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BIOCHEMICAL STUDY OF LARGE PRIMATE RESPONSE TO SEVERE ENVIRONMENTAL STRESSORS

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FOREWORD

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Finally, appreciation is expressed for the valuable advice and support of Dr. Gregory Pincus.

ABSTRACT

Biochemical studies were conducted on immature chimpanzees undergoing 20 hours without food and water at temperatures of 70°, 80°, 90°, 95° and 100°F at 50 per cent humidity; acceleration-deceleration tests; and the suborbital flight of chimpanzee No. 65 (HAM). Twelve urine determinations and seven plasma determinations were obtained with the view of evaluating respiration (acid-base balance), nitrogen metabolism, adrenal-pituitary and sympathico-adrenal systems.

PUBLICATION REVIEW

This technical documentary report has been reviewed and is approved.

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CARE AND HANDLING OF THE SUBJECTS

The animals used in this study were handled in accordance with the "Principles of Laboratory Animal Care" established by the National Society for Medical Research.

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BIOCHEMICAL STUDY OF LARGE PRIMATE RESPONSE TO SEVERE ENVIRONMENTAL STRESSORS

I. INTRODUCTION AND PURPOSE

The environmental test program of the Air Force (Task 68921*, Project 6892) has as one of its principal objectives an investigation of the biochemical changes observed in the large primate in response to severe environmental stresses such as temperature, simulated conditions involving the parameters of acceleration and deceleration, as well as actual suborbital and orbital space flight. Urine and plasma were obtained from young immature chimpanzees under "thermally neutral" conditions to establish the range of normal values for this species for a number of indices considered relevant to adaptation to severe environmental stresses. Urine determinations consisted of urea nitrogen (N), uric acid, creatinine, glucose, sodium (Na), potassium (K), chloride (Cl), inorganic phosphorus (PO_4), 17-hydroxycorticosteroids (17-OHCS), 17-Ketosteroids (17-KS), epinephrine (E) and norepinephrine (NE). Plasma determinations consisted of urea nitrogen, glucose, chloride, sodium, 17-hydroxycorticosteroids, cholesterol, and lymphocyte counts (whole blood).

II. DESCRIPTION AND EXPERIMENTAL DESIGN

A. Temperature Humidity Test (THT)

The immature chimpanzee was subjected to stresses involving sitting at temperatures of 70° and 80°F ("thermally neutral"); 85°, 90°, 95°, 100°F ("thermally stressful") with 50 percent relative humidity without food and water for a period of 20 hours. The apparatus and procedure used for conducting these tests have been previously described (Ref. 1, 2, 3).

Chimpanzees 2 to 4-1/2 years of age (four females and one male) had previous restraint adaptation histories of 34 hours to over 1600 hours. Following pretest physical examination, sensors were attached to the subjects for recording respiration rate, electrocardiogram, skin and rectal temperatures. The subject was then restrained in a vest and chair in an environmental test chamber providing controls of temperature, airflow and relative humidity.

B. Acceleration-Deceleration Experiments (AD) Simulating Launch and Re-entry Conditions (Ref. 4)

The acceleration-deceleration (AD) experiments were devised to simulate Atlas booster launch acceleration, and the

*Task 68921 has since been changed to 689202.

abrupt deceleration of water impact on landing of the Project Mercury capsule. Launch acceleration and abrupt deceleration was performed on the same day with a 4-hour programmed delay between the accelerations.

The simulated launch was performed on the Holloman High Speed Track (Ref. 5) by using a low acceleration thrust to obtain sufficient velocity for entrance into two water brakes where the simulated launch acceleration occurred. Abrupt deceleration was performed on the Daisy Decelerator (Ref. 6). The experimental subjects were always sitting upright (backward facing) during exposure to acceleration loads. Acceleration was measured on the sled and on the chest of the subjects in three orthogonal axes. The g axis loading on the subjects as shown in Figures 1 and 2 is as follows: X is from chest to back, Y is lateral movement, and Z is vertical movement.

1. Acceleration-Deceleration Experiment (AD-1, 6 Aug 1960, Subject No. 42):

HHST sled velocity was 417 feet/second upon entrance into the water brakes. Maximum sled acceleration during the thrust phase was 2.55 g and maximum sled deceleration during braking was 3.52 g. The total acceleration lasted 12.7 seconds. Data dropouts from the telemetry records prevented determination of the g level received by the subject.

Daisy Decelerator brake entrance velocity was 28.5 feet/second. The sled reached a peak of 21.37 g with a 1196 g/second rate of onset. Subject acceleration as measured on the chest in three orthogonal axes is shown in Figure 1.

2. Acceleration-Deceleration Experiment (AD-2, 26 Oct 1960, Subject No. 35):

HHST water brake entrance velocity was 480 feet/second. Maximum sled acceleration during the thrust phase was 3.14 g and maximum sled deceleration was 7.02 g. The total acceleration lasted 10.2 seconds. Thrust acceleration on the subject was estimated to be 4 g and maximum acceleration to the subject's chest in the brake area was estimated to be 14 g. Data dropouts prevented an accurate analysis of the g loads during the HHST run.

Daisy Decelerator brake entrance velocity was 36.0 feet/second. The sled reached a peak of 50.60 g with a 12,427 g/second rate of onset. Subject acceleration as measured on the chest in three orthogonal axes is shown in Figure 2.

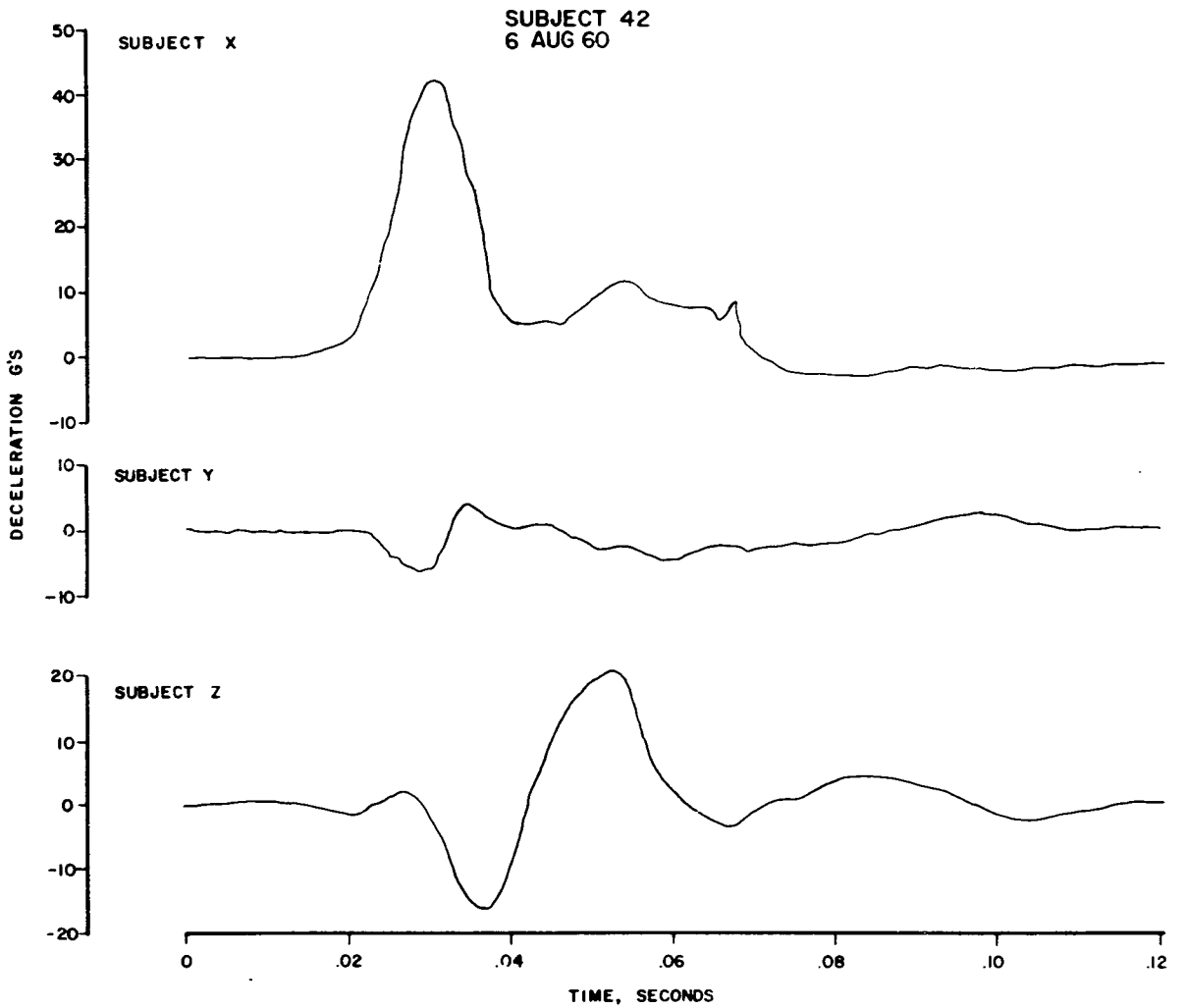

FIGURE 1. SUBJECT ACCELERATION AS MEASURED ON THE CHEST IN THREE ORTHOGONAL AXES

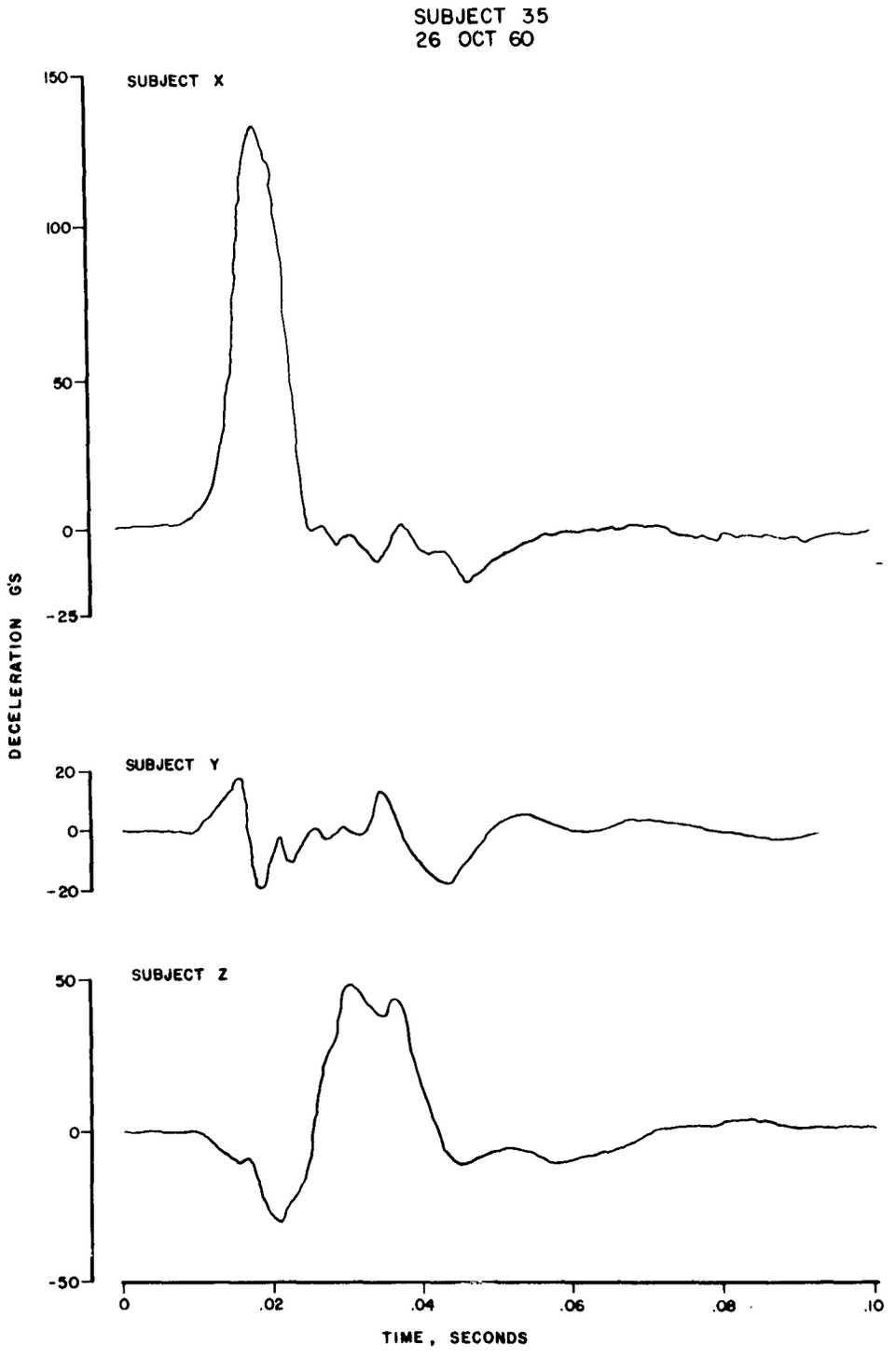

FIGURE 2. SUBJECT ACCELERATION AS MEASURED ON THE CHEST IN THREE ORTHOGONAL AXES

C. Suborbital Flight of Chimpanzee No. 65 (HAM)

Each experiment was carried out over a 5-day period, with blood sample No. 1 collected on the morning of the first day (control), sample No. 2 collected immediately after termination of the stress, which took place on the second day, and sample No. 3 collected 48 hours after termination of the stress test. Urine collections were scheduled so that there were two collections for each day: the first sample from 0730 to 1600 (day), and the second sample from 1600 to 0730 (night) the following day, and so on for a total of 10 samples.

Acceleration-deceleration experiments one and two, as well as the suborbital flight of chimpanzee No. 65 (HAM), were scheduled in a similar manner as that for temperature humidity tests (data in Appendix I).

The same schedule in urine and plasma collection as described above was carried out on mature chimpanzees (data in Appendix II) except for chimpanzee No. 3 (VICKIE) where urine was collected for 24-hour periods for 5 days.

III. METHODS

Urine was collected in metabolism cages (sometimes contaminated with faeces) into plastic bottles containing a crystal of thymol as preservative and frozen in dry ice. The blood samples were immediately centrifuged and the plasma obtained was frozen in suitable tubes in a similar manner. The frozen urine and plasma samples were kept in a freezer at Holloman Air Force Base for periods up to six months and then shipped in dry ice via air freight to Worcester, Massachusetts. The shipments were scheduled so that two complete THT (a total of 20 urine samples and 6 plasma samples) were received for processing at the laboratories of the Worcester Foundation for Experimental Biology every two weeks. The samples were allowed to thaw and after ascertaining that all solids (urine samples) were in solution and all foreign material removed--the appropriate aliquots were taken for each of the biochemical determinations.

The following methods were used for biochemical measurements: urea nitrogen, Barker 1944 (Ref. 7); uric acid, Folin 1933 (Ref. 8); creatinine, Folin 1914 (Ref. 9); glucose, Green and Wade 1952 (Ref. 10); phosphate, Fiske and Subbarow 1925 (Ref. 11); chloride, Schales and Schales 1941 (Ref. 12); sodium and potassium, flame photometry (Perkin-Elmer) (Ref. 13);

17-hydroxycorticosteroids, Pincus 1945 (Ref. 14); epinephrine and norepinephrine, von Euler and Lishajko 1959 (Ref. 15); cholesterol, Kingsley and Schaffert 1949 (Ref. 16).

All urinary excretion data presented on immature chimpanzees are expressed in terms of 20 mg. creatinine which was found to be useful in estimating hourly excretion rates. Urinary excretion data on mature chimpanzees are expressed in terms of 50 mg. creatinine which was equivalent to hourly excretion (Appendix III).

IV. RESULTS

A. Control Biochemical Values in the Immature Chimpanzee

Urinary control values were divided into two samples: sample 1, representing a day period, and sample 2, night. In Table I the values obtained on biochemical measures in the control urine samples indicate significant differences in day and night values for the following: chloride, sodium, potassium, 17-hydroxycorticosteroids, and 17-ketosteroids. The data also are comparable to that of the preadolescent human except for the unexpected low values in inorganic phosphate. The control plasma values are presented in Table II. Aside from the elevated values for plasma sodium, the data are consistent with those found in preadolescent humans. Normal values were reported in another study (Ref. 17).

It should be pointed out that the plasma 17-hydroxycorticosteroids (17-OHCS) and glucose values are certainly not basal. The large standard error observed for glucose as well as that for 17-OHCS will be discussed later in this presentation. Data of plasma cholesterol indicated marked inter-individual variation at a minimum; this indicates a characteristic value range for each animal studied.

Some additional data on five mature chimpanzees are presented in Appendix II. Though the data are rather incomplete, the values are in general comparable to those found in the adult human.

TABLE I

CONTROL VALUES

URINE

Biochemical Measure*	Sample 1			Sample 2		
	N	Mean	SE	N	Mean	SE
Urea N mg	23	178 ±	14.1	27	201 ±	15.5
Uric Acid mg	23	14.9 ±	0.94	26	17.1 ±	2.30
Glucose mg	22	32.1 ±	4.40	26	28.3 ±	2.20
Inorganic Phosphate mg	22	0.81±	.267	27	1.09±	.290
Chloride mEq	23	1.51±	.170	26	0.88±	.065
Sodium mEq	23	1.13±	.15	26	.70±	.08
Potassium mEq	23	1.50±	.168	26	1.07±	.08
Na/K	23	.83±	.102	26	.65±	.076
17-OHCS mcg	20	.16±	.028	23	.10±	.017
17-KS mg	9	.23±	.030	12	.13±	.013
Epinephrine mcg	5	.82±	.148	5	.65±	.170
Norepinephrine mcg	5	.83±	.518	5	1.98±	1.66

*20 mg. creatinine ☁ 1 hr. excretion

TABLE II

CONTROL VALUES - PLASMA

	Sample		
Biochemical Measure	N	Mean	SE
Urea N mg%	25	17.9 ±	1.49
Chloride mEq/L	13	108 ±	1.9
Sodium mEq/L	15	154 ±	2.4
Cholesterol mg%	21	246 ±	11.6
17-OHCS mcg%	22	26.8 ±	2.84
Glucose mg%	7	96 ±	14.0
Lymphocyte cu.mm.	38	6187 ±	285

B. Experimental Data

In Tables III and IV, respectively, the chloride data of plasma and urine are presented. No significant increases are observed in blood sample 2 which was obtained immediately after the experimental period in THT carried out in 70° and 80°F. Under "thermally stressful" conditions we observe a marked elevation in plasma chlorides from a control value of 108 ± 1.89 to 119 ± 1.77. In sample 3 which was taken 48 hours after termination of the test, we observed a return to control values. Urinary chloride values reached a low of .28 ± .043. The return to normal values occurs immediately in the "thermally neutral" condition of 80°F; under "thermally stressful" conditions of 85° and 90°F we first observe a slower return to normal values, and then we can see that in 90°F conditions there is an inability to maintain the normal values reached in samples 7 and 8 with significant declines in urinary chloride excretion observed in samples 9 and 10.

TABLE III

PLASMA CHLORIDE
mEq/L

Sample 1		108 ± 1.89 (13)
Sample 2	*	110 ± 2.99 (7)
	**	119 ± 1.77 (9)
Sample 3		107 ± 2.25 (11)

*70 - 80°F
**85, 90, 95, 100°F.

TABLE IV

CHLORIDE mEq*

URINE

SAMPLE NO.	CONTROL		
1	1.51 ± .17 (23)		
2	.88 ± .065 (26)		
	80°F.	85°F.	90°F.
3	1.39 ± .167 (4)	1.35 ± .451 (4)	1.44 ± .483 (3)
4	1.40 ± .244 (4)	.58 ± .19 (4)	.59 ± .137 (3)
5	.79 ± .044 (6)	.75 ± .36 (4)	.28 ± .043 (3)
6	1.14 ± .322 (8)	.92 ± .408 (5)	.79 ± .248 (4)
7	1.63 ± .419 (7)	.52 ± .17 (4)	1.69 ± .305 (4)
8	1.60 ± .275 (6)	1.66 ± .363 (4)	1.03 ± .315 (4)
9	2.52 ± .56 (8)	1.74 ± .240	.83 ± .292 (4)
10	1.51 ± .29 (7)	---	.67 ± .291 (4)

*20 mg. creatinine = 1 hr. excretion.

N = ( )

The data of the urinary sodium are presented in Table V. Under conditions of 80°F there is a slight trend toward decrease in urinary sodium excretion. Marked retention of sodium is observed under increasing temperature conditions: a minimum of .16 ± .07 is reached in sample 4 under 85°F conditions with a return toward normal values in samples 5 and 6. Under 90°F conditions, however, the severe retention of sodium reached in sample 4 of .16 ± .08 is sustained in sample 5 with a value of .15 ± .087. There is a slower return to normal values by samples 7 and 8 than under conditions observed in 85°F experiments. It should again be noted that under the "thermally stressful" conditions the urinary sodium excretion values are not sustained at control levels; this is similar to the data observed in the urinary chloride excretion. The plasma sodium data were highly variable and will be discussed later.

Unlike the results observed in urinary chlorides and sodium, the data of urinary potassium show no significant changes during the experimental period (Table VI). It should be noted that individual experiments showed increases of potassium during the experimental period. In view of the fact that the chimpanzees were without food and water during a 20-hour period, a negative potassium balance is indicated. The Na/K ratio data in Table VII presents the events occurring during the "thermally neutral" conditions of 80°F as compared to the "thermally stressful" undergone in 85°F and 90°F conditions. It should again be noted that under severe temperature conditions undergone in 90°F there is an inability of the chimpanzee to maintain the normal Na/K ratios attained in samples 6 through 8, inclusive, at the end of the experiment in samples 9 and 10.

The urine inorganic phosphate data in Table VIII indicates elevations in samples 5 and 6 in the thermally neutral conditions observed at 80°F. The samples represent the period immediately after termination of the 20-hour period when the chimpanzee was under a restrained condition without food and water. The elevations in inorganic phosphate are observed with same sample under 85°F and 90°F during the same period, except for the elevated phosphate excretion values observed under the severe environmental conditions undergone in 90°F where sample 4 shows a marked increase in inorganic phosphate. It is of interest that the inorganic phosphate data under conditions observed in 90°F do not return towards normal values even by the end of the experiment. In 85°F conditions, the results indicate a decrease in the urinary inorganic phosphate to normal values by the ninth and tenth samples.

TABLE V

SODIUM mEq*

URINE

SAMPLE NO.	CONTROL		
1	1.13 ± .15 (23)		
2	.70 ± .08 (26)		
	80°F	85°F	90°F
3	.56 ± .261 (4)	.73 ± .595 (4)	.43 ± .201 (3)
4	.68 ± .208 (4)	.16 ± .07 (4)	.16 ± .08 (3)
5	.50 ± .168 (6)	.88 ± .352 (5)	.15 ± .087 (3)
6	1.06 ± .259 (7)	.91 ± .368 (5)	.69 ± .327 (4)
7	1.49 ± .363 (7)	.87 ± .207 (5)	.89 ± .34 (4)
8	.94 ± .143 (6)	1.17 ± .241 (5)	.76 ± .255 (3)
9	1.25 ± .27 (8)	1.92 ± .504 (5)	.92 ± .271 (4)
10	.81 ± .118 (6)	.55 ± .156 (3)	.43 ± .188 (3)

*20 mg. creatinine $\cong$ 1 hr. excretion.

N = ( )

TABLE VI

POTASSIUM mEq*

URINE

SAMPLE NO.	CONTROL		
1	1.50 ± .168 (23)		
2	1.07 ± .08 (26)		
	80°F	85°F	90°F
3	.77 ± .141 (4)	.58 ± .309 (4)	.73 ± .306 (3)
4	1.35 ± .230 (4)	.94 ± .373 (4)	2.44 ± .886 (3)
5	.79 ± .205 (6)	.96 ± .181 (5)	1.05 ± .152 (3)
6	1.29 ± .160 (8)	.96 ± .160 (5)	1.16 ± .317 (4)
7	1.06 ± .183 (7)	.94 ± .287 (4)	1.19 ± .181 (4)
8	1.07 ± .104 (6)	.83 ± .160 (5)	1.03 ± .353 (3)
9	1.71 ± .232 (8)	1.41 ± .254 (5)	1.39 ± .318 (4)
10	1.04 ± .418 (6)	.60 ± .058 (3)	.86 ± .203 (3)

*20 mg. creatinine ≈ 1 hr. excretion.

N = ( )

TABLE VII

SODIUM/POTASSIUM

URINE

SAMPLE NO.	CONTROL		
1	.83 ± .102 (23)		
2	.65 ± .076 (26)		
	80°F	85°F	90°F
3	.96 ± .614 (4)	.70 ± .341 (4)	.43 ± .185 (3)
4	.51 ± .146 (4)	.22 ± .113 (4)	.06 ± .01 (3)
5	.82 ± .355 (6)	1.05 ± .500 (5)	.19 ± .03 (2)
6	.79 ± .177 (7)	.85 ± .291 (5)	1.19 ± .465 (3)
7	1.38 ± .27 (7)	.98 ± .451 (4)	.74 ± .205 (4)
8	.91 ± .147 (6)	1.36 ± .117 (5)	1.20 ± .263 (4)
9	.81 ± .195 (8)	1.30 ± .189 (5)	.60 ± .096 (4)
10	1.22 ± .342 (6)	.89 ± .188 (3)	.46 ± .089 (3)

N = ( )

TABLE VIII

INORGANIC PHOSPHATE mg.*

URINE

SAMPLE NO.	CONTROL		
1	.81 ± .267 (22)		
2	1.09 ± .290 (27)		
	80°F	85°F	90°F
3	2.06 ± 1.81 (5)	1.24 ± .76 (4)	.93 ± .438 (3)
4	1.11 ± .665 (4)	.89 ± .394 (3)	4.40 ± 1.34 (3)
5	4.39 ± 2.14 (6)	3.80 ± .996 (5)	9.42 ± 4.55 (3)
6	5.17 ± 2.07 (8)	6.44 ± 1.87 (5)	6.17 ± 1.45 (4)
7	.55 ± .103 (7)	3.23 ± .788 (5)	1.37 ± .76 (4)
8	.73 ± .327 (6)	3.04 ± 1.94 (5)	2.34 ± .82 (4)
9	.91 ± .40 (8)	1.22 ± .475 (5)	2.10 ± .45 (4)
10	.44 ± .109 (7)	.61 (2)	3.96 ± 1.35 (4)

*20 mg. creatinine ≃ 1 hr. excretion.

N = ( )

Urine urea nitrogen excretion data are presented in Table IX. No significant increases are observed in the excretion of urea nitrogen under the conditions observed in the temperature humidity tests. Individual values were observed which clearly indicated protein catabolism. The plasma urea nitrogen results were somewhat erratic (see Appendix I) and will be discussed later.

Increases in uric acid excretion were observed in a similar pattern to that noted in inorganic phosphate excretion (Table X). Elevations in uric acid excretion are observed in samples 6 and 7 under "thermally neutral" conditions of 80°F. The elevations are also present in 85°F and 90°F conditions, except that an increase in uric acid is observed in sample 4 under the severe conditions undergone in temperature humidity tests of 90°F. There is a return to normal levels under all three temperature humidity test conditions by sample 10.

Urinary glucose excretion presented in Table XI indicates a significant decrease in sample 4 in experimental conditions observed in 80°F and 85°F. There is a return to normal values immediately after termination of the fasting period. It is of interest to point out that in the "thermally stressful" conditions of 85°F and 90°F lower levels of glucose excretion are observed in sample 3 when compared with data on the same sample noted in 80°F conditions. It should also be pointed out that glycosuria was not present under the most severe environmental conditions. The plasma glucose data in Table XII show varying degrees of hyperglycemia in experimental conditions.

Epinephrine and norepinephrine excretion data are presented in Table XIII. General conclusions based on the limited data cannot be made. It is of interest that varying increases in epinephrine excretion are noted such as in THT No. 17, animal No. 42, undergoing 90°F conditions in samples 3 and 4, with a return to normal values by the end of the experiment as seen in samples 9 and 10. These data will be taken up during the discussion under the heading of sympathico-adrenal system.

Table XIV contains the 17-hydroxycorticosteroids excretion values. Increases, though slight, are observed during the experimental period under all three conditions, 80°F, 85°F and 90°F. The significance of these increases may be questionable. Individual chimpanzees showed marked elevations in 17-OHCS values during the experimental period. In view of the

TABLE IX

UREA N mg.*

URINE

SAMPLE NO.	CONTROL		
1	178 ± 14.1 (23)		
2	201 ± 15.5 (27)		
	80°F	85°F	90°F
3	162 ± 32.1 (5)	184 ± 16.9 (4)	161 ± 10.2 (3)
4	218 ± 44.7 (4)	242 ± 45.0 (4)	457 ± 171.2 (3)
5	202 ± 38.2 (6)	157 ± 30.0 (5)	230 ± 13.8 (3)
6	189 ± 81.0 (8)	152 ± 34.0 (5)	295 ± 68.8 (4)
7	149 ± 11.1 (5)	131 ± 20.6 (5)	178 ± 42.0 (4)
8	169 ± 33.5 (6)	137 ± 28.7 (5)	148 ±40.3 (4)
9	169 ± 34.1 (8)	172 ±38.9 (5)	237 ± 40.7 (4)
10	147 ± 23.5 (7)	172 ± 27.5 (3)	227 ± 34.8 (4)

*20 mg. creatinine ≅ 1 hr. excretion.

N = ( )

TABLE X

URIC ACID mg.*

URINE

SAMPLE NO.	CONTROL		
1	14.9 ± .94 (23)		
2	17.1 ± 2.3 (26)		
	80°F	85°F	90°F
3	17.0 ± 1.62 (5)	14.6 ± 2.4 (4)	13.0 ± 3.7 (3)
4	18.0 ± 2.60 (4)	16.2 ± 4.85 (4)	33.5 ± 12.5 (3)
5	15.4 ± 1.98 (5)	20.7 ± 2.02 (5)	20.1 ± 5.2 (3)
6	20.6 ± 3.26 (8)	21.4 ± 2.10 (5)	25.9 ± 5.6 (4)
7	24.0 ± 5.17 (5)	35.2 ± 5.5 (5)	15.5 ± .84 (4)
8	18.2 ± 4.41 (6)	15.3 ± 2.9 (5)	9.9 ± 1.8 (4)
9	16.5 ± 2.29 (8)	23.1 ± 7.4 (4)	14.9 ± 1.8 (4)
10	14.8 ± 2.17 (7)	18.0 ± 4.5 (3)	9.8 ± 1.3 (4)

*20 mg. creatinine $\tilde{=}$ 1 hr. excretion.

N = ( )

TABLE XI

GLUCOSE mg.*

URINE

SAMPLE NO.	CONTROL		
1	32.1 ± 4.4 (22)		
2	28.3 ± 2.3 (26)		
	80°F	85°F	90°F
3	31.4 ± 7.7 (4)	16.7 ± 3.4 (4)	17.0 ± 5.24 (3)
4	17.8 ± 1.94 (4)	13.1 ± 1.61 (3)	26.5 ± .72 (3)
5	35.5 ± 12.8 (6)	16.5 ± 4.46 (5)	27.4 ± 6.08 (3)
6	39.3 ± 9.04 (8)	35.6 ± 9.81 (5)	35.2 ± 5.2 (4)
7	29.5 ± 7.45 (5)	21.9 ± 2.71 (5)	14.0 ± 2.26 (4)
8	30.7 ± 5.74 (6)	27.3 ± 3.8 (5)	9.0 ± (2)
9	36.5 ± 4.46 (8)	30.1 ± 11.09 (5)	17.7 ± 4.98 (4)
10	30.0 ± 6.3 (7)	21.5 ± 4.8 (3)	14.4 ± 2.63 (4)

*20 mg. creatinine $\tilde{=}$ 1 hr. excretion.

N = ( )

TABLE XII

PLASMA GLUCOSE mg%

THT	Animal No.	Temp. F	Sample Number 1	2	3
16	49	80	---	142	---
17	42	90	---	115	---
18	35	90	58	71	67
19	50	95	---	---	120
19	41	95	89	97	123
23	41	100	62	107	55
23	50	100	66	88	---
24	46	100	130	145	188
24	35	100	---	125	143
25	49	100	121	103	155
25	50	100	147	123	92
AD-1	42		93	125	---
AD-2	35		134	92	150
MR-2	65		150	181	148

TABLE XIII

EPINEPHRINE AND NOREPINEPHRINE EXCRETIONS*

THT	ANIMAL NO.	TEMP. F		SAMPLE NO. 1	2	3	4	5	6	7	8	9	10
11	42	85	E	1.02	.28	.60	1.27	.69	.63	.96	.63	.19	.15
			NE	.26	.19	.40	.43	---	.18	1.15	.44	.27	.20
17	42	90	E	.60	1.24	4.90	1.90	1.10	1.14	1.00	.79	1.10	.39
			NE	.69	.92	1.06	.80	.10	.10	5.90	.42	1.28	.10
18	35	90	E	.40	.34	.33	.14	---	.34	.80	.40	.28	.56
			NE	.25	.13	.10	.74	---	.66	2.26	.39	.20	.10
18	50	90	E	1.24	.95	---	---	.42	2.36	1.42	2.20	1.18	.47
			NE	.10	.10	---	---	.10	---	1.34	.18	.24	.10
AD-1	42		E	.75	.43	3.08	.52	2.49	.37	1.38	.70	.76	.13
			NE	.25	.16	.46	2.20	4.98	.22	4.48	.42	2.17	.13
MR-2	65		E	.27	.17	.90	---	---	.14	.23	.34	.48	.38
			NE	.17	.10	.70	---	---	.24	.13	.17	.10	.42

*mcg./20 mg. creatinine

TABLE XIV

17-OHCS mg.*

URINE

SAMPLE NO.	CONTROL		
1	.16 ± .028 (20)		
2	.10 ± .017 (23)		
	80°F	85°F	90°F
3	.14 ± .025 (5)	.16 ± .054 (4)	.17 ± .014 (3)
4	.19 ± .039 (4)	.13 ±.022 (4)	.45 ± .192 (3)
5	.17 ± .037 (6)	.09 ± .010 (5)	.11 ± .010 (2)
6	.09 ± .014 (6)	.12 ± .030 (2)	.12 ± .010 (3)
7	.15 ± .054 (5)	.22 ± .072 (4)	.03 ± .00 (2)
8	.09 ± .014 (5)	.13 ± .063 (5)	.09 ± .049 (4)
9	.14 ± .037 (6)	.11 ± .027 (4)	.07 ± .014 (3)
10	.08 ± .022 (5)	.15 ± .050 (2)	.05 ±.014 (3)

*20 mg. creatinine ≃ 1 hr. excretion.

N = ( )

TABLE XV

URINARY 17-KETOSTEROIDS*

THT	ANIMAL No.	TEMP. F	SAMPLE NO. 1	2	3	4	5	6	7	8	9	10
16	41	80	---	.15	---	.16	.23	.23	.46	.11	.32	---
16	49	80	.23	.11	.10	---	---	.31	.14	.11	.15	.09
17	42	90	---	.09	.11	.52	.09	.29	.16	---	.31	.10
18	35	90	.22	.15	---	.41	---	.40	.36	.32	.23	.10
18	50	90	.31	.20	.23	---	.41	.68	.26	---	.31	.23
AD-1	42		---	.16	.19	.23	.28	.11	---	.15	.22	.22
MR-2	65		.11	.07	.11	---	---	.09	.20	.08	.08	.08

large standard error and small number of samples in each group, general conclusions are unwarranted. It is of interest to note that in the 17-OHCS data of "thermally neutral" conditions, the diurnal variation is only disturbed during the experimental period, samples 3 and 4. The animals revert back to the normal diurnal rhythm as seen in samples 5 and 6 the first day after the experimental period, 7 and 8 the second day, and 9 and 10 the third day after termination of the 20-hour period of restraint and deprivation of food and water. The diurnal variation under 85°F and 90°F conditions are markedly disturbed and are not re-established after the "thermally stressful" conditions. Plasma 17-OHCS will be taken up in the discussion. The data on urinary 17-KS presented in Table XV show individual increases under the stressful conditions of 90°F as observed in THT No. 17, animal No. 42; THT No. 18, animal No. 35, and THT No. 18, animal No. 50. Again, the data are rather limited and general conclusions are not warranted.

Plasma cholesterol data presented in Table XVI indicate elevations in sample 2 immediately after termination of the 20-hour experimental period. These elevations occur under "thermally neutral" 80°F as well as "thermally stressful" conditions of 85°F, 90°F, and 95°F. The experiments carried out under 100°F conditions were all aborted and are presented in the second portion of Table XVI.

V. DISCUSSION

A. Respiration

The plasma chloride data of the temperature humidity tests were separated as indicated in Table III. The results of the "stress" sample 2 plasmas were divided into two groups: one representing temperature humidity tests at 70° and 80°F and the other representing 85°, 90°, 95°, and 100°F which were the "thermally stressful" conditions. The plasma chloride values of the latter group showed elevation of 10.0 mEq/L over the control (sample 1) and post stress (sample 3). The differences between the control data and sample 2 of the "thermally neutral" group were negligible.

In Figure 3 is presented the distribution of plasma chloride values of the "stress" (i.e. sample 2) in relation to the mean respiratory rate per minute during the temperature humidity test. The respiration data were obtained from progress reports issued from the Ecology Section, Aeromedical Field Laboratory, Holloman Air Force Base. There appears to be a relationship between increased rate of respiration and elevated

TABLE XVI

PLASMA CHOLESTEROL

mg.%

THT	Animal No.	Temp. F	Pre-	Stress	Post-
4	46	80	271	297	281
5	35	80	196	233	196
8	41	80	218	354	324
10	42	80	166	226	184
13	42	80	156	208	196
11	42	85	133	201	145
12	44	85	208	199	173
14	35	85	242	304	234
18	35	90	242	296	248
19	41	95	219	244	292
23	41	100	269	340	381
23	50	100	280	279	---
24	35	100	273	306	269
24	46	100	259	250	249
25	49	100	292	342	252
25	50	100	263	250	243

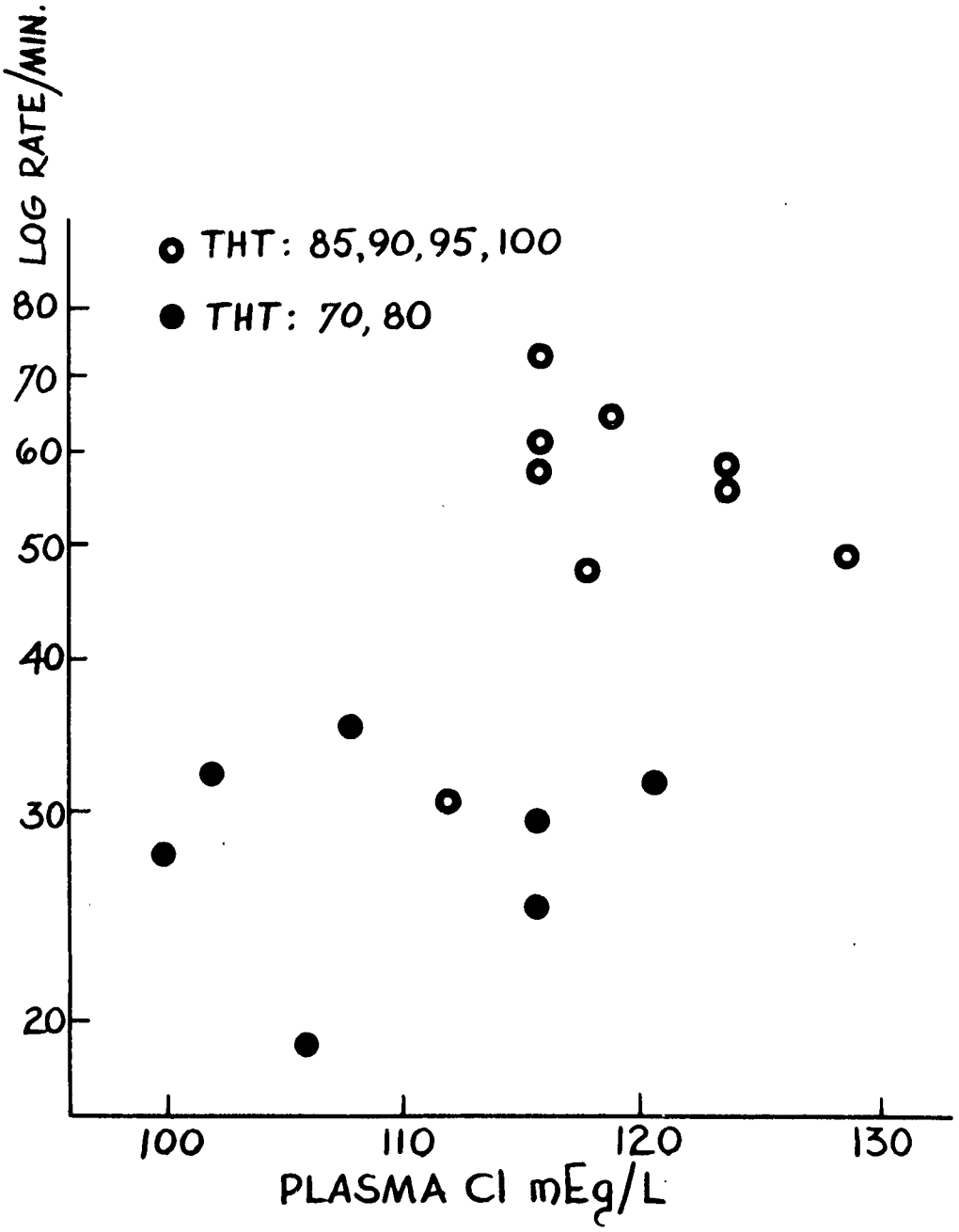

FIGURE 3. RESPIRATION AND PLASMA CHLORIDES OF STRESS SAMPLES

plasma chloride; a clear separation between the "thermally neutral" and the "thermally stressful" group occurs at a cutoff point where plasma chloride levels are over 116 mEq/L and respiration rates of 40 per minute.

In Figure 4 are presented the distribution of plasma sodium and plasma chloride data, all of the control values (sample 1), and samples 2 and 3 of the "thermally neutral" group. We are aware of the elevated sodium values observed in the control data and draw attention to the significant positive correlation of .73 obtained for this distribution of plasma sodium and chloride. When the plasma chloride and sodium data of samples 2 and 3 of the "thermally stressful" group are plotted in the same fashion, the correlation is only .28 (Fig. 5). It is apparent from Figure 5 that there is a high frequency of elevated chloride values with lower sodium values in the "thermally stressful" group. The decline of plasma sodium may be due to transport of sodium into the cell or through extra-renal route (sweat). The data presented in Table V indicate a marked decrease in sodium excretion in the stress period. Urinary chloride (Table IV) and potassium (Table VI) excretion do not follow qualitatively or quantitatively the direction of the sodium (Table VII). The marked decrease in sodium excretion during the "thermally stressful" condition as observed in urine samples 3 and 4 returns to normal or above normal values by samples 7 and 8 some 48 to 72 hours after the stress.

The distribution of the anions, inorganic phosphate and chloride in the urine on the control data (samples 1 and 2) are represented in Figure 6. We observe the full spectrum of urinary chloride values with the inorganic phosphate values revealing lower titers than we expected for the immature chimpanzee. Apparently two out of every three urine samples on which inorganic phosphate determinations were made gave values of less than 0.8 mg. percent; the relative accuracy of values obtained below this concentration by the method employed is questionable. It may be observed in Figure 6 that there are four points on the left-hand side of the distributions, indicating elevated phosphate levels. Examination of these data revealed that all of these points were contributed by one chimpanzee: animal No. 49. It was also observed that these high values of inorganic phosphates were distributed in a range of chloride values of 1.0 mEq. or less; we will return to these data.

In Table XVII are presented the urinary chloride and inorganic phosphates data of samples 1 and 6. The results obtained in samples 3 to 6, inclusive, were divided into two groups: "thermally neutral" and the "thermally stressful".

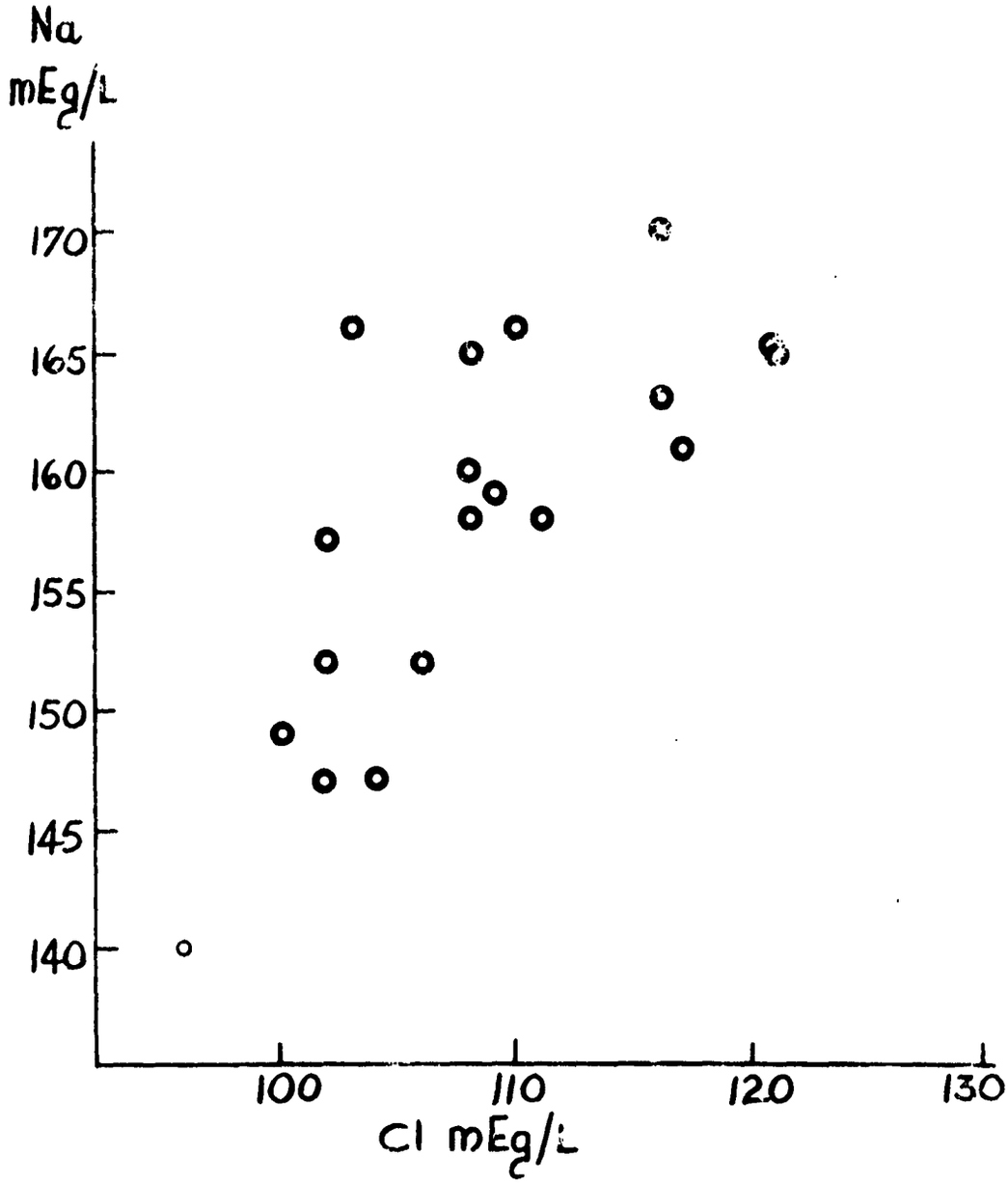

FIGURE 4. RELATION OF PLASMA SODIUM TO PLASMA CHLORIDES

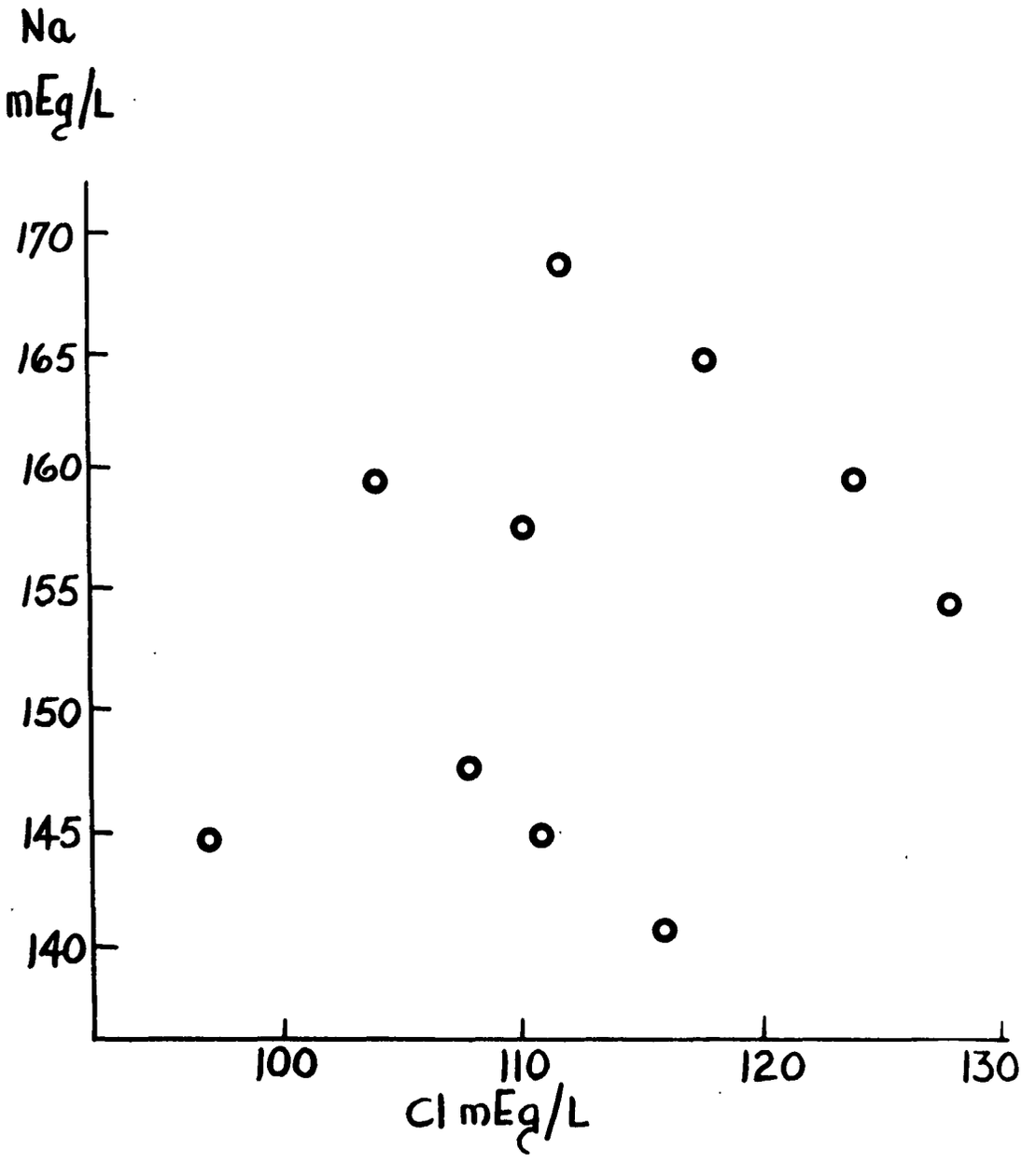

FIGURE 5. RELATION OF PLASMA SODIUM TO PLASMA CHLORIDES OF "THERMALLY STRESSFUL" TESTS

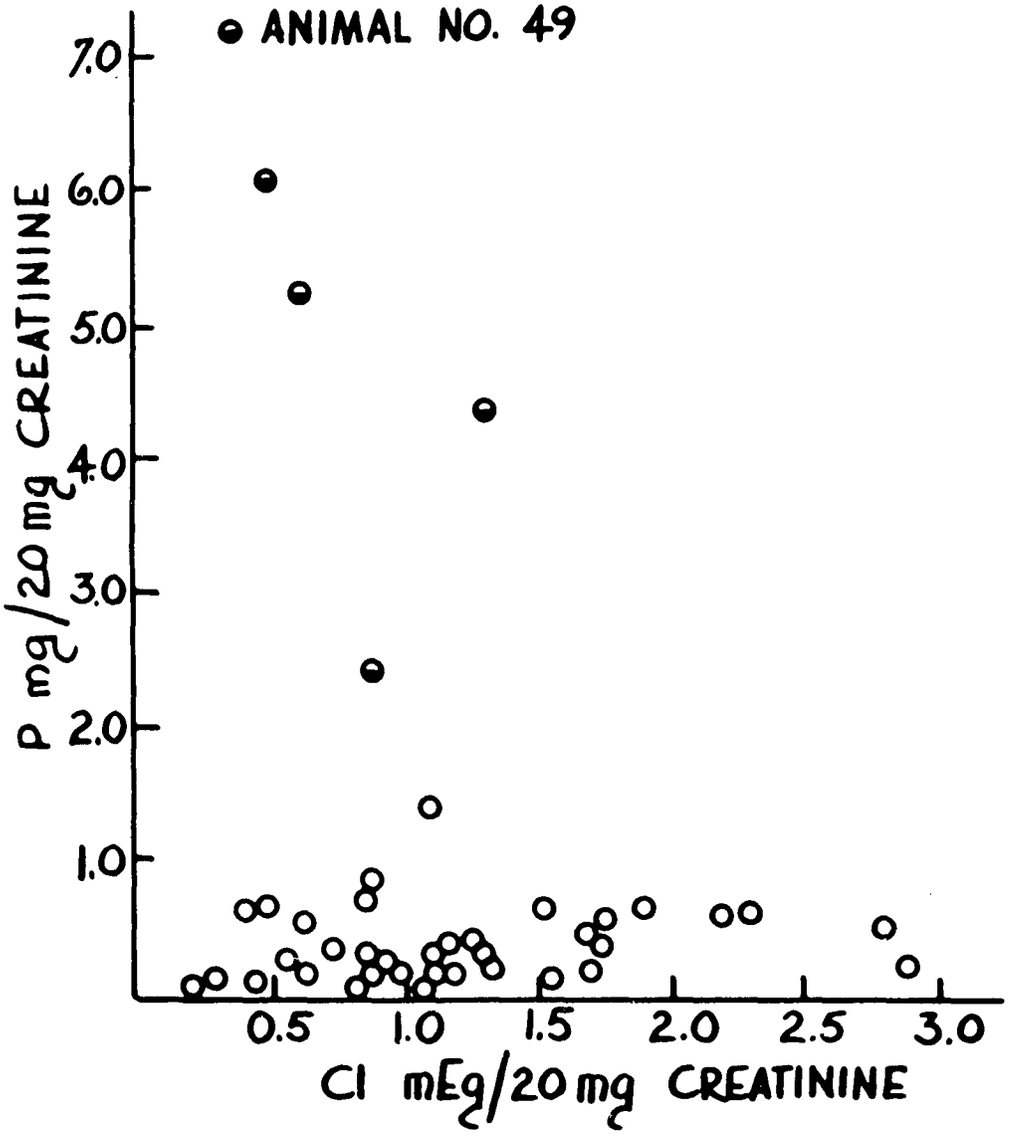

FIGURE 6. DISTRIBUTION OF URINARY PHOSPHATES AND CHLORIDES OF CONTROL DAY

TABLE XVII

URINE CHLORIDE AND PHOSPHORUS mg.***

	SAMPLE NO. 1	2	3	4	5	6
CHLORIDE mEq.	1.54 ± .194 (21)	.94 ± .060 (23)	* 1.26 ± .186 (5)	1.41 ± .157 (6)	.95 ± .292 (9)	1.20 ± .310 (11)
			** 1.39 ± .3025 (7)	.50 ± .098 (9)	.61 ± .181 (7)	.93 ± .224 (8)
PHOSPHORUS mg.	.47 ± .048 (19)	.43 ± .078 (21)	* .49 ± .195 (5)	1.12 ± .657 (4)	4.65 ± 1.807 (7)	5.22 ± 2.10 (8)
			** 1.10 ± .444 (7)	2.36 ± .705 (9)	5.75 ± 1.613 (10)	4.49 ± 1.04 (11)

*70-80°F

**85-90-95-100°F

***20 mg. creatinine = 1 hr. excretion

We observed lower chloride excretion rate in sample 2 than in sample 1. We expected a high inorganic phosphate value for sample 2, when compared with sample 1, but we did not obtain such results from our data. A slight and distinct elevation in chloride excretion is indicated in sample 4 of the "thermally neutral" group with an elevation in inorganic phosphate apparent in both groups in sample 4, with the rise reaching maximal levels in the "thermally stressful" group in sample 5 (Table VIII). An earlier initiation of elevated inorganic phosphates in sample 3 in the "thermally stressful" group was also observed. A definite phosphaturia is observed in both groups, which could be explained by immobility and fasting conditions undergone by the chimpanzee in these experiments. In Figure 6 we had observed the elevated inorganic phosphates in animal No. 49 with chloride levels of 1.0 mEq/20 mg. creatinine or less. Focusing our attention on only samples 5 and 6 of the "thermally stressful" group we obtained the distribution pictured in Figure 7 when urinary phosphates and chlorides were plotted on log-log scale. In brief, this distribution indicates that in these samples there is an elevated inorganic phosphate excretion rate when the chloride excretion rate is 1.0 mEq/20 mg. creatinine or less.

The foregoing results lend themselves to interpretation in terms of acid base balance and electrolytes. It is well established that chronic hyperventilation leads to elevation in plasma chlorides. Hyperventilation over long periods of time leads to loss of carbon dioxide with the subsequent diffusion of chloride from red cells and other tissues into the plasma. In the "thermally neutral" group we observed indications of increased chloride excretion such as sample 4 in Table XVII. The loss of sodium and chloride in the "thermally stressful" group through extra-renal (sweating) results in a marked dimunition in urinary chloride excretion, accompanied with an elevation in plasma chloride. The loss of sodium through extra-renal routes may be inferred from the data given in Table VII where a marked dimunition in the excretion of sodium is observed in the "thermally stressful" group. Conditions are also favorable to the diffusion of sodium into the tissues in exchange for potassium. The data in Figure 6 indicating lower plasma values in relation to the chloride supports this view. Chronic hyperventilation and sweating is accompanied by phosphaturia. The sequence of events for these conditions is as follows: hyperventilation leads to loss of carbon dioxide; the loss of carbon dioxide leads to diffusion of chloride from the cells and tissues into the plasma; the loss of sodium chloride through sweating results in a decrease in chloride excretion. The place of chloride as an anion in the urine is taken by inorganic phosphates

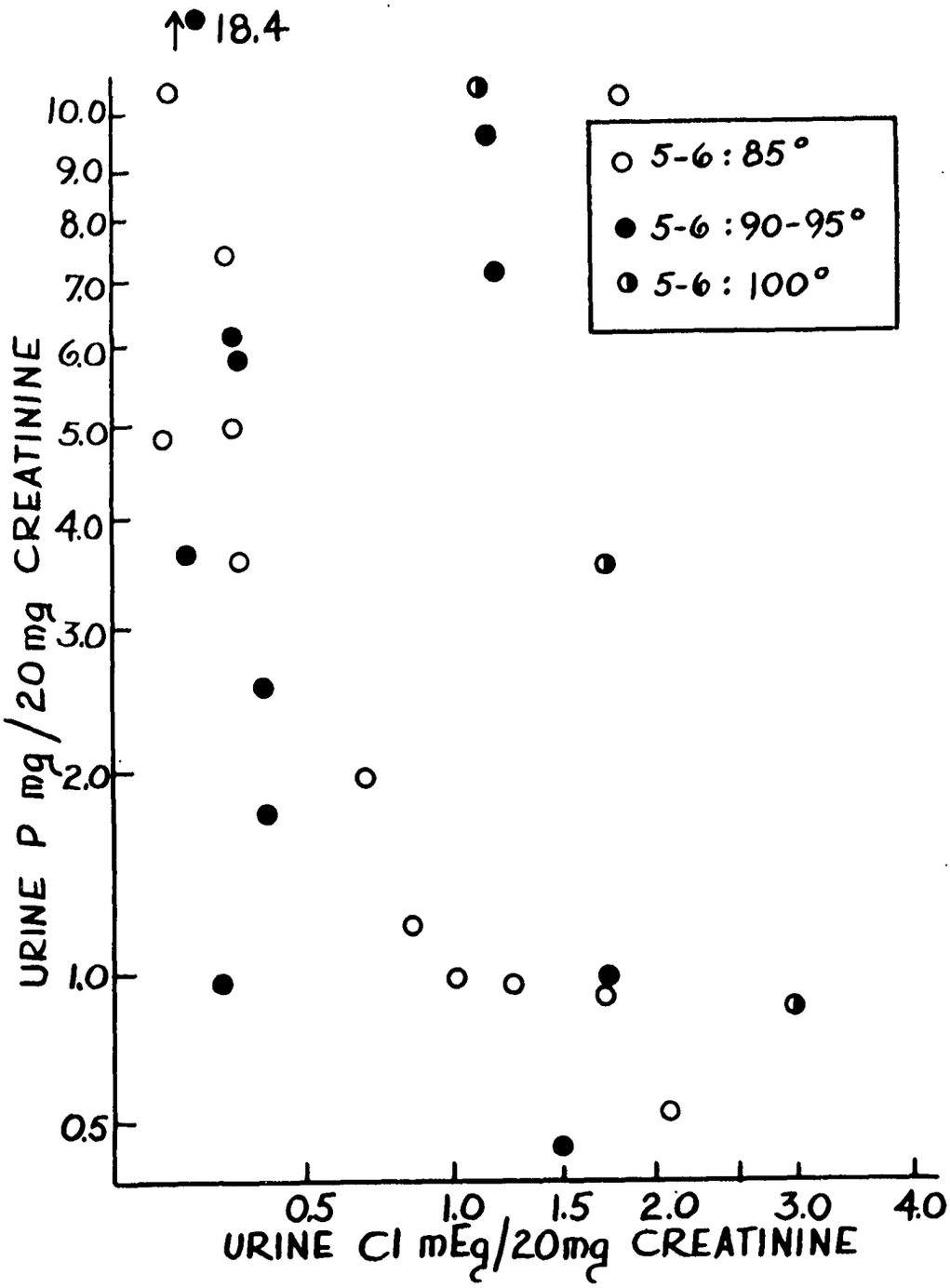

FIGURE 7. DISTRIBUTION OF URINARY PHOSPHATES AND CHLORIDES OF POST-STRESS DAY OF "THERMALLY STRESSFUL" TESTS

(Ref. 18). Hydrolytic cleavage of phosphoric acid esters into inorganic phosphates by phosphatase activity in the kidney may be the explanation of uric acid which may be explained by activity of phosphatase on purine phosphates and will be discussed in the next section.

A negative potassium balance is indicated from the data in Tables VI and VII. Though a marked decrease in sodium excretion is evident during the "thermally stressful" conditions, potassium excretion remains unchanged. Since no intake of potassium occurs during this period of stress and no changes in the excretion of potassium are indicated, there is a tendency over this 20-hour period toward a negative potassium balance. The potassium from the cells is replaced by the sodium as explained above. It is regrettable that we do not have plasma potassium data. However, it is highly likely that plasma potassium in "thermally stressful" conditions was elevated. Laborit and his coworkers (Ref. 19) have studied the influence of various physiopathologic conditions relating to acid base balance and hyperkalemia on the peripheral nervous system excitability. Under physiologic conditions the nerve excitability curve as described in their preparation is below that of homologous muscle. The nerve under these conditions is more excitable than the muscle. The greater the difference between nerve and muscle, the better the functional condition of the subject. The difference observed in athletes is generally very marked.

A negative potassium balance is first accompanied by an increase in excitability. As soon as this increase has become established, it is followed by a continuous drop in excitability that can be observed first on the nerve and then on the muscle. The biochemical indices reported above indicate that the peripheral nervous system should have been markedly depressed under conditions of these experiments. A presentation of the influence of electroytes on peripheral nervous system excitability has appeared recently (Ref. 19).

B. Nitrogen Metabolism

The indices relevant to nitrogen metabolism in the urine were creatinine, urea nitrogen, and uric acid; and in the blood, urea nitrogen.

Variability in the data due to the difficulty of obtaining timed urine collections were corrected by the use of creatinine coefficient:

$$\text{creatinine coefficient} = \frac{\text{mg. creatinine/24 hours}}{\text{weight in Kg.}}$$

Creatinine coefficient is based on muscle mass and in normal human males the range has been set at 22-26, and females 14-22 (Ref. 20). Preliminary data obtained on 102 urine samples gave the following distributions in terms of milligrams creatinine per hour of urinary excretion.

Mg. Creatinine	Number of Samples
Less than 9	11
10-14	21
15-19	18
20-24	31
25-29	11
30 and over	10

The median in this distribution is 20 mg. creatinine per hour. It was therefore decided that all urine data would be expressed in terms of 20 mg. creatinine to be equivalent of hourly excretion and .5 gm. creatinine to be equivalent to 24 hour excretion (see Appendix III).

All of the above data relates to immature chimpanzees weighing approximately 40 pounds and between three and four years of age. How do these data compare with preadolescent children? In a recent publication on the nitrogen metabolism of a group of children with a mean age of eight years and weighing on an average 65 pounds, a daily creatinine excretion of 574 mg. on a medium protein diet was reported (Ref. 21). It can be observed that the data on the immature chimpanzee compares favorably with the published report on preadolescent children.

In the upper portion of Table XVIII are presented the data of urea nitrogen of urine samples 1 and 2 and plasma sample 1. The lower portion of this sample table presents the stress data (sample 3 and 4) and the available plasma data of THT on animal No. 42 and No. 35. Data of both animals indicate marked elevations in urine urea nitrogen excretion and plasma concentrations. It may be safely assumed that in these tests there occurred a definite protein catabolism. It should be pointed out that these results were not observed consistently and that in general the data were inconclusive (Table IX).

TABLE XVIII

UREA NITROGEN

CONTROL

URINE*		BLOOD mc%	
Sample 1	178 ± 14.1 (23)	Sample 1	17.9 ± 1.49 (25)
Sample 2	201 ± 15.5 (27)		

STRESS

THT	ANIMAL NO.	TEMP. F	Sample No. 3	Sample No. 4	Sample No. 1	Sample No. 2	Sample No. 3
13	42	80	100	183	16.4	9.7	12.7
11	42	85	154	154	15.5	29.2	11.8
17	42	90	158	780	----	27.2	----
20	42	95	---	615	----	---	----
5	35	80	222	220	16.3	10.6	17.2
14	35	85	161	366	11.8	30.8	48.0
18	35	90	180	374	9.9	35.6	17.0

*20 mg. creatinine ≅ 1 hr. excretion

Uric acid results indicate a marked increase in excretion in the post-stress period covered by urine samples 5, 6 and 7 (Table X). The values return to normal levels at the end of the experiment. The similarity of the temporal aspects of these increases with those observed in the inorganic phosphate previously noted suggest increased catabolism of nucleoproteins. The mechanism may be related to phosphatases acting on purine phosphates under these conditions.

The excretion of urea nitrogen and uric acid in the immature chimpanzee also compares favorably in quantitative terms with the published reports on preadolescent children (Ref. 21).

C. Sympathico-Adrenal System

Table XIII presents the epinephrine (E) and norepinephrine (NE) excretion in terms of mcg./20 mg. creatinine. It may be noted that in animal No. 42 a greater increase in E and NE occurred during 90°F than 85°F conditions. There was also indication of diurnal variation of these indices (Ref. 22). In AD test 1 involving animal No. 42, we observe elevated E values during the period covered by sample 3. This is followed by an abrupt shift in the E and NE pattern with an increase in NE excretion. It is of interest that the notes available on the behavior of animal No. 42 during these periods indicated that the animal was quiet and fearful during the former period and then in the latter period this chimpanzee was agitated and aggressive (Ref. 22). Sample 3 represented urine formed during the period immediately after termination of these runs.

In the case of MR-2, animal No. 65 (HAM), sample 3 represented approximately a 4-hour urine collection immediately after being picked up at the end of the suborbital flight; the time represented by this sample was 1600-2200 on 31 January 1961. We observe an elevation in both E and NE in this sample especially when compared with samples 1 and 2 which were control samples.

The plasma glucose data obtained in this study are presented in Table XII. We observe varying degrees of hyperglycemia in many of the samples. These high values are possibly due to the procedure of sampling. It is nevertheless of interest to point out that the highest values were obtained on MR-2 immediately after the suborbital flight.

The results presented in terms of the sympathico-adrenal system indicate increases in the activity of this system

during the stress period. The data do not allow generalizations in terms of stress undergone and quantitative aspects of either the excretion of E and NE or in terms of the degree of hyperglycemia.

It should be pointed out that there was no generalized glycosuria in these stress tests. In fact there was a decrease in the glucose excretion rates during the period of the temperature humidity tests and immediately thereafter (Table XI). During the period of stress the chimpanzee received no food and water. Further studies are indicated for a more complete explanation of these results.

D. Pituitary-Adrenal System

Adrenal cortical activity was measured by estimations of urinary 17-ketosteroids (17-KS) and 17-hydroxycorticosteroids (17-OHCS) and plasma 17-OHCS and absolute lymphocyte count (Ref. 23, 24, 25). Analyses were also made for plasma cholesterol. The lymphocyte counts were calculated from white blood cell count data received from the laboratories of Aeromedical Field Laboratory*, Holloman Air Force Base.

In Table XV are presented the 17-KS results, indicating varying degrees of increases in this index during the stress (samples 3 and 4). Of particular interest are samples 4 of THT-17 (animal No. 42) and THT-18 (animal No. 35). The diurnal variation of 17-KS may be observed in these data (Ref. 26). Table XIV shows the data of the 17-OHCS excretion for THT-80-90°F inclusive. Marked increases were observed in individual experiments such as THT-11 and 17. However, 17-KS and 17-OHCS excretion results were not on the whole quantitatively significant when considered as an index of stress.

Plasma cholesterol data are presented in Table XVI. High plasma cholesterol concentrations are observed in both "thermally neutral" and "thermally stressful" conditions. No correlations are evident between the increase in plasma cholesterol and the increasing stress experienced by the chimpanzee in terms of temperature. It may be significant to observe that where the experiments were terminated before the full programmed 20-hour period, no consistent increases were observed in this index. It should be emphasized that plasma cholesterol is not being presented as an index of adrenal

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*Now known as 6571st Aeromedical Research Laboratory

cortical function. The data are of interest only in the finding that this measure increased in both "thermally stressful" and "thermally neutral" conditions when the experiments were run through the full 20-hour period.

Figure 8 depicts the plasma 17-OHCS data. The "basal" 17-OHCS data for the chimpanzee may be considered to be approximately 16 mcg. percent. Quantitative increases in sample 2 (stress sample) of the 17-OHCS data were observed with increases in temperature. The ceiling appears to be approximately 70 mcg. percent. It should be noted that AD test 1 shows less of an increase than AD test 2. Furthermore, the results obtained on chimpanzee No. 65 (HAM) (MR-2) immediately after the suborbital flight was somewhat less than the value obtained in the 20-hour stress period under 95°F. Interpretation of these data should be made with caution since there was the factor of a varying degree of time lapse from the point of termination of the stress to the time of sampling. The levels of these steroid determinations are consistent with those reported for preadolescent children (Ref. 27) and in the Rhesus monkey (Ref. 28).

The absolute lymphocyte counts are presented in Figure 9, indicating a gradual decrease in lymphocyte count as a response to increases in temperature. Furthermore, AD-2, by this index, appears to be a more stressful test than AD-1. The maximum g undergone in AD-1 was 21.37, while that of AD-2 was 50.6 g. Consistent with the findings in 17-OHCS, animal No. 65 (HAM) (MR-2) has a lymphocyte count of 800, which permits the interpretation that this animal underwent a severe acute stress.

The results of plasma 17-OHCS and absolute lymphocyte counts depicted in Figures 8 and 9 appear to be the most useful indices of adrenal cortical activity in terms of their quantitative relation to the degree of stress undergone.

VI. CONCLUSIONS

Biochemical studies of 12 urinary determinations and of determinations on plasma of the immature chimpanzee undergoing environmental stresses involving temperature-humidity tests, acceleration and deceleration tests, and the suborbital flight of animal No. 65 (HAM) were interpreted in terms of (a) acid base balance, (b) nitrogen metabolism, (c) sympathico-adrenal system and (d) pituitary-adrenal system. The temperature-humidity tests were analyzed in terms of "thermally neutral" (70-80°F) and "thermally stressful" (85-90-95-100°F).

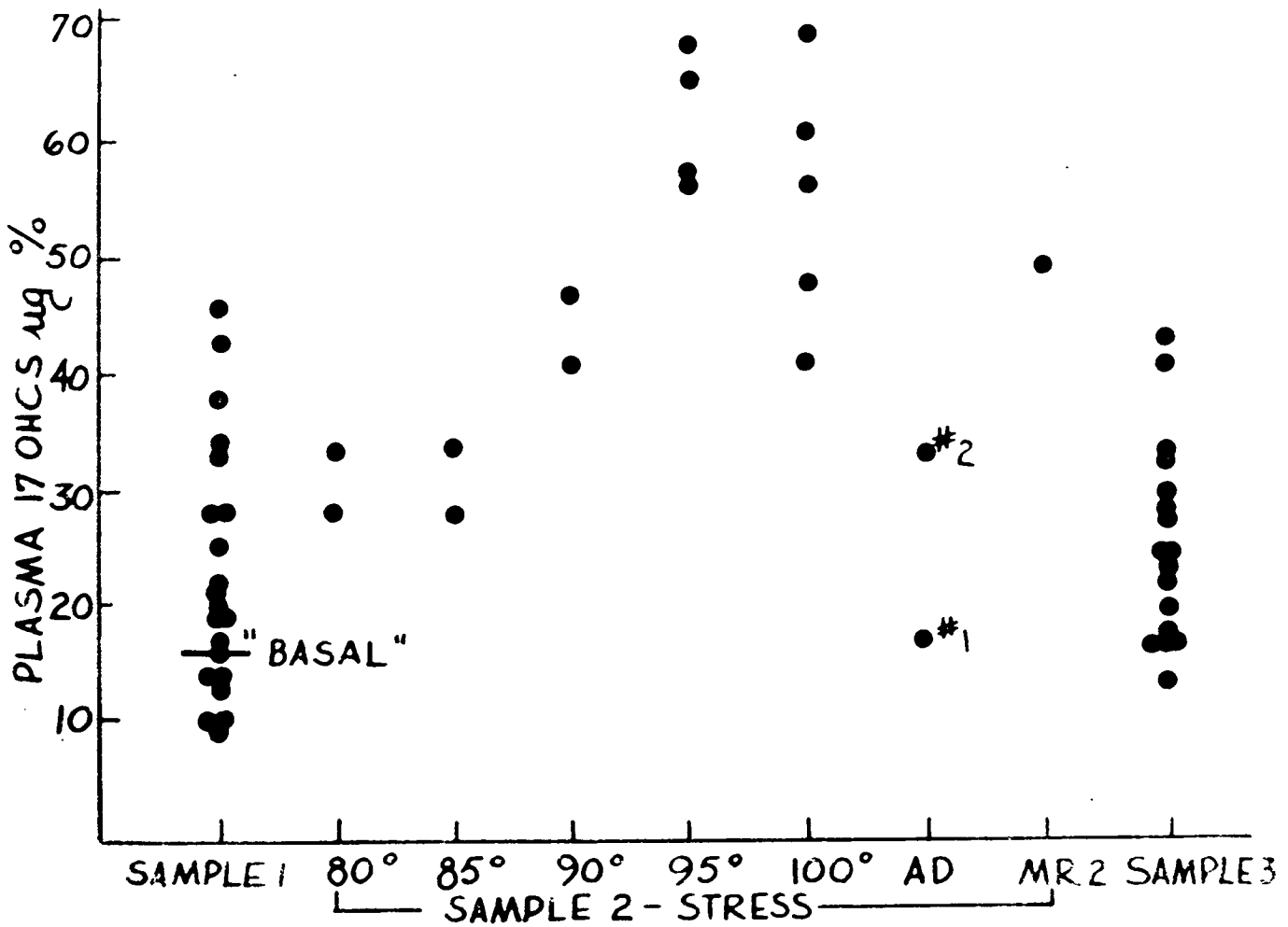

FIGURE 8. PLASMA 17-HYDROXYCORTICOSTEROIDS

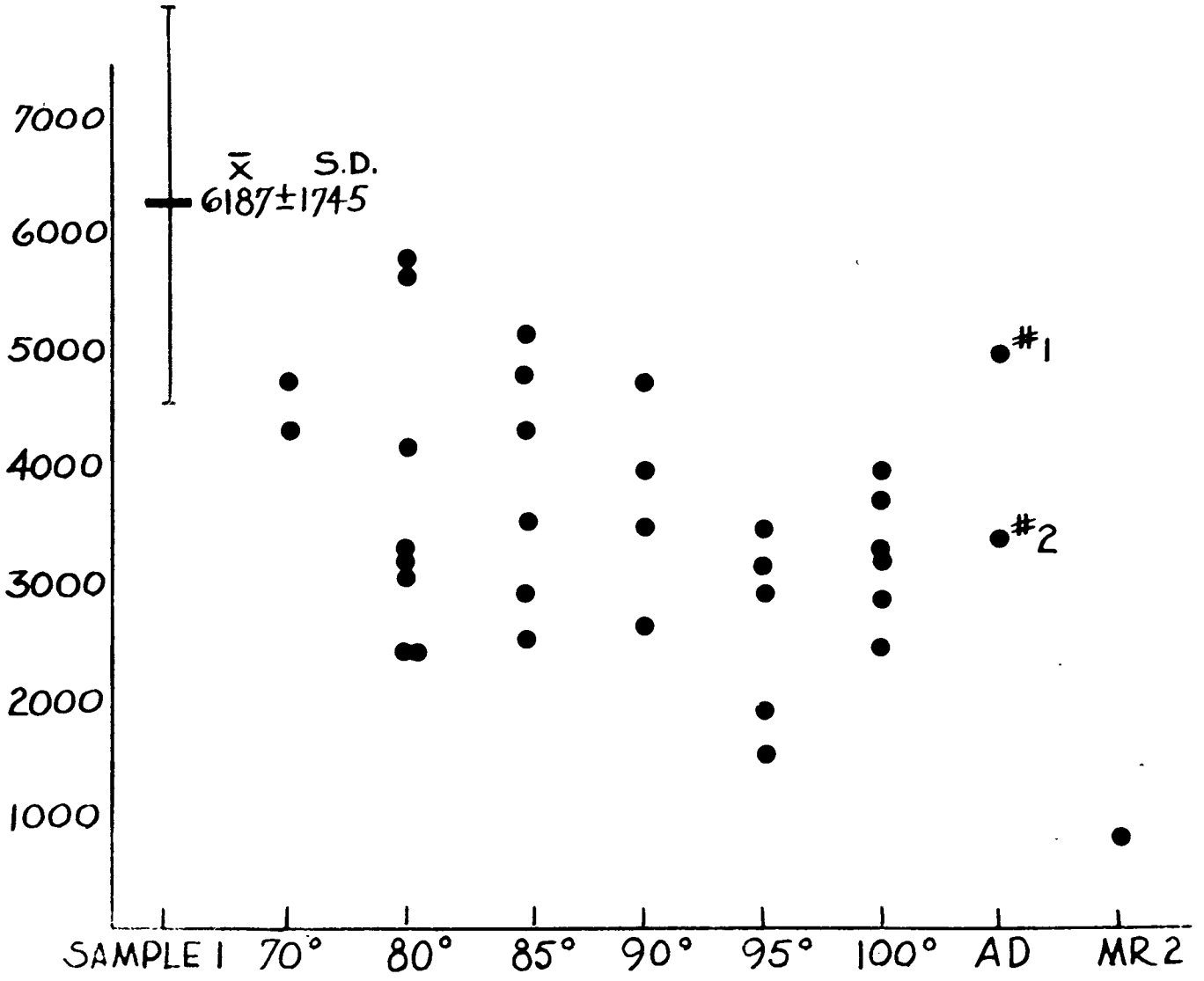

FIGURE 9. LYMPHOCYTE COUNTS OF STRESS SAMPLE

The "thermally stressful" ranges indicated elevated plasma chlorides with hyperventilation. Phosphaturia was observed in both groups with transient elevation in chloride excretion in "thermally neutral" group in comparison with a marked diminution of chloride excretion in the "thermally stressful" group. Sodium/potassium indicate loss of sodium through extra-renal routes (sweating). Nitrogen metabolism in the temperature-humidity tests showed varying degrees of protein catabolism, especially in the severe stress undergone in temperature ranges of 90-95°F. In these tests both urinary and plasma urea nitrogen were elevated. Elevation of epinephrine and norepinephrine excretion was observed during the stress conditions, with variable increases in blood glucose. Glycosuria was not observed during the stress periods. 17-Ketosteroids and 17-hydroxycorticosteroids showed nominal increases during the stress period; however, the lymphocyte count and plasma 17-hydroxycorticosteroids proved to be the more quantitative measures in terms of changes observed in these indices and the degree of the stress undergone. Plasma cholesterol levels were elevated in both the "thermally neutral" and "thermally stressful" groups under the conditions of the experiments.

Acceleration-deceleration tests indicate changes in biochemical measurements consistent with the stress undergone. Comparison of the stress experienced under simulated conditions with the suborbital flight of animal No. 65 (HAM) is presented.

VII. RECOMMENDATIONS

Studies should be continued along the same lines in terms of the indices measured in the study for space flights involving chimpanzees orbiting at varying distances from the earth. The steroidology of the chimpanzee should be extended with the use of modern technics now available. This can be accomplished by using the double isotope method (H^3 and C^{14}), which will give accurate secretion rates of steroid hormones such as that of the adrenal and gonads. Consideration should be given to developing technics using principles of automation and telemetry for evaluation of adrenal and gonad function during and after space flights.

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APPENDIX I

IMMATURE CHIMPANZEE DATA

THT 2 - Chimp 49

September 9, 1959

Plasma
(70°F)

Sample	Day	Time	Volume	Urea N mg. %	Cholesterol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	9-9	0900	7.0	20.8	266	103.5	147	**	**
2	9-11	0920	7.5	11.3	298	99.6	148.7	**	**
3	9-13	0800	6.0	26.7	262	QNS	QNS	**	**

** Not done

THT 3 - Chimp 41

September 21, 1959

Plasma
(70°F)

Sample	Day	Time	Volume	Urea N mg. %	Choles-terol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	9-21	0800	7.0	15.8	311	101.5	157		**
2	9-23	0915	6.0	15.8	302	115.5	170.1	15.62+	**
3	9-25	0730	7.0	10.8	254	110.5	157.4		**

**Not done
+ Samples 1, 2, and 3 pooled

THT 4 - Chimp 46

September 28, 1959

Plasma

(80°F)

Sample	Day	Time	Volume	Urea N mg. %	Cholesterol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	9-28	0900	6.25	26.0	271	121	165.2		**
2	9-30	0900	7.0	12.0	297	106	152.0	25.74+	**
3	10-2	++	++	11.5	281	103	166.0		**

++Recorded data not available
** Not done
+Samples 1, 2 and 3 pooled

THT 5 - Chimp 35 — Plasma

October 13, 1959 — (80°F)

Sample	Day	Time	Volume	Urea N mg. %	Choles-terol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	10-12	1000	6.0	16.3	196	QNS	QNS	QNS	QNS
2	10-14	1000	7.0	10.6	233	QNS	QNS	31.26	QNS
3	10-16	1000	7.0	17.2	196	QNS	QNS	QNS	QNS

THT 8 - Chimp 41

January 25, 1960

Plasma

(80°F)

Sample	Day	Time	Volume	Urea N mg. %	Choles-terol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	1-25	0900	6.0	12.8	218	95.5	140		QNS
2	1-27	1000	7.0	11.3	354	102	147.0	41.20+	QNS
3	1-29	0800	7.0	11.9	324	108	160.0		

+Samples 1, 2, and 3 pooled

THT 9 - Chimp #49 — Plasma

February 2, 1960 — (80° F)

Sample	Day	Time	Volume	Urea N mg. %	Choles-terol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
2	2-3	0930	7.0	21.8	188	108	165	38.7+	QNS
3	2-5	0800	8.0	15.8	218	102	152		QNS

+Samples 2 and 3 pooled

THT 10 - Chimp #42 — Plasma

February 15, 1960 — (80° F)

Sample	Day	Time	Volume	Urea N mg. %	Choles-terol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	2-15	0800	++	31.6	166	109	159	QNS	QNS
2	2-17	++	6.0	27.6	226	QNS	158	QNS	QNS
3	2-19	0800	++	36.8	184	108	161	QNS	QNS

++Recorded data unavailable

THT 11 - Chimp #42

March 15, 1960

Plasma

(85°F)

Sample	Day	Time	Volume	Urea N mg. %	Choles-terol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	3-15	0800	++	15.5	133	117	161	QNS	QNS
2	3-17	0800	++	29.2	201	129	154	QNS	QNS
3	3-19	0800	++	11.8	145	110	157	QNS	QNS

++Recorded data unavailable

THT 12 - Chimp #44 — Plasma

March 21, 1960 — (85°F)

Sample	Day	Time	Volume	Urea N mg. %	Cholesterol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	4-21	0900	6.5	17.1	208	108	166	10	QNS
2	4-23	0930	6.5	13.4	199	112	168	27.77	QNS
3	4-25	0900	7.0	18.1	173	114	159	17.22	QNS

THT 13 - Chimp #42

March 28, 1960

Plasma

($80^{\circ}F$)

Sample	Day	Time	Volume	Urea N mg. %	Cholesterol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	3-28	0900	5.5	16.4	156	QNS	QNS	10	QNS
2	3-30	1100	5.0	9.7	208	QNS	QNS	27.77	QNS
3	4-1	0900	++	12.7	196	QNS	QNS	17.22	QNS

++Recorded data unavailable

THT 14 - Chimp #35 — Plasma

April 5, 1960 — (85°F)

Sample	Day	Time	Volume	Urea N mg. %	Choles-terol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	4-5	0730	++	11.75	242	108	158	13.76	QNS
2	4-7	0900	++	30.8	304	QNS	QNS	34.22	QNS
3	4-10	0800	7.0	48.0	234	QNS	QNS	17.32	QNS

++Recorded data unavailable

THT 15 - Chimp #49 Plasma

April 18, 1960 (85°F)

Sample	Day	Time	Volume	Urea N mg. %	Choles-terol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	4-18	0700	++	37.6	288	QNS	169	33.25	QNS

++Recorded data unavailable

THT 15 - Chimp #41 — Plasma

April 18, 1960 — (85°F)

Sample	Day	Time	Volume	Urea N mg. %	Cholesterol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	4-18	++	++	16.5	357	QNS	QNS	21.57	QNS

++ Recorded data unavailable

THT 16 - Chimp #41

May 2, 1960

Plasma

(80°F)

Sample	Day	Time	Volume	Urea N mg. %	Cholesterol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
2	5-4	0900	++	7.5	429	116	163	QNS	QNS

++Recorded data unavailable

THT 17 - Chimp #42

May 9, 1960

Plasma

(90°F)

Sample	Day	Time	Volume	Urea N mg. %	Choles-terol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
2	5-11	++	++	27.2	231	116	140	QNS	115

++Recorded data unavailable

THT 18 - Chimp #50 — Plasma

May 16, 1960 — (90°F)

Sample	Day	Time	Volume	Urea N mg. %	Cholesterol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	5-16	++	++	13.0	253	112	QNS	38.24	QNS
2	5-18	++	++	34.8	285	118	164	41.43	QNS
3	5-19	++	++	17.2	280	QNS	QNS	32.84	QNS

++Recorded data unavailable

THT 18 - Chimp #35 — Plasma

May 16, 1960 — (90°F)

Sample	Day	Time	Volume	Urea N mg. %	Cholesterol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	5-16	++	++	9.9	242	QNS	151	18.92	58
2	5-18	++	++	35.6	296	124	QNS	47.02	71
3	5-20	++	++	16.95	248	108	147	18.38	67

++Recorded data unavailable

THT 20 - Chimp #42

June 6, 1960

Plasma

(Abort 19 hrs. 30 min.)

Sample	Day	Time	Volume	Urea N mg. %	Choles-terol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
3	6-10	++	++	17.7	136	QNS	QNS	14.16	QNS

++Recorded Data Unavailable

THT 21 - Chimp #49 — Plasma

June 13, 1960 — (95°F)

Sample	Day	Time	Volume	Urea N mg. %	Cholesterol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
2	6-15	++	++	13.3	376	QNS	165	56.44	QNS
3	6-17	++	++	13.4	336	97	144	43.28	QNS

++Recorded data unavailable

THT 23 - Chimp #41

June 27, 1960

Plasma

(100°F abort 13 hrs. 45 min.)

Sample	Day	Time	Volume	Urea N mg. %	Cholesterol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	6-27	++	++	18.20	269	110	QNS	42.64	62
2	6-20	++	++	15.50	340	116	QNS	56.52	107
3	7-1	++	++	11.10	381	93.5	QNS	29.33	55

++Recorded data unavailable

THT 23 - Chimp #50

June 27, 1960

Plasma

(100°F abort 6 hrs. 45 min.)

Sample	Day	Time	Volume	Urea N mg. %	Cholesterol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	6-27	++	++	14.75	280	102	QNS	46.92	66
2	6-29	++	++	16.87	279	116	QNS	48.00	88

++Recorded data unavailable

THT 24 = Chimp #46

November 6, 1960

Plasma

(100°F abort 3 hrs. 11 min.)

Sample	Day	Time	Volume	Urea N mg. %	Cholesterol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	11-6	++	++	7.55	259	102	143	24.88	130
2	11-8	++	++	8.30	250	119	143	69.32	145
3	11-11	++	++	9.35	249	119	147	24.88	188

++Recorded data unavailable

THT 24 - Chimp #35

November 6, 1960

Plasma

(100°F abort 11 hours)

Sample	Day	Time	Volume	Urea N mg. %	Cholesterol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	11-6	++	++	10	273	112	143	27.96	---
2	11-8	++	++	6.45	306	124	159	40.83	125
3	11-11	++	++	37.60	269	111	144	24.94	143

++Recorded data unavailable

THT 25 - Chimp #49

November 15, 1960

Plasma

(100°F abort 2 hrs. 10 min.)

Sample	Day	Time	Volume	Urea N mg. %	Choles-terol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	11-14	++	++	34.2	292	123	147	28.12	121
2	11-15	++	++	37.4	342	109	147	61.24	103
3	11-17	++	++	31.8	252	103	160	---	155

++Recorded data unavailable

THT 25 - Chimp #49

November 15, 1960

Plasma

(100°F abort 2 hrs. 10 min.)

Sample	Day	Time	Volume	Urea N mg. %	Cholesterol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	11-14	++	++	34.2	292	123	147	28.12	121
2	11-15	++	++	37.4	342	109	147	61.24	103
3	11-17	++	++	31.8	252	103	160	---	155

++Recorded data unavailable

THT 25 - Chimp #50

November 15, 1960

Plasma

(100°F abort 2 hrs. 10 min.)

Sample	Day	Time	Volume	Urea N mg. %	Choles-terol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	11-14	++	++	19.6	263	109	154	21.33	147
2	11-15	++	++	26.3	250	102	148	55.49	123
3	11-17	++	++	18.8	243	107	165	27.62	92

++Recorded data unavailable

Animal #42

August 5, 1960

Plasma

Acceleration-Deceleration #1

Sample	Day	Time	Volume	Urea N mg. %	Choles-terol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	8-5	++	++	48.8	177	102	QNS	9.9	93
2	8-7	++	++	16.6	171	122	QNS	16.8	125
3	8-9	++	++	10.1	175	QNS	QNS	23.7	QNS

++Recorded data unavailable

Animal #35

October 26, 1960

Plasma

Acceleration-Deceleration #2

Sample	Day	Time	Volume	Urea N mg. %	Choles-terol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	10-26	++	++	97.2?	332	103.5	139.6	31.54	134
2	10-27	++	++	5.0	297	79	148	33.34	92
3	10-29	++	++	7.8	296	94	142	41.32	150

++Recorded data unavailable

Animal #65 - HAM

January 30, 1961

Plasma

MR--2

Sample	Day	Time	Volume	Urea N mg. %	Cholesterol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	1-30	0800	++	34.9	270	120	148	12.8	150
2	1-31	1630	++	7.00	320	116	146	48.7	181
3	2-2	0800	++	16.5	297	113	147	ca 20	148

++Recorded data unavailable

THT #2: 70°F

Animal #49

Date September 9, 1959

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	159	10.9	79.0	.35	2.92	1.17	4.45	.26	.53	**	**	**
2	125	8.7	34.9	.14	1.10	.24	1.80	.13	.41	**	**	**
3												
4	302	23.4	8.7	2.49	1.30	0.30	1.96	.15	---	**	**	**
5	497	29.9	1.54	0.21	0.30	.73	.40	.22		**	**	**
6	182	11.8	27.4	2.16	0.85	0.14	.47	.30	.11	**	**	**
7	101	8.5	16.2	.28	0.16	0.50	.57	.80	.27	**	**	**
8	134	9.0	28.8	.88	0.13	0.20	.24	.80	---	**	**	**
9												
10												

* 20 mg. Creatinine

** Not done

THT #3: 70°F

Animal #41

Date September 21, 1959

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	258	16.1	39.3	.22	.91	.40	.78	.51	.07	**	**	**
2	247	15.8	25.1	.98	.90	.60	.92	.60	---	**	**	**
3	249	17.1	25.8	1.21	.73	.15	.72	.21	___	**	**	**
4	258	13.2	19.1	7.61	1.54	.54	.82	.66	.16	**	**	**
5	266	24.0	22.1	5.96	2.63	1.14	1.41	.81	---	**	**	**
6												
7												
8	172	8.5	245.0	1.63	1.70	.56	1.23	.46	.07	**	**	**
9	194	6.7	98.0	5.68	3.04	1.50	2.13	.70	___	**	**	**
10												

* 20 mg. Creatinine
** Not done

THT #4: 80°F

Animal #46

Date September 28, 1959

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	289	14.1	42.8	.43	1.75	.99	1.62	.61	---	**	**	**
2	215	20.5	44.0	.23	1.15	.94	.73	1.29	.19	**	**	**
3	256	14.3	46.5	.26	1.83	.29	1.16	.25	.13	**	**	**
4												
5	369	---	46.4	1.25	.89	1.10	1.00	1.10	.32	**	**	**
6	318	16.0	79.0	2.97	.94	1.93	2.10	.92	---	**	**	**
7	---	---	---	1.15	.60	.45	.40	1.12	.06	**	**	**
8												
9	265	12.8	42.0	3.54	1.79	.71	2.05	.36	.22	**	**	**
10	155	16.3	64.4	0.91	3.02	1.18	3.00	.39	---	**	**	**

* 20 mg. Creatinine

** Not done

THT #5: 80°F

Animal #35

Date October 13, 1959

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1												
2	133	35.4	27	.36	1.28	1.30	.37?	**	.13	**	**	**
3	222	14.4	41.5	.35	1.21	.156	.81	.19	.17	**	**	**
4	200	12.2	22.8	.64	2.00	1.20	1.65	.73	.16	**	**	**
5												
6	270	16.7	23.8	.41	.83	1.45	1.27	1.14	.12	**	**	**
7												
8												
9	355	14.7	49.0	1.44	.12	.54	2.17	.25	.05	**	**	**
10	274	22.6	30.0	.18	1.03	--	**	**	--	**	**	**

* 20 mg. Creatinine

**Not done

THT #8: 80°F

Animal #41

Date January 25, 1960

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	96	8.6	12.2	2.22?	1.31	.32	1.16	.27	.13	**	**	**
2	277	55.7	46.8	.24	1.19	.28	1.13	.25	.10	**	**	**
3												
4												
5	102	8.1	17.5	.14	.81	.04	.36	.15	.14	**	**	**
6	122	22.7	36.0	1.85	2.85	1.65	1.14	1.45	.09	**	**	**
7	162	12.1	20.6	.38	3.54	1.97	1.28	1.54	.19	**	**	**
8	107	39.5	29.9	.39	2.14	.97	1.06	0.92	.08	**	**	**
9	88	23.8	20.7	.22	1.65	.55	1.17	.47	.17	**	**	**
10	110	15.7	25.6	.45	1.23	.60	.22	2.76	.05	**	**	**

* 20 mg. Creatinine
** Not done

THT #9: 80°F

Animal #49

Date February 2, 1960

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1												
2	102	10.5	20.2	2.50	.99	.22	.73	.32	.11	**	**	**
3												
4	348	16.3	14.0	3.10	.82	.18	1.08	.16	.14	**	**	**
5	240	15.1	95.0	12.5	.71	.13	.62	.20	.07	**	**	**
6	214	12.9	81.0	11.4	.71	.10	.47	.21	.07	**	**	**
7	125	?	23.0	.53?	1.05	.48	.40	1.20	.35	**	**	**
8	219	19.0	31.5	2.36	2.40	.82	1.33	.62	.09	**	**	**
9	148	17.8	32.3	.62	3.32	2.26	1.50	1.50	.27	**	**	**
10	95	5.3	20.5	.50	1.88	.59	.83	.71	.08	**	**	**

* 20 mg. Creatinine

** Not done

THT #10: 80°F

Animal #42

Date February 15, 1960

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	227	15.4	55.0	.36	.74	.51	.88	.55	.17	**	**	**
2	164	16.3	35.3	.23	1.01	.96	1.09	.88	.12	**	**	**
3	105	14.8	25.7	.28	1.07	.48	.61	.63	.22	**	**	**
4												
5	155	17.7	17.0	.31	.80	.84	1.45	.58	.14	**	**	**
6	116	12.7	21.2	.17	1.03	.84	1.20	.70	.04	**	**	**
7	---	22.0	45.0	.55	2.18	1.44	1.47	.97	.13	**	**	**
8	89	14.3	35.3	.32	1.82	1.63	1.06	1.54	.06	**	**	**
9	91	6.0	44.2	.43	1.60	.71	1.02	.70	.07	**	**	**
10	113	14.2	19.4	.08	.96	.81	.82	.99	.06	**	**	**

* 20 mg. Creatinine

** Not done

THT #11: 85°F

Animal #42

Date March 15, 1960

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	118	22.5	12.4	.69	1.91	2.67	1.38	1.93	.13	**	1.02	.26
2	162	12.5	41.6	.38	1.29	1.07	.89	1.20	.09	**	.28	.19
3	154	17.7	10.3	.09	.67	.21	.32	.66	.31	**	.60	.40
4	154	14.2	15.0	.95	.05	.03	.46	.065	.20	**	1.27	.43
5	124	21.2	7.6	4.92	.33	.75	.83	.90	.08	**	.69	--
6	110	25.2	15.2	3.40	.34	.31	.85	.37	.15	**	.63	.18
7	112	30.5	15.1	1.69	.59	.94	.94	1.00	.32	**	.96	1.15
8	116	14.2	16.9	1.96	1.62	1.73	1.03	1.68	.07	**	.63	.44
9	81	11.7	10.2	.94	1.40	.67	.72	.97	.08	**	.19	.27
10	118	9.9	13.5	.73	.40	.36	.62	.58	.10	**	.15	.20

* 20 mg. Creatinine

** Not done

THT #12: 85°F

Animal #44

Date March 21, 1960

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	174	7.7	11.5	.74	2.18	3.2	1.68	1.91	.03	**	**	**
2	193	16.2	16.2	.30	1.13	1.22	.95	1.28	.03	**	**	**
3	197	19.2	21.0	.20	1.04	.15	.31	.48	.17	**	**	**
4												
5	195	22.4	13.5	.97	1.78	2.23	.74	3.0	.06	**	**	**
6	173	27.0	68.0	9.72	2.35	2.14	1.11	1.84	**	**	**	**
7	200	44.0	27.0	3.54	.73	1.25	.56	2.24	.07	**	**	**
8	167	21.4	28.5	1.92	2.30	.78	.58	1.34	.10	**	**	**
9	155	20.5	13.4	1.70	**	1.06	1.31	.81	.19	**	**	**
10	194	25.6	20.7	.50	**	.86	.70	1.23	.20	**	**	**

* 20 mg. Creatinine

**Not done

THT #13: 80°F

Animal #42

Date March 28, 1960

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	120	18.2	10.3	.17	.30	1.08	1.00	1.08	.08	**	**	**
2	215	45.0	21.3	.22	.65	1.19	1.08	1.09	.07	**	**	**
3	100	22.4	12.2	.13	1.48	1.32	.52	2.78	.14	**	**	**
4	183	18.9	18.9	.46	1.31	.66	.86	.77	.17	**	**	**
5	154	16.9	14.2	9.31	.90	.57	1.19	.48	.24	**	**	**
6	150	35.8	25.1	15.20	.16	.30	1.55	.19	.13	**	**	**
7	159	15.2	10.2	.34	.35	1.27	1.13	1.12	.06	**	**	**
8	143	10.0	17.7	.38	.70	.77	.77	1.00	.06	**	**	**
9	195	21.8	15.7	.52	2.16	2.28	2.90	.78	.07	**	**	**
10	113	10.3	14.8	.30	.80	.54	.26	1.51	.17	**	**	**

* 20 mg. Creatinine

**Not done

THT #14: 85°F

Animal #35

Date April 5, 1960

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	101	15.3	55.0	.76	1.57	1.54	1.32	1.16	.05	**	**	**
2	177	23.0	32.0	.82	.91	.45	1.05	.43	.05	**	**	**
3	161	13.0	24.0	1.30	2.68	2.52	1.51	1.65	.07	**	**	**
4	366	7.2		1.54	.54	.35	.71	.49	.11	**	**	**
5	92	17.5	15.1	4.81	.19	.47	.72	.65	.09	**	**	**
6	107	12.4	16.5	7.62	.38	.69	.66	1.02	—	**	**	**
7	152	20.0	25.8	5.98	.75	1.21			--	**	**	**
8	147	21.4	20.4	10.66	.66	1.19	.83	1.46	.06	**	**	**
9	300	15.7	21.6	.36	1.49	1.74	1.06	1.65	.11	**	**	**
10	pooled											

* 20 mg. Creatinine

**Not done

THT #15: 85°F

Animal #49

Date April 18, 1960

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	185	25.0	55.2	0.50	1.71	.51	.67	.76	.23	**	**	**
2	212	10.2	31.0	4.40	1.26	.41	.73	.56	.13	**	**	**
3												
4	207	30.0	9.9	0.18	.76	.18	.56	.32	.11	**	**	**
5	119	15.6	12.7	6.34		.21	.84	.25	.11	**	**	**
6	95	15.3	45.0	10.60	.22	.12	.67	.18	.09	**	**	**
7	86	30.6	15.6	3.26	.033	.103	.51	.20	.16	**	**	**
8	43?	5.7?	36.0	.045		.51	.53	.96	.04	**	**	**
9	113	44.7	70.8	2.84	1.55	3.46	1.93	1.79	.08	**	**	**
10												

* 20 mg. Creatinine
**Not done

THT #15: 85°F

Animal #41

Date April 18, 1960

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	100	12.0	18.1	.14	1.53	.73	1.44	.51	.12	**	**	**
2	517	19.3	24.0	.62	.64	.63	.97	.65	.13	**	**	**
3	227	8.6	11.6	3.37	1.02	.07	.21	.03	.10	**	**	**
4	244	13.6	14.4	---	.98	.08	2.05	.004	.10	**	**	**
5	256	27.2	33.6	2.0	.72	.74	1.68	.44	.13	**	**	**
6	277	27.5	33.7	.87	1.33	1.32	1.51	.88	---	**	**	**
7	109	51.2	26.3	1.69	---	.85	1.75	.49	.35	**	**	**
8	216	13.8	35.0	.65	2.07	1.68	1.21	1.39	.38	**	**	**
9	212	---	3.46	.30	2.55	2.71	2.05	1.32	---	**	**	**
10	206	18.7	30.3	?--	?--	.43	.50	.86	---	**	**	**

* 20 mg. Creatinine

**Not done

THT #16: 80°F

Animal #41

Date May 2, 1960

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1												
2	222	16.8	45.7	.09	.24	.87	2.33	.37	--	.15	**	**
3												
4	143	24.6	15.6	.27	1.50	.70	1.83	.38	.31	.16	**	**
5	192	19.6	23.3	2.84	.63	.37	.15	2.46	.11	.23	**	**
6	156	15.0	20.5	.39	2.20	1.20	1.25	.96	--	.23	**	**
7	126	40.4	48.9	.51	2.25	3.54	1.21	2.93	--	.46	**	**
8	310	13.4	15.5	.38	.91	.72	1.40	.51	--	.11	**	**
9	108	11.5	49.3	.21	6.10?	1.13	1.86	.61	--	.32	**	**
10												

* 20 mg. Creatinine

**Not done

THT #17: 90°F

Animal #49

Date May 9, 1960

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	149	14.5	40.4	6.1	.47	1.28	2.25	.57	.07	**	.85	2.87
2	200	11.7	29.1	5.12	.58	...58	1.20	.49	.07	**	.68	8.60
3												
4	197	15.1	26.5	7.08	.53	.054	1.39	.04	.17	**	.94	1.10
5	225	15.1	16.4	6.30	.30	.31	1.34	.22	.10	**	1.06	2.50
6	188	11.5	45.8	5.66	.29	1.07	.61	1.75	.14	**	.64	.18
7	130	14.7	20.0	3.44	1.74	1.90	1.59	1.20	--	**	2.85	13.2
8	70	7.8	---	1.42	1.07	---	---	1.29	.06	**	1.07	.94
9	128	11.0	6.5	2.84	.75	1.41	1.86	.76	.10	**	.49	11.1
10	132	8.0	21.6	4.00	.90	---	---	---	.04	**	.20	.17

* 20 mg. Creatinine

**Not done

THT #17: 90°F

Animal #42

Date May 9, 1960

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	214	13.7	36.4	.67	.42	.46	2.13	.22	--	--	.60	.69
2	177	25.9	13.7	.72	.50	.47	.95	.49	.03	.09	1.24	.92
3	158	20.4	27.0	.08	.60	.64	.92	.70	.20	.11	4.90	1.06
4	780	57.6	25.3	3.00	.40	.32	.42	.08	.82	.52	1.90	.80
5	210	14.6	28.5	3.56	.20		.98	---	.12	.09	1.10	.10
6	452	35.8	32.0	2.54	.44		2.07	---	.11	.29	1.14	.10
7	304	14.2	10.5	.22	1.04	.44	1.33	.33	---	.16	1.00	5.90
8	120	14.6	---	1.37	.84	.67	.75	.90	.24	---	.79	.42
9	248	15.9	29.1	2.83	.80	1.22	1.91	.64	---	.31	1.10	1.28
10	232	8.7	8.9	5.53	.30	.21	.60	.35	---	.10	.39	.10

* 20 mg. Creatinine

THT #18: 90°F

Animal #35

Date May 16, 1960

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	181	15.1	11.4	.67	3.94	.86	1.67	.52	---	.22	.40	.25
2	120	13.2	21.6	.29	.94	.29	1.36	.21	.06	.15	.34	.13
3	180	9.2	15.4	1.54	2.27	.013	.14	.08	.17	---	.33	.10
4	394	27.8	10.5	3.12	.86	.11	1.73	.06	.38	.41	.14	.74
5												
6	370	22.3	36.4	9.50	1.18	.29	1.07	.27	.13	.40	.34	.66
7	145	15.2	16.8	.24	1.50	.52	1.10	.47	.03	.36	.80	2.26
8	260	11.0	20.0	4.80	1.84	1.24	1.73	.71	.03	.32	.40	.39
9	248	13.0	9.2	1.82	1.6	.88	1.27	.70	.06	.23	.28	.20
10	299	1.38	58.5	6.34	1.38	.81	1.26	.64	.03	.10	.56	.10

* 20 mg. Creatinine

THT #18: 90°F

Animal #50

Date May 16, 1960

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	211	19.0	8.7	.63	2.08	.71	1.34	.53	--	.31	1.24	.10
2	195	12.6	60.0	.18	**	**	**	.38	--	.20	0.75	.10
3	145	9.4	15.0	1.17	1.47	.61	1.15	.53	1.50	.23	0.28	0.10
4												
5	257	30.6	37.4	18.4	.35	.13	.83	.16	--	.41	0.42	.10
6	172	34.2	41.8	7.0	1.25	1.41	.90	1.56	--	.68	2.36	--
7	134	18.0	10.6	1.6	2.50	.72	.74	.97	.03	.26	1.42	1.34
8	142	6.2	7.0	1.8	.40	.37	.61	1.90	.05	--	2.20	.18
9	325	19.7	22.2	.94	.18	.18	.55	.33	.06	.31	1.18	.24
10	247	8.8	13.4	.19	.10	.29	.72	.40	.08	.23	0.47	.10

* 20 mg. Creatinine

THT #20: 95°F

Animal #42

(abort 19 hrs.30 min.)

Date June 6, 1960

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	303	11.0	33.0	.58	1.78	1.2	.78	1.54	.09	**	**	**
2	270	12.7	28.6	.26	.945	1.81	1.30	1.40	.08	**	**	**
3												
4	615	16.0	19.7	.45	.49	.04	1.39	.027	.27	**	**	**
5												
6	198	6.3	26.0	.90	1.79	.55	.95	.58	--	**	**	**
7	207	15.3	22.0	.48	1.01	.67	.267	2.54	.16	**	**	**
8	480	24.4	34.0	.68	3.80	3.74	3.15	1.19	.10	**	**	**
9	248	10.0	19.0	.30	1.82	1.73	1.08	1.58	.07	**	**	**
10	202	9.6	16.4	.15	.32	.17	.20	.86	--	**	**	**

* 20 mg. Creatinine

**Not done

THT #21: 95°F

Animal #49

Date June 13, 1960

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	88	12.0	18.0	.33	1.71	1.98	1.46	1.36	.02	**	**	**
2	267	12.9	26.0	.79	.87	1.44	1.08	1.33	.05	**	**	**
3												
4	282	12.9	18.5	3.3	.80	.09	1.72	.04	.22	**	**	**
5	360	19.5	28.0	1.7	.40	.14	1.06	.13	.08	**	**	**
6	200	13.8	31.7	.94	.31	.01	.25	--	.05	**	**	**
7	130	14.5	26.6	.09	2.16	.99	.85	1.16	.06	**	**	**
8	143	13.3	43.7	1.8	.68	.64	.56	1.14	--	**	**	**
9	90	5.5	33.4	1.5	.71	.85	.57	1.49	.10	**	**	**
10	Lost											

* 20 mg. Creatinine

** Not done

THT #23: 100°F

Animal #41 (abort 13 hrs. 45 min.)

Date June 27, 1960 *Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	155	15.9	55.2	.71	2.3	1.76	2.22	.80	.21	**	**	**
2	138	11.1	25.4	.17	1.34	.88	1.45	.61	.14	**	**	**
3												
4												
5	161	16.9	20.8	1.02	.96	.29	1.00	.29	--	**	**	**
6	162	16.7	30.3	.52	2.22	1.59	1.35	1.18	.09	**	**	**
7	116	10.4	34.0	.36	1.89	1.60	1.34	1.19	.27	**	**	**
8	147	14.3	11.9	.15	1.54	1.83	1.90	.97	--	**	**	**
9												
10	137	6.0	25.8	.10	.74	.99	1.50	.66	--	**	**	**

* 20 mg. Creatinine
**Not done

THT #23: 100°F

Animal #50

(abort 6 hrs. 45 min.)

*Urine

Date June 27, 1960

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	138	16.4	12.3	.44	1.17	.74	1.33	.55	.14	**	**	**
2	122	11.6	12.5	.14	.88	.29	.81	.36	.04	**	**	**
3												
4												
5	890	32.2	44.6	3.3	1.81	.51	1.22	.42	.06	**	**	**
6	200	12.3	26.0	10.0	1.28	.93	1.22	.75	.06	**	**	**
7	286	11.7	284.0	1.24	4.00	3.4	1.77	1.93	--	**	**	**
8	151	13.0	50.8	.37	.82	.41	1.06	.38	--	**	**	**
9												
10	151	12.3	13.7	.49	.43	.30	1.00	.30	.06	**	**	**

* 20 mg. Creatinine

** Not done

THT #24: 100°F

Animal #46 (abort 3 hrs. 11 min.)

Date November 6, 1960

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	215	17.3	20.0	.49	1.04	1.25	1.43	.87	.04	.19	**	**
2	206	4.5	20.4	3.20	.285	.62	1.11	.56	.03	.13	**	**
3	120	9.7	10.0	.27	.187	.045	.82	.0045	.08	.23	**	**
4	136	8.4	12.1	4.60	.32	.30	.42	.71	--	.27	**	**
5	125	10.9	13.8	.105	.92	.94	1.09	.86	--	.33	**	**
6	131	9.1	16.5	3.45	2.03	2.02	.39	--	--	.25	**	**
7	118	8.9	40.0	.33	1.85	1.55	1.33	1.17	--	.54	**	**
8	146	4.1	32.3	2.38	1.85	.34	.67	.51	--	.054	**	**
9	269	6.7	15.6	3.48	2.53	.97	.92	1.05	--	.37	**	**
10	138	9.1	17.5	2.52	.375	.165	.28	.59	__	.24	**	**

* 20 mg. Creatinine

**Not done

THT #24: 100°F

Animal #35

(abort 11 hrs.)

Date November 6, 1960

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	118	5.4	--	.15	.45	.73	.55	1.33	.51	**	**	**
2	188	4.6	11.6	.31	.61	.28	1.08	.26	.02	**	**	**
3												
4	118	16.8	7.9	1.63	.10	.04	.34	.011	--	**	**	**
5	222	19.3	14.0	1.22	.83	1.78	2.56	.47	--	**	**	**
6	154	10.4	11.4	.78	3.24	1.75	1.48	1.18	--	**	**	**
7	191	6.5	--	.57	1.50	2.78	1.47	1.89	--	**	**	**
8	172	5.4	15.8	.22	1.58	.63	.75	.84	--	**	**	**
9	189	7.8	15.0	.57	.83	.50	.60	.84	--	**	**	**
10	159	4.4	20.4	.10	.41	.30	.62	.49	--	**	**	**

* 20 mg. Creatinine
**Not done

THT #25: 100°F

Animal #49

(abort 2 hrs. 10 min)

*Urine

Date November 15, 1960

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	320	17.7	17.9	--	1.18	1.29	2.00	.69	--	.39	**	**
2	263	6.6	31.1	5.02	.34	.35	.49	.72	.27	.10	**	**
3												
4	175	7.6	13.1	4.7	.12	.02	.63	.03	.04	.20	**	**
5	258	8.3	14.2	2.38	.86	.86	.62	1.38	--	.32	**	**
6	208	5.2	27.4	1.65	1.76	.74	1.15	.65	--	.14	**	**
7	228	7.4	29.8	8.40	2.85	4.10	7.2	.57	--	.36	**	**
8	229	5.2	15.0	5.02	2.14	1.88	1.18	1.60	--	.13	**	**
9	222	13.4	40.6	10.07	4.25	6.5	.96	--	--	.38	**	**
10	151	7.0	31.6	3.35	1.96	1.63	1.50	1.09	--	.14	**	**

* 20 mg. Creatinine

**Not done

THT #25: 100°F

Animal #50

Date November 15, 1960

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1												
2	152	10.4	9.9	--	.79	.28	.61	.46	.33	.18	**	**
3												
4	92	7.5	7.2	.13	.47	.032	.20	.016	.13	.19	**	**
5	89	11.6	6.1	.14	2.00	.08	.63	.013	--	.11	**	**
6	58	9.5	5.6	3.3	.92	.41	.38	1.08	.08	.075	**	**
7	85	9.8	--	.46	1.34	1.00	1.02	.97	.17	.13	**	**
8	75	8.8	13.3	8.0	1.06	.39	.77	.51	.22	.12	**	**
9	85	8.3	7.3	--	2.40	1.53	1.24	1.23	.28	.13	**	**
10	92	15.1	9.1	8.6	.91	.49	.80	.61	.36	.12	**	**

* 20 mg. Creatinine

**Not done

AD-1

Animal #42

Date August 5, 1960

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	189	11.0	29.2	.083	3.26	1.03	1.28	.81	.16	—	.75	.25
2	176	8.2	13.2	.074	.80	1.28	.89	1.44	.10	.16	.43	.16
3	260	6.7	11.4	.127	2.43	.248	.75	.33	.07	.19	3.08	.46
4	164	9.8	70.0	.344	1.83	1.16	1.05	1.11	---	.23	.52	2.20
5	160	8.0	40.0	.123	2.28	.368	.45	.81	---	.28	2.49	4.98
6	132	9.8	53.0	.058	1.58	2.65	1.79	1.56	---	.11	.37	.22
7	163	9.5	12.8	.128	1.60	.592	1.57	.38	.03	---	1.38	4.48
8	201	7.9	20.4	.18	1.67	2.05	1.13	2.03	.04	.15	.70	.42
9	120	12.0	15.1	.16	1.48	1.12	1.72	.65	.11	.22	.76	2.17
10	137	6.4	22.8	.146	.88	1.02	.81	1.26	.08	.22	.13	.13

* 20 mg. Creatinine

AD-2

Animal #35

Date October 25, 1960

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	133	19.7	25.8	.16	1.10	---	---	---	---	**	**	**
2	106	12.2	12.3	.38	1.39	.60	.80	.75	---	**	**	**
3												
4	235	17.9	28.9	1.09	1.21	.24	1.02	.23	---	**	**	**
5	105	16.0	17.9	.125	1.27	.36	.776	.47	---	**	**	**
6	150	10.0	12.5	.195	2.23	1.31	1.59	1.21	.02	**	**	**
7	144	16.0	12.3	.162	2.31	2.23	3.10	1.39	--	**	**	**
8	125	16.9	7.1	5.22	.89	.61	1.02	.60	--	**	**	**
9	133	16.3	7.6	.55	.44	.78	1.16	.67	--	**	**	**
10	138	20.4	---	3.02	.68	.43	.84	.52	.03	**	**	**

* 20 mg. Creatinine
**Not done

MR-2

Animal #65 - HAM

Date Jan. 30, 1961

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	157	10.3	52.0	.34	2.47	1.16	.93	1.24	---	.108	.27	.17
2	145	8.3	98.0	.36	1.60	.90	.69	1.31	.03	.067	.17	.10
3	153	13.3	85.0	9.00	.81	.43	.82	.54	---	.114	.90	.70
4	157	9.7	23.0	.11	.50	1.39	.524	2.65	.20	---	---	---
5	158	7.4	16.6	.18	.10	.327	.78	.42	.06	---	---	---
6	134	8.5	21.7	.15	.50	.202	.318	.64	---	.091	.14	.24
7	136	10.6	35.5	.35	.91	.465	.61	.76	.08	.202	.23	.13
8	152	9.6	11.5	.89	.35	.590	.618	.96	.02	.081	.34	.17
9	139	11.6	32.5	.24	.75	.52	.67	.78	---	.083	.48	.10
10	215	10.1	77.0	1.02	2.72	2.30	1.16	1.95	.04	.081	.38	.42

* 20 mg. Creatinine

MR-2 BACKUP

Animal #35 - ELVIS

Date January 30, 1961

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	114	4.9	10.5	.88	2.55	1.48	2.04	.73	.10	**	1.09	.25
2	168	6.2	13.2	2.93	1.99	1.90	1.07	1.78	.06	**	.87	.40
3	102	9.8	20.0	4.67	1.46	1.46	1.33	1.10	.057	**	.41	.10
4	150	9.3	8.5	.43	.61	.14	.78	---	---	**	.10	.40
5	103	9.1	12.4	5.85	2.94	4.90	2.95	1.66	---	**	.95	.60
6												
7	60	8.9	6.0	1.70	1.27	1.95	.80	2.44	---	**	.70	.70
8	96	9.2	6.3	4.40	.99	.51	.55	.93	---	**	.18	.10
9	102	5.5	14.5	.44	1.33	.71	.62	1.15	---	**	.25	.25
10	210	8.3	14.6	1.54	.18	1.49	.88	1.70	.078	**	.36	.83

Sample No. 6 lost

* 20 mg. Creatinine
**Not done

APPENDIX II

MATURE CHIMPANZEE DATA

Baseline Data

Animal #3 Vickie

Date March 25, 1961

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	98	15.0	16.9	1.82	.28	99	2.20	.45	.14		.48	.20
2	129	15.4	12.2	7.40	.25	1.21	2.18	.56	.15		.56	.33
3	112	12.8	15.3	10.30	.17	.36	2.10	.17	.10		.15	.11
4	129	21.1	15.1	2.07	.25	.35	1.74	.20	---		.49	.21
5	134	14.2	49.4	1.02	.67	.57	1.95	.29	---		.27	.23
6												
7												
8												
9												
10												

* 50 mg. Creatinine

Baseline Data

Animal Big Mike

Date April 25, 1961

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	152	19.1	26.3	.18	2.28	1.29	2.72	.48	.04			
2	251	14.0	51.6	.68	1.12	.30	2.05	.15	.11			
3	132	13.3	58.4	.35	1.15	.99	2.57	.39	.11			
4	155	12.0	25.4	3.16	.75	.54	1.74	.31	.12			
5	103	23.0	9.1	.92	1.25	2.10	2.40	.88	.19			
6	123	26.0	19.0	1.68	1.14	.78	2.60	.30	.13			
7	118	20.7	14.0	.52	1.05	1.67	2.05	.82	.14			
8	136	27.0	9.0	.47	1.[illegible]	.90	2.42	.37	.75 ?			
9	102	22.1	27.0	1.60	1.40	1.84	1.89	.97	.20			
10	113	24.0	55.5	.66	1.43	1.34	1.20	1.12	---			

* 50 mg. Creatinine

Baseline Data

Animal #132 Fita

Date June 26, 1961

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	264	17.3	32		1.13	.72	2.36	.31	.18		.89	1.54
2	356	16.3	32		1.92	.66	.62?	1.06	.22		.52	.38
3	290	12.4	41		2.93	.92	2.43	.38			.95	<.10
4												
5	293	13.6	43		3.10	.65	2.35	.28			.51	<.10
6	340	17.9	61		2.72	2.30	5.10	.45			.44	.47
7	260	11.3	55		2.18	.95	3.45	.28			.28	.67
8	392	14.1	41		1.39	1.08	2.25	.48			.27	.45
9	293	11.1	53		1.65	1.30	3.74	.35			1.00	1.45
10												

* 50 mg. Creatinine

Baseline Data

Animal #134 Zeta

Date July 1961

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	165	24.0	88	.51	1.00	1.20	1.72	.70	---		---	---
2	236	29.2	64	.74	2.10	3.03	1.78	1.70	---		.82	.57
3	115	21.2	51	---	1.39	.58	1.02	.57	---		<.10	.32
4	111	18.4	47	---	1.67	3.30	1.16	2.85	---		.37	<.10
5	110	10.7	28	3.18	3.27	.88	1.50	.75	---		.72	.61
6	100	13.2	26	1.44	1.69	1.08	1.24	.87	---		.39	<.10
7	106	14.0	24	.26	.95	1.62	2.71	.60	---		.66	.83
8	192	20.4	51	.30	1.74	.82	2.78	.30	---		<.10	2.20
9	117	13.2	42	.75	1.73	2.78	2.88	.97	---		.68	1.43
10	185	18.6	35	---	3.25	2.58	---	---	---		.17	1.00

* 50 mg. Creatinine

Baseline Data

Animal #135 Beta

Date May 23, 1961

*Urine

Sample No.	Urea mg.	Uric Ac. mg.	Glucose mg.	PO_4 mg.	Cl mEq.	Na mEq.	K mEq.	Na/K	17-OHCS mg.	17-KS mg.	E mcg.	NE mcg.
1	150	21.0	93	--	1.88	1.75	5.5	.32	.40		.21	18.4
2	240	28.0	54	.57	2.51	1.80	3.54	.51	---		<.10	4.65
3	162	27.4	47	.50	3.19	3.20	6.53	.49	.17		.40	3.53
4	148	21.8	34	.31	2.50	1.92	4.40	.44	.24		.43	1.26
5	152	30.8	49	---	2.13	3.54	5.10	.70	.28		<.10	8.28
6												
7	152	29.4	54	.99	2.58	2.44	4.50	.54	---			
8												
9	155	13.4	68	.44	1.48	1.48	6.05	.25	.23		.40	.23
10												

* 50 mg. Creatinine

Big Mike

April 22, 1961

Sample	Day	Time	Volume	Urea N mg. %	Choles-terol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
2	4-24	+	+	12.2	149	97.1	148	15.3	
3	5-1	+	+	12.3	196	111	150	13.0	

Vickie

March 24, 1961

Sample	Day	Time	Volume	Urea N mg. %	Cholesterol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	3-24	+	+	NG	NG	NG	NG	30.7	NG
3	4-1	+	+	12.1	152	113	143.9	40.0	140

Fita #132

June 26, 1961

Sample	Day	Time	Volume	Urea N mg. %	Choles-terol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1	6-26	+	+	12.3	278	97	143	16.8	60
2	6-28	+	+	13.7	302	107	140	20.4	100

Zena #134

Sample	Day	Time	Volume	Urea N mg. %	Choles-terol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1		+	+	12.6	270	94.0	140		122
2		+	+	13.5	242	98.5	137		127

Beta #135

May 29, 1961

Sample	Day	Time	Volume	Urea N mg. %	Cholesterol mg. %	Chloride mEq/L	Na mEq/L	17-OHCS mcg. %	Glucose mg. %
1		+	+	9.3	302	107	143	32.3	Q.S
2		+	+	QNS	QNS	103	137	QNS	QNS
3		+	+	14.2	213	QNS	QNS	QNS	QNS

APPENDIX III

PROGRESS REPORT - 21 FEBRUARY 1961

NITROGEN METABOLISM

by Fred Elmadjian

NITROGEN METABOLISM

Indices of nitrogen metabolism contained in this report are urinary creatinine, urea nitrogen, uric acid and plasma urea nitrogen. The data include results obtained in temperature humidity test (THT) 3, 11, 12, 14, 15 and 18. These tests were selected because of the relative completeness of the sampling for preliminary evaluation (refer to Progress Report on Urinary Electrolytes, dated 15 February 1961).

Urinary nitrogen excretion is influenced by (a) diet, (b) excretion rate, and (c) anabolic and catabolic processes. A more complete discussion of the physiological and biochemical factors will be forthcoming in a later report.

Ten urine collections were scheduled for each THT. The odd numbered samples represent urine collected at approximately 0700-1600 (day) and the even numbered at approximately 1600-0700 (night). The protocols called for setting of temperature, humidity, and the chimpanzees were immobile for approximately 20 hours, deprived of food and water during the stress (samples 3 and 4).

Urinary Creatinine: The data presented in Table I is expressed in terms of total creatinine in each sample received. In addition to the average excretion of each of the 10 samplings in the 6 experiments, the average daily excretion for each day of the test is also given. Note that there is some variability in the data presented for samples 1, 2, 5, 6, 7, 8, 9 and 10. It should be pointed out that the odd numbered samples represent about 8.5 hours, while those of the even numbered samples represent excretion over a 15.5 hour period. The greater variability in creatinine excretion observed in samples 3 and 4 may be due to incompleteness of urinary collections; this is highly likely in THT 12, samples 3 and 4; THT 14, sample 3; and THT 18, sample 3. The average daily creatinine excretion of days 1, 3, 4 and 5 are calculated as 459 mgm: this value may be expressed in terms of creatine excretion per hour; this is calculated as 19 mgm/hour. This compares quite favorably with the 20 mgm. as the value for hourly creatinine excretion selected in the Progress Report dated 15 December 1960. All other urinary data in this report is presented in terms of 20 mgm. creatinine and these values are considered to be equivalent to hourly excretion rates.

Urinary Urea Nitrogen: The data presented in Table II contains the values of each sample of the 6 THT and the average of samples 1 through 10, in terms of 20 mgm. creatinine. In

Table IV are given the daily urea nitrogen excretion for each of the five days calculated from the basic assumption that 20 mgm. creatinine is equal to hourly excretion rates. In view of the protocol calling for withholding food and water during period of the second day (samples 3 and 4) a negative nitrogen balance of moderate properties is indicated. This is supported by the data of plasma urea nitrogen and the fact that the urea nitrogen excretion during the stress period is at least 10 percent greater than the days when the animals had access to food and water. Note especially the elevated plasma urea nitrogen in THT 11, 14 and 18 in sample 2 (stress sample) and the little or no change in plasma values of THT 3 and 12 (Table V).

Urinary Uric Acid: There is a moderate to marked increase in uric acid excretion in samples 5, 6 and 7 (Table III). Some indications of an increase are observed even during the stress samplings (samples 3 and 4 of THT 12 and sample 3 of THT 18). The values return to pre-stress levels in samples 8, 9, and 10. Nucleoprotein catabolism is indicated in increased uric acid excretion. The similarity of temperal aspects of increases in inorganic phosphate tends to support this conclusion (refer to Progress Report dated 15 February 1961).

Comments: The data of nitrogen metabolism presented in this report relates to immature chimpanzees, weighing approximately 40 pounds and 3-4 years of age. How do these data compare with preadolescent children? In a recent publication of the nitrogen metabolism of a group of children with a mean age of 8 years and weighing on an average 63 pounds, showed a daily creatinine excretion of 574 mgm. and total urinary nitrogen of 7270 mgm. on a medium protein diet.* These data compare favorably with data in Tables I-IV of this report.

The data of THT indicate that the stress resulted in moderate negative nitrogen balance, indicative of tissue catabolism. The values for urea nitrogen return to normal levels the day after stress, and uric acid values return to pre-stress levels by the third day after the stress.

---

*James, J.H., Nitrogen Metabolism. Symposium on Metabolic Patterns in Preadolescent Children. Fed. Proc. 19: 1009, No. 4, Dec., 1960.

TABLE I

TOTAL CREATININE
mgm.

Animal No.	THT	SAMPLE NO. 1	2	3	4	5	6	7	8	9	10
41	3*	198	117	99	113	218	---	---	65	204	---
42	11	147	388	298	323	244	363	87	289	170	248
44	12	116	20	35	8.7	111	340	61	205	111	375
35	14	206	318	32.3	147	128	352	193	392	111	---
41	15	212	189	193	185	442	220	81	339	146	370
35	18	195	398	34.2	213	---	402	130	145	183	284
	Average	179	272	115.2	164.9	229	335	110	239	154	319
	Average	Day 1 - 451		Day 2 - 280		Day 3-564		Day 4 - 349		Day 5 - 473	

*The protocols indicate 12-hour collections in THT-3; all other THT represent approximately 8.5 hours for odd numbers and 15.5-hour collections for even numbered samples.

TABLE II

UREA NITROGEN mgm/20 mgm Creatinine

Animal Nc.	THT	SAMPLE NO. 1	2	3	4	5	6	7	8	9	10
41	3	258	247	249	258	266	---	---	172	194	---
42	11	118	162	154	154	124	110	112	116	81	118
44	12	174	193	197	---	195	173	200	167	155	194
35	14	101	177	161	66	92	107	152	147	300	---
41	15	100	517	227	244	256	277	109	216	212	206
35	18	181	120	180	394	---	370	145	450	248	299
Average		155	236	195	283	187	207	143	211	198	204

TABLE III

URIC ACID mgm/20 mgm Creatinine

Animal No.	THT	SAMPLE NO. 1	2	3	4	5	6	7	8	9	10
41	3	16.1	15.8	17.1	13.2	24.0	---	---	8.5	6.7	---
48	11	22.5	12.5	17.7	14.2	21.2	25.2	30.5	14.2	11.7	9.9
44	12	7.7	16.2	19.2	22.4	27.0	44.0	21.4	20.5	25.6	20.7
35	14	15.3	23.0	13.0	7.2	17.5	12.4	20.0	21.4	15.7	---
41	15	12.0	19.3	8.6	13.6	27.2	27.5	51.2	13.8	---	18.7
35	18	15.1	13.2	9.2	27.8	---	22.3	15.2	19.0	13.0	13.8
Average		14.8	18.0	14.1	16.4	23.4	26.3	27.7	16.2	14.5	15.8

TABLE IV

TOTAL URINARY NITROGEN EXCRETION mgm/day

Day	1	2	3	4	5
Urea Nitrogen	4965	6035	4800	4472	4840
Uric Acid Nitrogen*	146	132	220	175	133
Creatinine Nitrogen*	167	104	209	129	175
Total Nitrogen (approx. 90%)	5278	6271	5229	4776	5148

*Calculated from mgm uric acid and mgm creatinine

TABLE V

PLASMA UREA N mg%

Animal No.	THT	SAMPLE NUMBER 1	2	3
41	3	15.8	15.8	10.8
42	11	15.5	29.2	11.8
44	12	17.1	13.4	18.1
35	14	11.8	30.8	48.0
41	15	16.5	---	---
35	18	9.9	35.6	17.0
Average		14.6	24.9	21.1

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