# Evaluation of the Long-Term Nutritional Potential of A Chemically Defined Liquid Diet for Small Primates

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## ABSTRACT

Feeding trials were conducted to evaluate the long-term nutritional potential of a chemically defined liquid diet for Saimiri sciureus (squirrel monkeys) and to determine whether such a diet can serve as their sole source of water and nutrients.

Six squirrel monkeys were maintained on a 50% (w/v) chemically defined liquid diet and three others were maintained on a standard stock diet for 13 - 16 months. Both groups of monkeys appeared to be active and healthy. Five out of the six monkeys fed the liquid diet gained or maintained weight. One monkey showed a marked weight loss. Diet intake of the liquid-fed group averaged 72 ml/day (129 cal/day). Their ad-libitum water intake averaged 166 ml/day. The three monkeys fed the standard-stock diet each gained weight. Their diet consumption averaged 53 g/day (cal/day) and their ad-libitum water intake averaged 110 ml/day.

After the monkeys were on the 50% (w/v) chemically defined liquid diet for one year, they were deprived of their ad-libitum drinking water and fed the liquid diet as their sole source of water and nutrients. The diet concentration was reduced to 40 and 33% (w/v). Under these conditions the monkeys survived but did poorly. Weight loss occurred and they showed signs of dehydration. The weight loss observed when the monkeys were fed the 40% (w/v) diet appeared to be due to dehydration. Their weight loss on the 33% (w/v) diet appeared to be due to dehydration as well as inadequate nutrient intake. In the latter instance, the monkeys failed to consume a sufficient amount of diet to fully compensate for the lower diet concentration.

At termination of the experiment, hematological studies showed that most blood values were normal. Leukocytes were slightly lower in all monkeys,

regardless of their previous diet history. There was no clear evidence that the blood values measured were influenced by the diets studied.

Gross necropsies showed that monkeys fed the stock diet were generally in better physical condition than the liquid-fed animals. Filariasis was observed in both groups. The organ weights of the liquid-fed monkeys tended to be smaller than those of the stock-fed group. Tail alopecia due to "hair-pulling", and signs of dehydration due to the water deprivation regimens were prevalent in the liquid-fed monkeys. There were no other gross pathological lesions associated with diet. Histological examinations are in progress and will be reported at a later date.

## INTRODUCTION

The objectives of the studies herein reported were two-fold:

1. To complete our evaluation of the long-term nutritional potential of a chemically defined liquid diet for Saimiri sciureus initiated under Contract NASw-517, and,

2. To determine, whether, as in the case of the rat (1), a single solution of such a diet can simultaneously satisfy the water and nutritive requirements of the squirrel monkey over a short period of time.

## GENERAL PROCEDURES

The animals studied and the procedures employed were essentially the same as described in our last annual report to NASA (2). Monkeys which had previously adapted to a liquid regimen (2) were fed a 50% (w/v) chemically defined liquid diet (Table 1) throughout the experimental period. Control animals were fed a standard-stock biscuit (Rockland Primate Diet) (2). Body weights were measured bi-weekly. Diet and water consumption were measured daily. After the monkeys had been on the liquid regimen for at least one year their drinking water was withdrawn, and the liquid diet served as their sole source of water and nutrients. It was fed at concentrations of 40 and 33% (w/v). At termination of the experiment, the monkeys were bled for hematological studies, and then sacrificed for gross necropsy and histological examination.

RESULTS

Six squirrel monkeys were maintained on a 50% (w/v) chemically defined liquid diet for 13 - 16 months. All were active and appeared healthy. Alopecia was observed on the tails of several monkeys, but there were no signs of hair loss or dermatitis on the torso or head region of these animals. Most of the monkeys gained or maintained body weight on the liquid regimen (Table 2). Only one monkey lost a large amount of weight (i.e., monkey 4 lost 158 g). Diet intake ranged between 57 and 92 ml/day. Body weight changes were related to diet intake but not in a linear fashion. Ad-libitum water intake ranged between 97 - 143 ml/day and averaged 117 ml/day. Total water intake (dietary water + ad-libitum water) ranged between 136 - 194 ml/day and averaged 166 ml/day.

The three monkeys fed the stock diet each gained weight. Their diet consumption averaged 53 g/day, (196 cal/day). Ad-libitum water intake (equivalent to total water intake) averaged 110 ml/day.

After the monkeys had been fed the 50% (w/v) chemically defined liquid diet for one year, they were deprived of their ad-libitum drinking water and fed the same diet (Table 1) as their sole source of water and nutrients at reduced concentrations, i.e., 40 and 33% (w/v).[1] Initially the monkeys were switched to the 40% (w/v) diet for two to four weeks. During this time, all but one (monkey 13) lost weight and one monkey (monkey 15) died (Table 3). Nutrient intakes for each monkey (except monkeys 6 and 14) were within 5% of their respective intakes when fed the 50% (w/v) diet with ad-libitum water (Tables 2, 3 and 5). Monkeys 6 and 14 decreased their intakes markedly. Water intake contributed by the diet was greater when the monkeys (except monkey 14) consumed the 40% (w/v) diet than when they consumed the 50% (w/v) diet with ad-libitum water. However, total water intake was greater when they were on the latter regimen.

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[1] Monkey 13 received the 50% (w/v) diet + drinking for only five months prior to starting this regimen.

When the monkeys were switched to the 33% (w/v) diet, they all lost weight. In all cases nutrient intake was less than when they were fed the 40% (w/v) diet. Water intake contributed by diet was greater than when the monkeys consumed the 40% (w/v) diet, but it was still far less than when ad-libitum water was provided with the 50% (w/v) diet.

Four monkeys were returned to the 50% (w/v) diet + ad-libitum water, after they had been on the water deprivation regimens for four to six weeks (Table 3). Their nutrient and water consumption approximated the levels observed prior to water deprivation (Table 5) and all gained weight (Table 4). In two cases (monkeys 7 and 14), they gained more than they lost on the 33 and 40% (w/v) regimens (Tables 3 and 4).

At termination of the experiment, hematological determinations were made on seven monkeys which were bled by cardiac puncture prior to being sacrificed. Erythrocyte (RBC), hematocrit and hemoglobin values were unaffected by the dietary regimens studied (Table 6). Several values deviated slightly from the normal range suggested for squirrel monkeys (4). Total leukocyte (WBC) counts were low in almost all cases, and were lowest for monkeys fed the stock diet. All had WBC counts below the normal range. Eosinophils were abnormally high in two animals (monkeys 5 and 18) fed the stock diet. Monocytes were abnormally high in two liquid-fed monkeys (monkeys 4 and 7) and lymphocytes were abnormally low in three monkeys (monkeys 2, 4 and 6) on the liquid regimens. Neutrophils in the liquid-fed animals exceeded the normal range but occurred more frequently than in the stock-fed animals.

After bleeding, all surviving monkeys were sacrificed and gross autopsies were performed. In general, monkeys fed the stock diet had a better gross physical appearance than those fed the liquid diet. Two animals (monkeys

10 and 18) fed the stock diet were classified in good physical condition, and one (monkey 5) was classified fair. In the liquid-fed group, two were classified in good physical condition (monkeys 2 and 14), one was classified fair (monkey 7) and three (monkeys 4, 6 and 13) were emaciated. Skin dryness and tail alopecia were prevalent in these animals. Filarial worms were present in almost all the monkeys studied regardless of diet.

Post-mortem organ weights (Table 7) tended to be less for the liquid-fed monkeys. This was particularly true for the livers. The weight differences between the other organs of the two dietary groups was relatively small and appeared to be related to body weight. Details of the necropsies performed on each monkey are presented in the Appendix.

DISCUSSION

The results of the first phase of this study show that squirrel monkeys can be maintained in a good state of health when fed a chemically defined liquid diet for a prolonged period of time (13 - 16 months).

Because the ages of the monkeys were unknown, we can only conclude that the liquid diet tested was adequate for maintaining body weight and for promoting weight gain. It is doubtful that the diet was optimal. Our previous report suggested that it may be deficient in calcium and fat, borderline in phosphorus and sub-optimal in amino acid pattern (2). However, due to the limited objectives of the present study, no modifications were made. The fact that two liquid-fed monkeys gained as much as, or more than stock-fed animals (Table 2, monkey 2 vs. 10; monkeys 2 and 15 vs. 18) while the remainder did not do as well, could be related to age, diet intake and/or diet composition.

The second phase of this study showed that squirrel monkeys survive, but do not do well, when a chemically defined diet serves as their sole source of water and nutrients (Table 3). A 40% (w/v) and a 33% (w/v) each were inadequate when the monkeys were deprived of a separate supply of drinking water. Weight loss occurred and the animals showed signs of dehydration.

The weight loss observed when the monkeys were fed 40% (w/v) diet appeared to be chiefly due to dehydration. In all but two cases (monkeys 6 and 14) caloric intakes were equivalent to the previous experimental period when they received a 50% (w/v) diet with drinking water (Table 5).

When the monkeys were fed the 33% (w/v) diet, they did not (except for monkey 2) compensate for the dilution by increasing their intake (Table 5).

As a result, their energy and total nutrient intakes were below their intakes on the previous two regimens, i.e., 40% (w/v) minus ad-libitum water and 50% (w/v) + ad-libitum water.

These findings are in contrast to our earlier observations with rats, where we determined that a 37% (w/v) diet could simultaneously satisfy their water and nutritive requirements (1). At diet concentrations, similar to those fed in this study, i.e., 50 - 40 - 30% (w/v) rats satisfied their energy requirements by increasing their intakes as the diets became more dilute. In so doing, they consumed the same amount of water (solely from the diet) as the control group receiving ad-libitum water.

Under the conditions of this experiment (with the exception of monkey 2) squirrel monkeys did not exhibit this capacity. This may have been due to a relatively high water requirement and to dehydration initiated by the 40% (w/v) minus ad-libitum water regimen and carried over to the 33% (w/v) minus ad-libitum water regimen. In the case of monkey 2, energy and nutrient intakes were virtually equivalent on all regimens (Table 5). Nevertheless, body weight loss occurred, suggesting poor diet utilization or the onset of dehydration due to insufficient dietary water. Gross necropsy of monkey 2 did not reveal any signs of dehydration (Appendix).

One index of the relationship of water intake to solid nutrient intake is the water:energy ratio. During these studies, monkeys fed the stock diet consumed an average of 108 ml and 196 cal/day and those on the 50% (w/v) + ad-libitum regimen averaged 153 ml and 127 cal/day. Their water:energy ratios were 0.6 and 1.2 respectively. These ratios can be satisfied by a 22% (w/v) diet (water:energy ratio - 1.2) and a 40% (w/v) diet (water: energy ratio - 0.6). We already noted that a 40% (w/v) diet causes dehydration. A 22% (w/v) diet, on the other hand, might prove satisfactory

if consumed in ample quantity. Its water:energy ratio is equivalent to that voluntarily attained by monkeys fed a 50% (w/v) diet with ad-libitum water (Table 3).

The ideal diet for simultaneously satisfying the water and nutritive requirements of the squirrel monkey may be one with a water:energy ratio between 0.6 and 1.2, i.e., between 20% and 40% (w/v). This would be expected if the water requirement of the monkey decreases with decreasing diet osmolarity due to dilution. Studies should be conducted in which diets varying in concentration from 20% - 30% (w/v) are fed to squirrel monkeys as their sole source of water and nutrients. Such diets should be able to satisfy their nutritive requirements without exceeding their volume capacity.

Finally, mention should be made about the terminal hematologies and gross port-mortem necropsies. Blood values were highly variable and generally were not influenced by diet (Table 6). Wide variations in blood values between squirrel monkeys and in the same squirrel monkey are not uncommon and have been reported by others (3 and 4). In the present study, only one sample was taken from each monkey. In future studies, we recommend at least three samplings for each animal.

Most blood values were considered to be normal. Only WBC counts were low, but this was true regardless of dietary regimen. Although the distribution of WBC differed slightly between animals on different regimens, the deviations were too small and the number of samplings too limited to draw any conclusions.

Gross necropsies showed the stock-fed monkeys to be in better physical condition than the liquid-fed animals (Table 7 and Appendix). This may have been partially due to the effects of dehydration. Prior to depriving

the monkeys of drinking water they appeared to be in good physical condition, were active and healthy, maintained or gained weight and did not show many of the signs of dehydration observed on autopsy, i.e., emaciation, scaley skin, dryness, etc. Alopecia of the tail was noted throughout these studies in both liquid and stock-fed monkeys, but it was prevalent in the former group. This was due in part to the metal floor of the cage and to "hair-pulling and chewing" by the liquid-fed monkeys.

Apart from dehydration due to the water deprivation regimens there were no gross pathological signs attributable to diet. The vital organs of the liquid-fed monkeys tended to be generally smaller than the stock-fed animals but this was generally related to body size. Histological examinations are now being performed on these organs as well as other tissues and should be completed in several months.

## RECOMMENDATIONS

The results of these experiments are preliminary and require additional follow-up. Due to budgetary restrictions, it was necessary to confine the scope of the program and to conduct the experiments with a limited number of animals. The following list of recommendations suggests those areas of investigation which we feel will be useful to NASA in the future development of liquid diet for squirrel monkeys and other primates. Several were previously listed in our last report (2).

1. Adaptation studies to determine the most expeditious way to transfer squirrel monkeys to a liquid diet and to establish a routine procedure of implementation.

2. Metabolism studies (preferably with female squirrel monkeys) to establish requirement levels for such major nutrients as protein, energy, calcium, and phosphorus and to determine nutrient utilization by monkeys fed liquid diets.

3. Performance studies to determine whether squirrel monkeys which have been maintained on a liquid diet for at least six months can perform in-flight tasks with the same dexterity as control animals fed stock diets.

4. Microbiological studies to isolate and biochemically identify the intestinal flora of squirrel monkeys on solid and liquid diets.

5. Water deprivation studies to determine whether a liquid diet at concentrations of 20 - 30% (w/v) (i.e., at lower concentrations than herein tested) can serve as a single source of water and nutrients for the squirrel monkey.

6. Histological studies to determine:

   a. tissue and cellular changes resulting from long-term liquid diet feeding
   b. whether such changes alter normal function and metabolic patterns
   c. whether such changes are reversible

7. Diet optimization studies to improve upon the acceptance and nutritional efficacy of chemically defined liquid diets.

TABLE I

Composition of Liquid Test Diet*

| Carbohydrates | g/l |
|---|---|
| Glucose | 340.0 |
| **Amino acids** | **g/l** |
| Protein hydrolysate | 102.3 |
| L-methionine | 3.4 |
| L-tryptophan | 1.5 |
| L-phenylalanine | 3.5 |
| L-arginine·HCl | 0.9 |
| L-lysine·HCl | 4.4 |
| Glycine | 1.6 |
| **Minerals, macro** | **g/l** |
| Sodium chloride | 2.3 |
| Sodium bicarbonate | 1.8 |
| Potassium gluconate | 12.9 |
| Magnesium gluconate | 2.1 |
| Calcium glycerophosphate | 14.0 |
| Ferrous ammonium sulfate | 0.7 |
| **Minerals, trace** | **mg/l** |
| Manganese acetate·$4H_2O$ | 130.9 |
| Cupric acetate·$H_2O$ | 7.5 |
| Ammonium molybdate·$4H_2O$ | 3.0 |
| Cobalt acetate·$4H_2O$ | 4.5 |
| Potassium iodide | 15.1 |
| Zinc benzoate | 11.1 |

| Vitamins, water soluble | mg/l | |
|---|---|---|
| Ascorbic acid | 375 | |
| Biotin | 0.22 | |
| Vit. $B_{12}$ (0.1% trituration) | 75.0 | |
| Calcium pantothenate | 37.5 | |
| Choline·HCl | 2.5 | g |
| Folic acid | 0.37 | |
| Inositol | 187.5 | |
| Niacin | 28.12 | |
| p-amino benzoic acid | 225 | |
| Pyridoxine·HCl | 4.72 | |
| Riboflavin | 5.62 | |
| Thiamine·HCl | 3.75 | |
| **Vitamins, fat soluble** | **mg/l** | |
| Vit. A acetate, 3000 IU/mg | 5.0 | |
| Calciferol, 40 IU/mg | 3.5 | |
| Vit. $D_3$, 200 IU/mg | 9.9 | |
| Menadione | 2.1 | |
| α-tocopheryl acetate 1 IU/mg | 25.0 | |
| Ethyl linoleate | 2.0 | g |
| Polysorbate 80 | 3.0 | g |

* Total nutrient concentration 50% (w/v)

TABLE 2

Body Weight, Diet Consumption and Water Consumption of Squirrel Monkeys Fed a Chemically Defined Liquid Diet or a Stock Diet for a Prolonged Period of Time.

| Monkey | Duration | Body Weight Initial | Body Weight Δ | Diet Intake* | | Water Intake* Diet Ad Libitum | Water Intake* Total |
|---|---|---|---|---|---|---|---|
| | mos | g | g | ml/day | cal/day | ml/day | |
| | | | | Liquid-Diet** | | | |
| 2 | 16 | 914 | (+)165 | 91.8± 1.7+ | 165.2 | 62.3 | 112.0± 2.2+ 174.3 |
| 4 | 15 | 782 | (-)158 | 57.4± 1.6 | 103.3 | 38.9 | 97.9± 2.3 136.8 |
| 6 | 14 | 603 | (+) 33 | 70.9± 2.8 | 127.6 | 48.1 | 97.7± 2.8 145.8 |
| 7 | 16 | 566 | (+) 62 | 72.4± 1.4 | 130.3 | 49.2 | 117.2± 3.1 166.4 |
| 14 | 13 | 729 | (-) 65 | 66.2± 2.6 | 119.2 | 44.9 | 132.3± 4.9 177.2 |
| 15 | 14 | 606 | (+)133 | 74.0± 1.9 | 133.2 | 50.2 | 143.3± 6.4 193.5 |
| | | | | Stock-Diet‡ | | | |
| | | | | g/day | | | |
| 5 | 16 | 778 | (+)178 | 53.7± 2.1 | 198.7 | | 107.9± 4.5 107.9 |
| 10 | 16 | 905 | (+)169 | 55.9± 1.5 | 206.8 | | 107.9± 4.5 107.9 |
| 18 | 12 | 751 | (+)115 | 49.0± 0.9 | 181.3 | | 108.7± 2.2 108.7 |

* Average Daily Consumption Per Month.

** For Composition See Table 1.

\+ Mean Value ± Standard Error.

‡ Rockland Primate Diet.

TABLE 3

Diet Consumption and Body Weight Change of Squirrel Monkeys Fed Two Concentrations of a Chemically Defined Liquid Diet Without Ad-Libitum Water

| | | 40% (w/v) | | | 33% (w/v) | | |
|---|---|---|---|---|---|---|---|
| Monkey | Initial Body Wt. | Intake | Duration | Body Wt. | Intake | Duration | Body Wt. |
| | g | ml/day | wks | g | ml/day | wks | g |
| 2 | 1079 | 109.9± 2.7 | 3 | (-) 23 | 128.5± 1.6* | 15 | (-) 59 |
| 4 | 624 | 70.2± 3.2 | 3 | (-) 45 | 66.0± 1.1 | 3 | (-)143 |
| 6 | 636 | 75.1± 3.7 | 3 | (-) 43 | 72.5± 1.3 | 3 | (-) 67 |
| 7 | 628 | 91.8± 1.8 | 4 | (-) 27 | - | - | - |
| 13 | 714 | 61.2± 2.9 | 2 | (+) 6 | 66.6± 1.6 | 15 | (-)214 |
| 14 | 628 | 46.2± 2.9 | 2 | (-) 36 | 53.6 ± 4.4 | 2 | (-) 89 |
| 15 | 739 | 90.1± 5.4 | 10 days | D** | - | - | - |

* Mean Value ± Standard Error.

** Died on 11th Day.

TABLE 4

Body Weight Changes, Energy Intake and Water Intake of Squirrel Monkeys Fed Three Different Concentrations of a Chemically Defined Liquid Diet

| | Energy Intake | | | Water Intake | | | Δ-Body Wt. | | |
|---|---|---|---|---|---|---|---|---|---|
| Diet % (w/v) | 40 | 33 | 50 +$H_2O$ | 40 | 33 | 50 +$H_2O$ | 40 | 33 | 50 +$H_2O$ |
| Monkey | cal/day | | | ml/day | | | g | | |
| 4 | 101.1 | 78.4 | 116.8 | 51.9 | 51.9 | 156.4 | (-)45 | (-) 143 | (+) 77 |
| 6 | 108.1 | 86.1 | 111.2 | 55.6 | 57.0 | 149.0 | (-)43 | (-) 67 | (+) 12 |
| 7 | 132.2 | - | 145.3 | 67.9 | - | 172.2 | (-)27 | - | (+)87 |
| 14 | 66.5 | 63.7 | 130.9 | 34.2 | 42.1 | 169.5 | (-)36 | (-) 89 | (+)191 |

TABLE 5

Energy Intake and Water Intake of Squirrel Monkeys Fed a Chemically Defined Liquid Diet With and Without Ad-Libitum Water

| Diet % (w/v) | Energy Intake | | | | Water Intake | | | |
|---|---|---|---|---|---|---|---|---|
| | 50 | 40* | 33* | 50 | 50 | 40* | 33* | 50 |
| | cal/day | | | | ml/day | | | |
| 2 | 165 | 158 | 153 | - | 174 | 81 | 101 | - |
| 4 | 103 | 101 | 78 | 117 | 137 | 52 | 52 | 156 |
| 6 | 128 | 108 | 86 | 111 | 146 | 56 | 57 | 149 |
| 7 | 130 | 132 | - | 145 | 166 | 68 | - | 172 |
| 13 | 85 | 88 | 79 | - | 103 | 45 | 52 | - |
| 14 | 119 | 67 | 64 | 131 | 177 | 34 | 42 | 170 |
| 15 | 133 | 130 | - | - | 194 | 67 | - | - |

* Minus Ad-Libitum Water.

TABLE 6

Hematology of Squirrel Monkeys Fed a Stock Diet or a Chemically Defined Liquid With and Without Ad-Libitum Water

| Measurement | Normal* Values | Stock Diet | | | Liquid Diet | | | Liquid Diet(-)$H_2O$ |
|---|---|---|---|---|---|---|---|---|
| | | #5 | #10 | #18 | #4 | #6 | #7 | #2 |
| RBC x $10^6/mm^3$ | 6.3 - 6.7 | 6.52 | 5.81 | 7.14 | 6.31 | 6.07 | 6.06 | 6.74 |
| Hcrt % | 37 - 41 | 37 | 40 | 41 | 40 | 38 | 39 | 38 |
| Hb gm % | 12.4-13.2 | 11.3 | 12.2 | 12.2 | 12.0 | 12.4 | 12.6 | 12.7 |
| WBC x $10^3/mm^3$ | 7.2-11.0 | 4.5 | 3.3 | 2.9 | 9.7 | 5.4 | 7.3 | 3.6 |
| Lymphocytes % | 18 - 48 | 41 | 38 | 26 | 4 | 12 | 38 | 13 |
| Monocytes % | 2 - 4 | 4 | 2 | 2 | 7 | 2 | 7 | 3 |
| Neutrophils % | 48 80 | 49 | 58 | 66 | 89 | 85 | 54 | 84 |
| Eosinophils % | 0 - 2 | 6 | 1 | 6 | 0 | 0 | 0 | 0 |
| Basophils % | 0 - 2 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |

* Courtesy of Yerkes Primate Center

TABLE 7

Post-mortem Organ Weights of Squirrel Monkeys Fed a Stock Diet or a Chemically Defined Liquid Diet with and without Ad-Libitum Water

| Organ | Stock Diet | | 50% (+) $H_2O$ | | 33% (-) $H_2O$ | |
|---|---|---|---|---|---|---|
| | #10 | #18 | #7 | #14 | #2 | #13 |
| | grams | | | | | |
| Heart | 3.8 | 3.7 | 3.2 | 3.2 | 4.4 | 2.1 |
| Lung | 5.8 | 5.0 | 5.1 | 5.1 | 6.4 | 4.5 |
| Liver | 23.9 | 21.0 | 15.7 | 13.2 | 18.4 | 17.3 |
| Spleen | 1.7 | 0.5 | 0.4 | 0.6 | 0.5 | 0.2 |
| Adrenals | 0.1 | 0.3 | 0.2 | 0.2 | 0.2 | 0.1 |
| Lt. Kidney | 2.7 | 2.8 | 2.6 | 2.0 | 2.4 | 2.0 |
| Rt. Kidney | 2.8 | 2.9 | 2.4 | 1.9 | 2.3 | 2.0 |
| Body Wt. | 1020 | 810 | 640 | 680 | 910 | 490 |

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# APPENDIX

# NECROPSY REPORT

Necropsy No.: Y69-8
Animal No.: No. 2
Date: 1/15/69
Prosector: H. McClure, N. Golarz, S. Pakes
Hours Post-mortem: 0

## Necropsy Findings:

This male squirrel monkey weighs 910 grams and appears to be in relatively good physical condition. The haircoat is thick and shiny, and there is ample subcutaneous fat. The toenails appear to be longer than normal. The incisors are quite loose and the gums are bleeding. Necrotic debris was scraped from between the incisors and over the gums.

Filarial worms are present in the abdominal cavity. A soft nodule, measuring 1.2 x 0.9 cm, is associated with the anterior portion of the esophagus. When sectioned, this nodule exudes a tenacious, greenish, purulent material. The wall of the nodule did not appear to be fibrous.

The liver has a slightly yellowish-tan color and has a somewhat firm consistency - slight resistance to sectioning. The stomach is empty. The mucosa shows diffuse congestion/hemorrhage in the region of the cardia and fundus. The small intestine is empty - mucosa is normal. The cecum is moderately distended with air. The large colon contains a small quantity of semi-formed fecal material.

## Gross Diagnosis:

1) Sacrificed
2) Gingivitis
3) Filariasis
4) Abscess, Submucosal, Esophagus

NECROPSY REPORT

Necropsy No.: Y68-148
Animal No.: No. 4
Date: 12/10/68
Prosector: H. McClure
Hours Post-mortem: 0

Necropsy Findings:

The animal weighs 570 grams and appears markedly emaciated. The skin has a dry, dirty appearance. Nodular lesions are present in the skin along the dorsal surface of the tail.

A few filarial worms are present in the abdominal cavity. The thoracic viscera are grossly normal. Occasional whitish foci are present in the muscles of the neck. The liver has a slightly yellowish-tan color, but otherwise appears grossly normal. Prominent yellowish streaks are present in the medulla of both kidneys. A single subcapsular cyst is present on the left kidney. A similar subcapsular cyst is present on the right kidney. Another cyst is located in the medullary region of the right kidney. Some pitting is also evident on the cortex of the right kidney.

The stomach is empty. A circular area of marked thickening of the stomach wall is present near the pylorus. This area of thickening measures 1 cm in thickness and almost completely encircles the stomach. A small quantity of yellowish fluid is present in the small intestine. Numerous small red nematodes, measuring approximately 4 mm in length, are present in the small intestine. The cecum and large colon contain semi-formed fecal material.

Necropsy No.: Y68-148
PAGE 2

Gross Diagnosis:

1) Sacrificed
2) Emaciation, Marked
3) Filariasis
4) Intestinal Nematodes
5) Cysts, Kidneys

# NECROPSY REPORT

Necropsy No.: Y68-146
Animal No.: No. 5
Date: 12/10/68
Prosector: H. McClure
Hours Post-mortem: 0

## Necropsy Findings:

The animal weighs 670 grams and appears to be in only fair physical condition. No subcutaneous fat, and only minimal mesenteric and omental fat is present. Two filarial worms are present in the abdominal cavity.

The gastro-intestinal tract is completely empty. No gastro-intestinal parasites are noted. The liver has a faintly yellowish color. Prominent yellowish streaks are present in the medulla of the left kidney. The kidneys are otherwise grossly normal, and capsules strip readily, revealing smooth cortical surfaces. The lungs are grossly normal except for a small area of hemorrhage in the left lower lobe. The latter is probably due to prior cardiac puncture for collection of a blood sample. Numerous white foci are present in the muscles of the neck. All other organs and tissues appear grossly normal.

## Gross Diagnosis:

1) Sacrificed
2) Filariasis

NECROPSY REPORT

Necropsy No.: Y68-147
Animal No.: No. 6
Date: 12/10/68
Prosector: H. McClure
Hours Post-mortem: 0

Necropsy Findings:

The animal weighs 490 grams and appears markedly emaciated. The skin has a dry, scaley, "dandruffy" appearance. Both legs are flexed at the knee joint and cannot be fully extended. The spine has a prominent arched appearance. Nodular lesions are present on the skin, near the base of the tail.

A few filarial worms are present in the abdominal cavity. The liver has a yellowish-tan color, but is otherwise unremarkable. The kidneys show no gross lesions, and the capsules strip readily.

The stomach is filled with food, and mucosa is grossly normal. The small intestine contains a small quantity of watery material. Semi-formed fecal material is present in the large colon. No gastro-intestinal parasites are noted. Occasional whitish foci, as noted in the previous animal, are present in the muscles of the neck.

Gross Diagnosis:

1) Sacrificed
2) Emaciation, Marked
3) Filariasis

NECROPSY REPORT

Necropsy No.: Y69-9
Animal No.: No. 7
Date: 1/15/69
Prosector: H. McClure, N. Golarz, S. Pakes
Hours Post-mortem: 0

Necropsy Findings:

This male squirrel monkey weighs 640 grams and appears to be in fair physical condition. There is some loss of hair over the base of the tail, and a callus-like thickening is present on both heels. The lower incisors are missing.

Several filarial worms are present in the abdominal cavity. The liver has a slightly yellowish-tan color, and is somewhat firm in consistency. The stomach contains a small amount of bile-stained fluid. The small intestine is empty - Mucosa is normal. The cecum and large colon contain a small quantity of semi-formed fecal material.

Gross Diagnosis:

1) Sacrificed
2) Filariasis

NECROPSY REPORT

Necropsy No.: Y69-11
Animal No.: No. 10
Date: 1/16/69
Prosector: H. McClure, N. Golarz
Hours Post-mortem: 0

Necropsy Findings:

This male squirrel monkey weighs 1020 grams and appears to be in good body condition. The hair coat is good and has a glossy appearance. The toenails are longer than normal. Ample quantities of subcutaneous and mesenteric fat are present.

One small parasite, approximately 8 mm long, is present in the mesentery. The stomach is moderately distended with food and air. The small intestine is empty. A small quantity of semi-formed fecal material is present in the upper large colon. Faint whitish streaks are present in the medullary regions of the kidneys. The pelvis of the left kidney contains several small, yellowish, firm calculi. The pelvis of the right kidney contains similar, though smaller, calculi.

Gross Diagnosis:

1) Sacrificed
2) Parasite, Mesentery, Unidentified
3) Urinary Calculi, Renal Pelvis

NECROPSY REPORT

Necropsy No.: Y69-6
Animal No.: No. 13
Date: 1/15/69
Prosector: H. McClure, N. Golarz, S. Pakes
Hours Post-mortem: ?

Necropsy Findings:

This male squirrel monkey weighs 490 grams, and shows considerable emaciation. The skin has a somewhat bluish discoloration, and a dry, scaley appearance. Much of the tail is devoid of hair.

The right kidney shows a 1 mm, circumscribed, grayish lesion at the cortico-medullary junction, located at the anterior pole.

The stomach contains a small amount of food and hair. A few scattered petecchial hemorrhages are present in the gastric mucosa. Occasional mucosal petecchiae are also present in the duodenum. The small intestine contains small quantities of ingesta. The mucosa is normal. A small quantity of semi-formed fecal material, admixed with hair, is present in the colon. The cecum is moderately distended with air. It also contains a considerable quantity of hair. Occasional foci of mucosal hemorrhage are also present in the cecum.

Gross Diagnosis:

Dead on arrival - no specific cause of death was detected at necropsy, other than emaciation and probably dehydration. Stress associated with shipment probably contributed to the animals death.

NECROPSY REPORT

Necropsy No.: Y69-7
Animal No.: No. 14
Date: 1/15/69
Prosector: H. McClure, N. Golarz, S. Pakes
Hours Post-mortem: 0

Necropsy Findings:

This male squirrel monkey weighs 680 grams and appears to be in relatively good physical condition. The haircoat is thick and shiny, but somewhat dry. The skin has a somewhat scaley appearance, and a bluish coloration. The toenails appear to be slightly longer than normal. The base of the tail shows an area of alopecia with a rough, thickened skin. A papillomatous-like lesion, measuring 0.7 x 1.5 cm is present on the lateral volor surface of the foot, just distal to the tarsal joint. This lesion has a greyish color and roughened, irregular surface.

Six adult filarial worms are present in the abdominal cavity. The dorsal surface of the central lobe of the liver shows a well circumscribed, greyish lesion approximately 1 mm in diameter. This lesion is raised slightly above the hepatic surface and is surrounded by a narrow red zone. One additional similar-type lesion was found in the hepatic parenchyma.

The animal appears to have an ample supply of subcutaneous and mesenteric fat.

The surface of the kidneys is somewhat pitted and granular, although the capsules are readily removed. Faint whitish streaks are evident in the medullary regions of both kidneys. The cortex of the kidneys is slightly pale.

Necropsy No.: Y69-7



The stomach and small intestine are empty. The cecum and large colon contain small quantities of greenish-brown mucoid material.

Gross Diagnosis:

1) Sacrificed
2) Filariasis
3) Papilloma (?), Skin, Foot

NECROPSY REPORT

Necropsy No.: Y69-10
Animal No.: No. 18
Date: 1/16/69
Prosector: H. McClure, N. Golarz
Hours Post-mortem: 0

Necropsy Findings:

This male squirrel monkey weighs 810 grams and appears to be in good physical condition. The haircoat is good and has a shiny appearance. A small, superficial laceration is present on the chin. Lesions are present on either side of the nose, which appear to have been possible sites of drainage (photographs made).

Considerable subcutaneous and mesenteric fat are evident. Faint yellowish streaks are present in the medulla of the kidneys. The gastrointestinal tract is empty, except for a small amount of semi-formed material in the cecum and large colon. The mucosa of the gastro-intestinal tract is normal. Filarial worms are present in the abdominal cavity.

Gross Diagnosis:

1) Sacrificed
2) Filariasis