of Variance	<u>Analysis of Variance</u>		$\bar{x}$ square	F
	Sum of Squares	df		
Groups	9.63	2	4.81	2.46
Test Period	85.60	3	28.53	14.63
Interaction	63.39	6	10.56	5.41
Within Groups	4700	24	1.95	
Total	205.62	35		

Chart 4. Spleen Weight Divided
by Body Weight

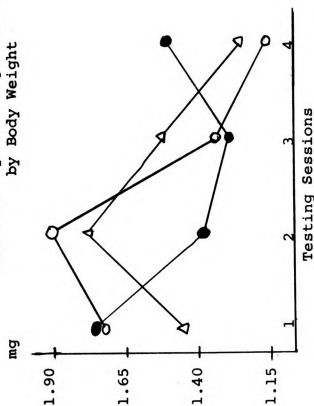


Chart 5. Liver Weight Divided
by Body Weight

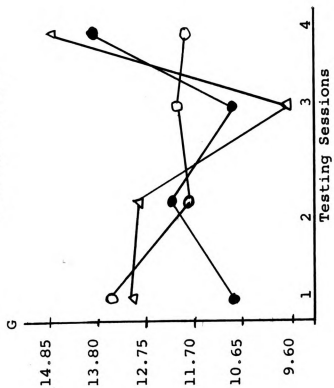
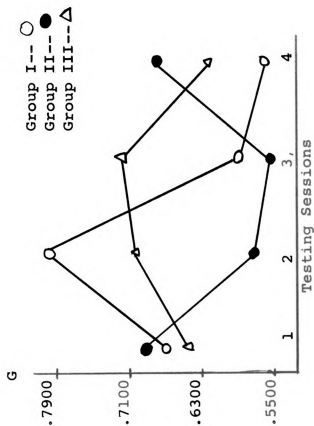
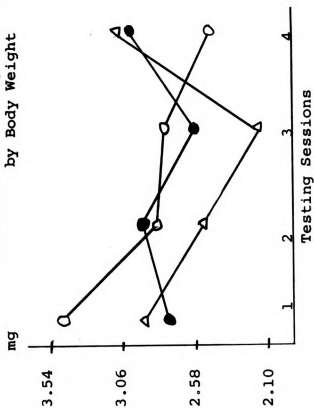


TABLE II
SPLEEN WEIGHT DATA

Source of Variance	<u>Analysis of Variance</u>		$\bar{x}$ square	F
	Sum of Square	df		
Groups	1.42	2	.7100	.0870
Test Period	91.65	2	30.55	3.74
Interaction	86.73	6	14.45	1.77
Between Groups	179.80	11	16.34	2.00
Within Groups	196.00	24	8.16	
Total	375.80			

TABLE III
LIVER WEIGHT DATA

Source of Variance	<u>Analysis of Variance</u>		$\bar{x}$ square	F
	Sum of Square	df		
Group	3.87	2	1.93	.1408
Test Period	161.30	3	53.76	3.92
Interaction	245.96	6	40.99	2.99
Between Groups	411.13	11	37.37	2.72
Within Groups	329.00	24	13.70	
Total	740.13			

Here again the data does not seem to follow any really interpretable pattern.

In Chart 6 and Table V significance can be found throughout the testing periods for the spleen. All three groups show a decrease in organ weight over the testing period. The most noticeable change occurred with the underdistance group.

As shown by Chart 7 and Table VI the liver weight decreased for all three until the final testing session. During this final testing session the organ weight increased for the overdistance and sedentary groups, while remaining lower for the underdistance group.

Chart 8 and Table VII shows a significant increase in specific gravity within the testing sessions.

Chart 6. Kidney Weight Divided
by Body Weight

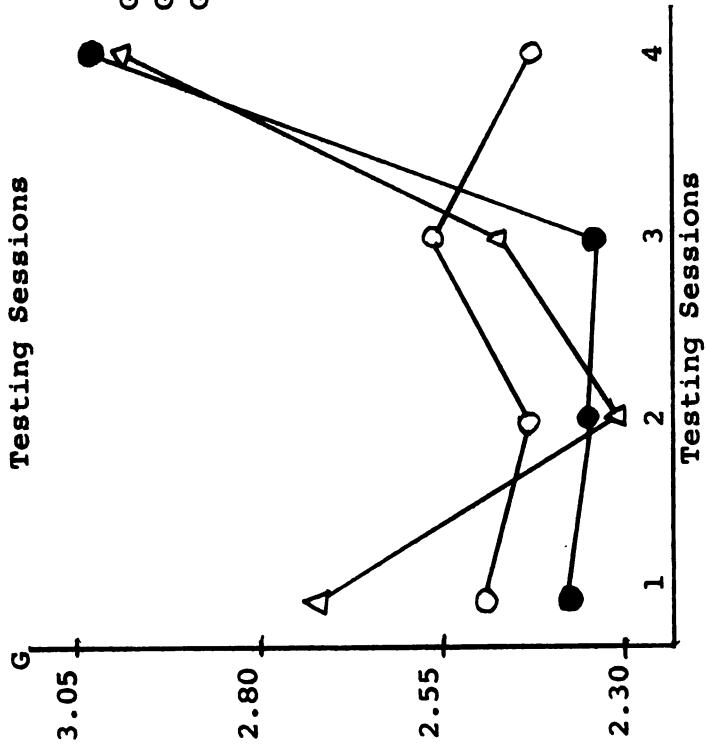
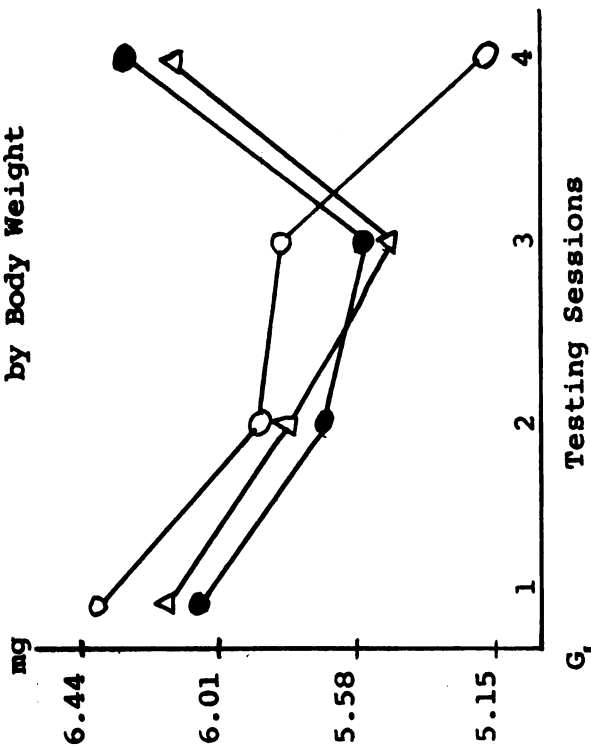


Chart 7. Teste Weight Divided
by Body Weight

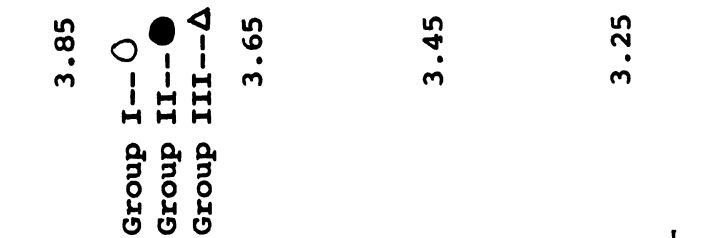
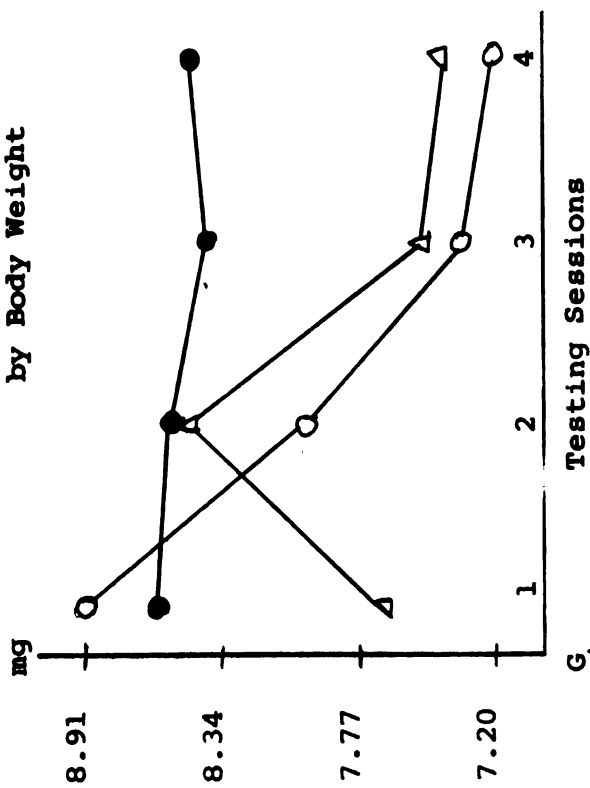


TABLE V

KIDNEY WEIGHT DATA

Source of Variance	<u>Analysis of Variance</u>			
	Sum of Square	df	$\bar{x}$ Square	F
Group	6.8	2	3.40	.1314
Test Period	169.8	3	56.60	2.18
Interaction	281.4	6	46.90	1.81
Between Groups	458	11	41.63	1.60
Within Groups	621	24	25.87	
Total	1079	N-1) 35		

TABLE VI

TESTE WEIGHT DATA

Source of Variance	<u>Analysis of Variance</u>			
	Sum of Square	df	$\bar{x}$ Square	F
Group	407.60	2	203.80	4.51*
Test Period	381.99	3	127.33	2.81
Interaction	413.57	6	68.92	1.52
Between Groups	1203.16	11	109.37	2.42
Within Groups	1084.00	24	45.16	
Total	2287.16			

*Remain Large

Chart 8. Body Weight

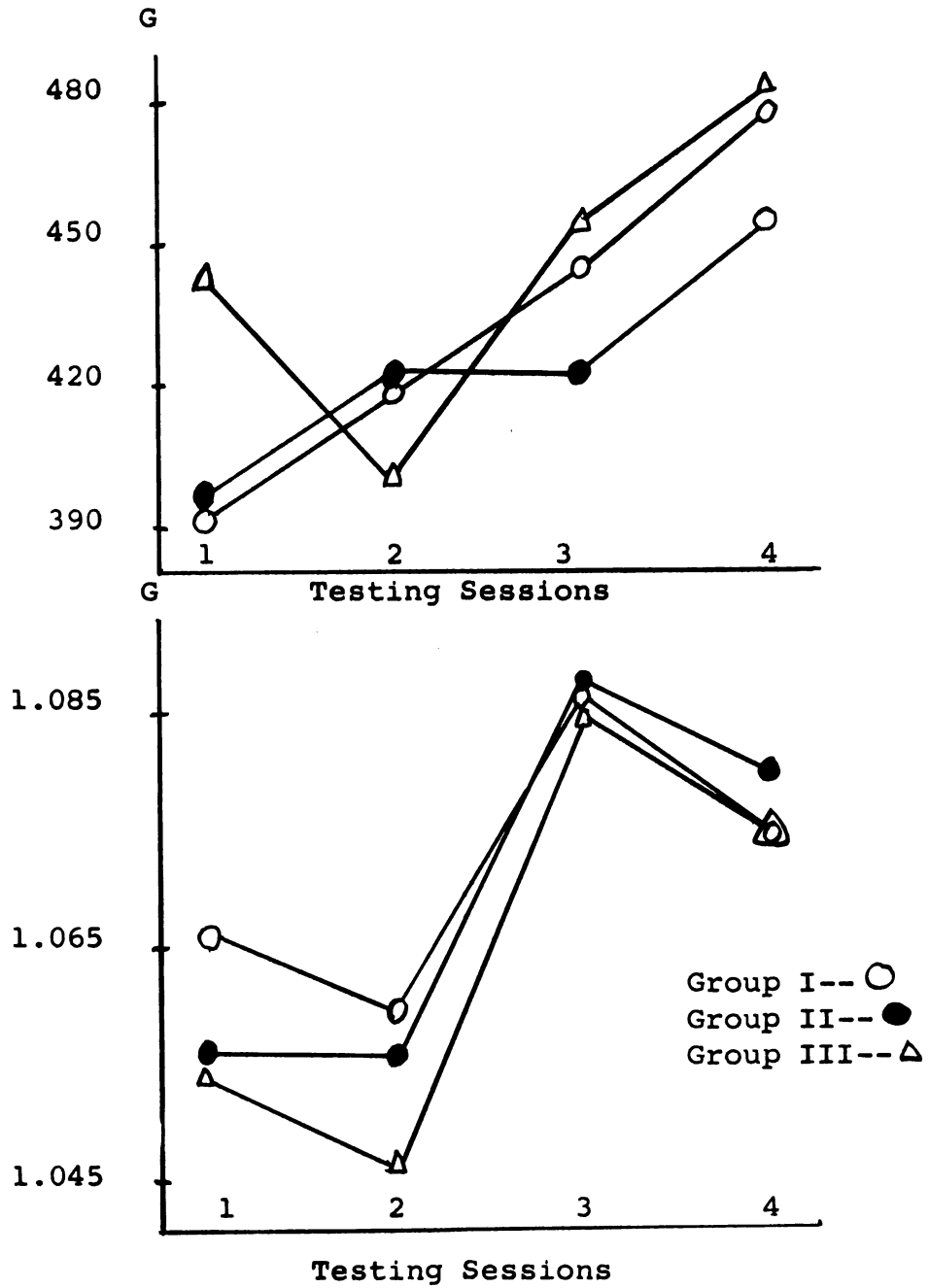


Chart 9. Specific Gravity

TABLE VII
SPECIFIC GRAVITY DATA

Source of Variation	<u>Analysis of Variance</u>			
	Sum of Square	df	$\bar{x}$ Squares	F
Group	.0002	2	1.00	1.52
Testing Period	.0064	3	21.33	23.23*
Interaction	.0001	6	.16	.24
Within Groups	Err .0016	24	.66	
Total	.0083	35		

*Remain Larger

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to determine the effect different types of training would produce on the organ weights of the adult male rat. This was accomplished by randomly dividing the thirty-six male albino rats into three groups of twelve each. Group 1 trained for low durations, high intensity (underdistance). Group 2 was the group trained for high duration, low intensity (overdistance). A third group was used as a control group. This group was sedentary throughout the experiment.

The animals in group 1 trained everyday with the exception of testing days. These animals swam for one minute and then rested for one minute with a high percentage of their body weight attached. Twenty repetitions represented a maximum workout. The animals in the overdistance group trained the same number of days, but swam constantly with a small percentage of their body weight attached to a maximum of one hour. The sedentary group received no special exercise, however they were allowed to become accustomed to the water.

Four testing sessions were assigned to the experimental design. These were on the third, sixth, ninth, and twelfth weeks. Three animals from each group randomly picked on these days and sacrificed. The organ weights of heart, adrenals, testes, kidneys, spleen, and liver were recorded along with specific gravity. These were then tested for statistical significance by means of analysis of variance.

Conclusions

Subject to the limitations previously presented and in light of the duration of the experiment the following conclusions have been drawn.

1. There was no difference in the results produced by training, compared to the sedentary group.

2. In every case the decrease in organ weight was more pronounced in the underdistance group than in the overdistance or sedentary group.

3. In general the effects seemed to be a decrease in organ weight. A decrease in organ size in regard to this study refers to organ weight. This does not eliminate the possibility that the actual size of the organ may have increased.

Recommendations

1. Although this study has not cleared up the confusion concerning the effects of exercise on organ weights, it is recommended that a similar study be repeated with a larger number of animals used.

2. A more realistic average could be obtained if more animals were used in each testing session. . Extremes would not affect the average as much with more animals being tested.

3. When dealing with organ weights, pathogen free animals should be used to prevent certain diseases which could cause the distortion of results.

4. It is recommended that animals be sacrificed before training starts to enhance the comparison of data.

5. It is also recommended that a longer training be used. This would help to make the effects of the experiment more pronounced and realistic.

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BIBLIOGRAPHY

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APPENDIX

TABLE VIII

INDIVIDUAL AND AVERAGE WEEKLY BODY WEIGHTS--GROUP I

Animal Number	<u>Date of Weighing</u>						
	3/2	3/9	3/16	3/23	3/30	4/6	4/13
1.	4865	428.0	431.5	447.5	462.0	450.0	440.0
2.	446.0	416.0	407.5				
3.	401.5	329.5					
4.	435.5						
5.	394.0	377.0	380.0	385.0	388.0	415.0	422.0
6.	421.0	393.5	394.5	398.0	355.5	432.0	415.0
7.	453.0	423.5	416.5	408.0			
8.	421.0	392.5	390.0	383.5			
9.	414.0	387.5	361.0	357.5	370.5	409.0	418.0
10.	449.0	407.5					
11.	400.5	367.0	369.5	379.0			
12.	394.0	386.0	390.0	395.5	412.4	420.0	410.0
13.	432.5	413.5	403.0	382.5	393.0	423.5	439.0
14.	365.0	360.0	377.5	401.0	384.5	375.0	385.5
15.	406.5	373.0	376.0	383.5	379.0	372.5	385.5
16.	413.5	414.0	415.5	421.5	383.5	390.0	424.0
17.	400.5	317.0	392.5	432.0	424.0	425.0	476.5
Ave.	418.7	389.9	393.3	397.5	392.1	411.7	423.6

Animal Number	<u>Date of Weighing</u>					
	4/10	4/17	5/4	5/11	5/18	5/25
1.	449.0	457.0	471.5			
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.	413.5	418.0				
13.	429.0	434.0	448.5	462.0	443.5	464.5
14.	389.0	401.5	412.0	436.0	419.5	442.0
15.	386.5	400.5	411.0	428.0	436.5	451.5
16.	414.5	429.0	445.5			
17.	461.0	473.5	487.0	492.0	501.5	513.5
Ave.	419.9	429.9	441.9	454.5	450.3	467.9

TABLE IX

INDIVIDUAL AND AVERAGE WEEKLY BODY WEIGHTS--GROUP II

Animal Number	<u>Date of Weighing</u>						
	3/2	3/9	3/16	3/23	3/30	4/6	4/13
1.	403.0	385.0	373.5				
2.	445.5						
3.	419.0						
4.	421.0	402.0	400.5	403.0	412.0	425.5	400.0
5.	423.5	395.5	390.0	379.5	355.5	374.5	399.5
6.	389.5	375.0	381.5	393.0	373.5	375.0	403.0
7.	429.0	395.0	397.0	407.5	356.0		
8.	415.0	400.0	387.0				
9.	416.0	398.0	376.5	370.0	381.5	408.5	408.5
10.	417.0	393.5	395.0	398.0	406.5	386.5	410.0
11.	438.5	400.5	404.5	402.0	400.0	418.0	440.0
12.	467.0	388.0	382.0	378.5	380.0	385.5	397.0
13.	448.5	409.5	411.0	422.5	408.0	422.5	451.0
14.	329.0	341.0	347.5	357.0			
15.	454.0	426.0	424.5	417.0			
16.	360.5	394.5	398.0	407.0			
17.	362.0	353.5	371.5	385.0	391.0	417.5	414.0
Ave.	414.0	390.7	389.1	393.6	385.5	402.2	416.6

TABLE IX (Continued)

INDIVIDUAL AND AVERAGE WEEKLEY BODY WEIGHTS--GROUP II

Animal Number	<u>Date of Weighing</u>					
	4/20	4/27	5/4	5/11	5/13	5/25
1.						
2.						
3.						
4.						
5.	435.5	426.0	421.5			
6.	414.0	408.5	402.5			
7.						
8.						
9.	440.5	441.0	442.5	451.0	454.5	458.0
10.	410.5	416.0	419.0	442.5	453.0	458.5
11.						
12.						
13.	447.5	458.0	474.5	482.5	497.5	451.0
14.						
15.						
16.						
17.	437.0	438.0	438.5			
Ave.	430.8	431.3	433.1	458.7	468.3	455.8

TABLE X

INDIVIDUAL AND AVERAGE WEEKLEY BODY WEIGHTS--GROUP III

Animal Number	<u>Date of Weighing</u>						
	3/2	3/9	3/16	3/23	3/30	4/6	4/13
1.	450.0	447.5	448.0	452.0	416.0	396.0	417.0
2.	252.5	319.0	337.5	368.0	355.5	369.5	369.5
3.	446.0	457.5	451.0	457.5	422.5	436.0	393.5
4.	451.0	460.0	461.0	464.5	425.0	416.5	399.0
5.	443.0	424.5	429.0	446.5			
6.	407.0	399.0	403.0	424.5	409.5	430.5	392.5
7.	414.5	401.5	411.0	426.5	433.5	442.5	405.0
8.	423.0	398.5	417.5	436.0	433.5	447.5	405.0
9.	453.5	425.5	431.0	444.5	410.5	448.5	406.5
10.	421.5	423.5	420.5	422.0			
11.	459.0	446.0	450.0	467.0	465.5	478.0	454.0
12.	441.0	450.0	457.5	461.5	462.5	481.5	456.0
13.	435.0	435.0	434.0	427.5	429.5	452.5	437.5
14.	450.0	434.0	447.0	460.0			
15.	412.0	432.0	437.0	448.0	455.0	473.0	442.0
16.	374.5	392.0	397.5	411.0	418.5	436.5	411.5
Ave.	420.8	421.6	427.0	438.6	425.9	436.3	414.5

TABLE X (Continued)

INDIVIDUAL AND AVERAGE WEEKLEY BODY WEIGHTS--GROUP III

Animal Number	<u>Date of Weighing</u>					
	4/20	4/27	5/4	5/11	5/18	5/25
1.						
2.						
3.	390.0	419.0	451.5			
4.	379.0	393.5	455.5			
5.						
6.	395.5	430.5	452.5			
7.	426.5	440.0	462.5	464.0	421.5	458.5
8.						
9.	415.0	437.0	451.5	463.0	401.5	466.0
10.						
11.	478.0	483.0	499.5	518.0	466.0	465.5
12.	485.0	492.5	512.0	522.0	467.0	517.5
13.	426.5	441.5	476.0	480.5	461.5	496.5
14.						
15.	443.0	327.5	387.0			
16.	414.5	437.5	476.0	490.0	453.5	491.0
Ave.	425.3	440.2	463.4	498.6	445.2	482.5

TABLE XI

FIRST TESTING SESSION

Group Number	Weight Live	Kidney	Heart	Adrenal	Spleen
1- 7	408	2.5716	1.3120	0.0746	0.6929
1- 8	383.5	2.5685	1.3128	0.0817	0.7489
1-11	379	2.3374	1.1200	0.0710	0.5723
2-14	357	2.2277	1.0071	0.0662	0.5496
2-15	417	2.4542	1.2811	0.0641	0.6505
2-16	407	2.4565	1.3055	0.0603	0.8722
3- 5	446.5	2.8045	1.2990	0.0532	0.5600
3-10	422	2.6920	1.2455	0.0577	0.6476
3-14	460	2.6918	1.4765	0.0627	0.7380

SECOND TESTING SESSION

Group Number	Weight Live	Kidney	Heart	Adrenal	Spleen
1- 5	422	2.2120	1.1583	0.0539	0.5429
1- 6	415	2.2994	1.2526	0.0507	1.1200
1- 9	418	2.8594	1.3562	0.0570	0.7323
2- 4	426.5	2.5854	1.2508	0.0598	0.6063
2-11	440	2.2432	1.2041	0.0510	0.5436
2-12	397	2.1600	1.1292	0.0587	0.5814
3- 1	417	2.6727	1.1113	0.0612	0.7471
3- 2	369.5	2.0529	1.0867	0.0530	0.7512
3- 8	406	2.2350	1.2102	0.0490	0.5985

TABLE XI (Continued)

FIRST TESTING SESSION

Group Number	Liver	Testes	Carcass Wt. In Air	Carcass Wt. In H ₂ O	Specific Gravity
1 -7	14.4310	3.4595	329.9	19.79	1.0638
1- 8	13.9640	3.5666	329.8	20.93	1.0677
1-11	17.4875	2.2768	323.1	16.37	1.0533
2-14	10.3493	3.0204	288.0	17.97	1.0665
2-15	11.3087	3.7296	344.8	15.57	1.0472
2-16	10.5679	2.8957	330.0	16.86	1.0538
3- 5	14.0439	3.1565	365.1	17.16	1.0493
3-10	12.2094	3.1785	340.8	15.61	1.0480
3-14	12.4990	3.8321	371.7	19.36	1.0549

SECOND TESTING SESSION

Group Number	Liver	Testes	Carcass Wt. In Air	Carcass Wt. In H ₂ O	Specific Gravity
1- 5	11.1546	3.4324	345.1	18.87	1.0578
1- 6	11.0488	3.0626	343.4	19.30	1.0595
1- 9	13.0669	3.5175	342.2	19.40	1.0600
2- 4	12.2488	3.8647	349.4	19.43	1.0588
2-11	12.3290	3.2058	368.0	18.08	1.0516
2-12	12.1215	3.6884	336.2	16.82	1.0526
3- 1	13.4202	3.2116	367.2	20.94	1.0604
3- 2	9.1083	3.3154	321.6	15.34	1.0500
3- 8	15.8424	3.1256	359.4	10.08	1.0288

TABLE XII

THIRD TESTING SESSION

Group Number	Weight Live	Kidney	Heart	Adrenals	Spleen
1- 1	471.5	2.3884	1.5438	0.0760	0.6055
1-12	418.0	2.6881	1.5461	0.0596	0.6137
1-16	445.5	2.6607	1.2389	0.0518	0.5511
2- 5	421.5	2.1850	1.2700	0.0604	0.5829
2- 6	402.5	2.3351	1.1835	0.0605	0.5429
2-17	438.5	2.4686	1.3103	0.0648	0.5213
3- 3	451.5	2.4842	1.3373	0.0622	0.5371
3- 4	455.5	2.3390	1.0954	0.0584	0.8057
3- 6	452.5	2.6578	1.2758	0.0567	0.7509

FOURTH TESTING SESSION

Group Number	Weight Live	Kidney	Heart	Adrenals	Spleen
1-13	464.5	2.5096	1.3299	0.0478	0.5384
1-15	451.5	2.1593	1.1628	0.0484	0.4347
1-17	513.5	2.6981	1.3074	0.0566	0.6872
2- 9	458.0	3.0456	1.4254	0.0655	0.7013
2-10	458.5	2.6905	1.3518	0.0489	0.6918
2-13	451.0	2.6075	1.6075	0.0588	0.6568
3- 9	466.0	3.2849	1.3263	0.0567	0.6214
3-11	465.5	2.9045	1.3633	0.0655	0.5562
3-12	517.5	2.6797	1.3838	0.0603	0.6818

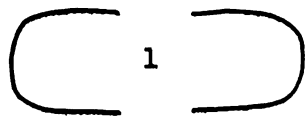
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THIRD TESTING SESSION

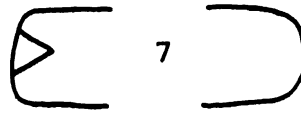
Group Number	Liver	Testes	Carcass Wt. In Air	Carcass In H ₂ O	Specific Gravity
1- 1	10.0351	3.4447	363.0	28.06	1.0838
1-12	15.0810	2.9961	343.0	28.81	1.0917
1-16	11.5875	3.3032	362.7	28.42	1.0850
2- 5	12.7216	2.4792	339.6	28.83	1.0928
2- 6	9.1580	3.6748	323.3	27.86	1.0943
7-17	10.7603	3.4393	345.6	24.28	1.0756
3- 3	9.3345	3.1526	344.8	27.96	1.0882
3- 4	9.5080	3.3407	349.2	27.76	1.0864
3- 6	10.0654	3.7802	360.0	25.55	1.0764

FOURTH TESTING SESSION

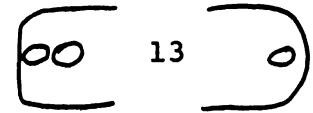
Group Number	Liver	Testes	Carcass Wt. In Air	Carcass In H ₂ O	Specific Gravity
1-13	12.8700	3.4016	378.4	26.89	1.0765
1-15	9.9974	3.3758	372.5	22.48	1.0811
1-17	12.7118	3.4989	425.4	24.18	1.0603
2- 9	14.3304	4.0803	374.0	27.58	1.0796
2-10	12.2777	3.6019	371.0	25.27	1.0731
2-13	14.9735	3.9349	385.5	29.52	1.0829
3- 9	15.2242	3.1536	380.0	29.55	1.0843
3-11	13.7000	3.7437	401.5	27.41	1.0732
3-12	15.4820	3.8432	415.3	23.57	1.0602



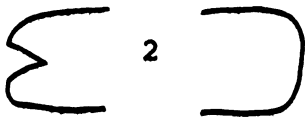
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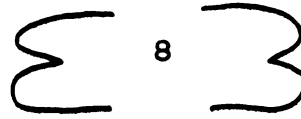
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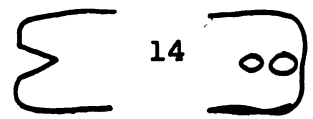
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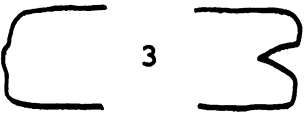
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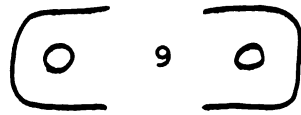
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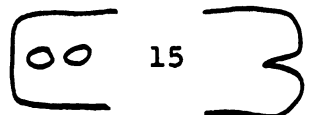
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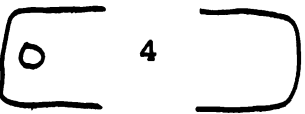
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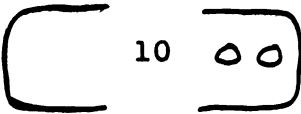
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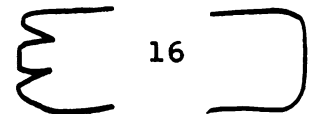
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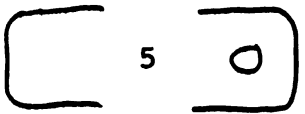
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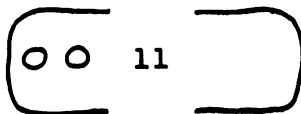
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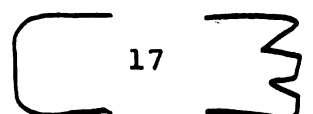
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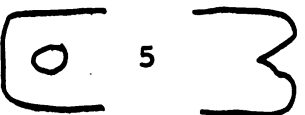
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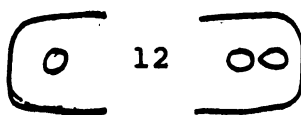
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12

Chart 10. Identifying Ear Markings

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