MANAGEMENT OF AN OVERWEIGHT PROSIMIAN

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INTRODUCTION

It is not unusual for the body weight of primates to increase dramatically once they are brought into captivity. The presence of abundant food and the absence of exercise contributes to this weight increase. Exercise and the quantity of food can be important factors, but the nutritional content of the food is often over-looked. Captive diets usually do not reflect natural diets, particularly for leaf-eating primates.

The Duke University Primate Center (DUPC) houses the world's largest colony of sifakas: 17 Verreauxi sifaka (*Propithecus verreauxi*) and 2 golden crowned sifiaka (*P. tattersalli)*. The only other sifakas in captivity are three at the Los Angeles Zoo (two of which came from the DUPC). Sifakas are members of the family Indriidae that also includes woolly lemurs (*Avahi laniger)* and indri (*Indri indri*). Members of this family are primarily leaf-eaters, which may explain previous difficulty in keeping them in captivity. In this paper we present the results of a management plan to control body weight in our captive sifakas as well as some dietary suggestions for leaf-eating prosimians.

THE PROBLEM

One of our captive born females (Sabina) became grossly overweight after she matured (Fig 1). Her weight reached a high of 10, 337 grams. The average weight of our captive adult females is 4,519 grams and the average weight of wild sifaka females is 3,882 grams. IN addition to limiting her mobility and contributing to injuries, Sabina's weight gain apparently interfered with her reproductive cycle, because she did not become pregnant even though she was with a proven breeding male. Since she was with her mother, it is possible that her normal sexual cycle was suppressed.

Sabina was housed in a family group with her mother, two younger sisters and an unrelated male. Table 1 shows the pre-September, 1991, daily diet for our sifakas while our new health-wise diet is listed in Table 2. The old diet is standard fare for captive primates with its mix of commercial chow plus fresh fruit and vegetables. In addition, fresh forage from the surrounding Duke Forest and mango leaves from Florida (collected by the Mango Connection) were provided to every group of sifaka. During fall, fresh forage is collected, wrapped in plastic and placed in chest-freezers to be used during the winter months when most North Carolina trees drop their leaves. The addition of fresh forage coincided with increased fertility and survival rate of infants.

Observations of the group's feeding behavior when given the old diet, demonstrated that Sabina was monopolizing the food trays and consuming all or nearly all of the high fat items on the trays, i.e., she was eating all of the peanuts and avocado for five animals. She was able to do this because females are dominant to males in sifakas (Richard & Nicoll, 1987) and adults are dominant to sub-adults. Flavia, Sabina's mother, should have been dominant to Sabina, but Sabina has a much stronger personality than her mother. Nutritional analyses in Table 3 show that peanuts and avocados are very high in fat and low in fiber. Unfortunately, the commercial

chow ZuPreem that was being fed in the old diet, is also high in fat and very low in fiber (Table 3).

THE SOLUTION

Since none of the other group members were overweight there was a reluctance to eliminate the high fat items from their diet or to change the commercial chow being fed them, particularly because Flavia was lactating for 6 or 7 months per year and both of Sabina's sisters were doing well on this high fat-low fiber diet. Also, extra high fat food was provided whenever there was an infant being weaned. The belief was that the extra food was necessary for the slow-eating infants to get enough food. Sabina could not be removed from the group, because there was no suitable mate available for her. Thus, we had to prevent her from obtaining the high fat items from the trays without removing her from the group.

The company that manufactures the Invisible Fence for dogs came to our rescue. In September, 1991, an Invisible Fence R6500 receiver was placed around Sabina's neck and a AT880 transmitter was mounted near one of the trays containing the food items listed in Table 1. After some initial adjustments of the collar holding the receiver and re-positioning the food tray, Sabina began to lose weight because the transmitter pervented her from approaching the tray with peanuts and avocados but did not interfer with her eating from the low fat diet tray placed in another location. Our goal for her was a weight loss of about 200-300 grams per month. A weight loss of more than 300 grams per month appears to trigger hepatic lipidosis in sifakas (DUPC medical records).

Sabina lost weight slowly, indicating that the system design was successful. On May 13, 1992 She was removed from her natal group and placed with a male sifaka, Vespasian who was also slightly overweight. The receiver was removed on June 4, 1992, because she continued to lose weight on the new diet.

After being placed with Vespasian, Sabina experienced her first sexual receptive period. The new male could have triggered her first cycle or her significant weight loss could have been the reason. She and Vespasian were observed to copulate on November 9, 10, and 11, 1992. This is the normal breeding period for the DUPC sifakas, however, she did not become pregnant.

Sabina's weight on March 16, 1993, was 6,880 grams. She has lost 3,457 grams in 18 months or an average of 192 grams per month. Her diet continues to be restricted with the ultimate goal of reducing her body weight to the average body weight of 4.5 kg. for the other DUPC sifaka females.

DISCUSSION AND SUMMARY

The use of a novel method of restricting access to high fat food items was successful in bringing about a gradual weight loss for one of the DUPC's overweight sifakas. Her weight gain and the gradually increasing weight of our *Propithecus* colony in general resulted in a complete evaluation of the diets used at the DUPC and a comparison of our diet for captive animals with that for wild *Propithecus* . The result was a change in the diet for *P. verreauxi* and a modification of the diet for our entire colony of 485 prosimians. Superabundant food and lack of exercise played a role in Sabina's weight increase, but it is likely that the nutritional content of the food was equally important.

Wild leaf-eating primates eat foods that have one fifth the amount of fat, 1/2 the amount of protein, and 2 to 15 times the amount of fiber when compared to the captive diet for DUPC sifakas (Table 3). These are major dietary differences which, when added to the decreased exercise, could have serious negative impact on captive animals. Of the three components, the

type of fat may be the most critical factor, since hyper- and hypolipidemias and the development of atherosclerotic lesions can be affected by certain kinds of ingested fats.

There have been no plasma lipoprotein studies of sifakas, but analysis of fruit-eating spider monkeys (*Ateles geoffroyi*) and leaf-eating howling monkeys (*Alouatta palliata*) found that they had the lowest proportion of high density lipoproteins (HDL) of any primate while HDL carried more than 2/3 of the total plasma cholesterol in seed-eating capuchins (*Cebus albifrons*) (Clark et al., 1987). Fruit and leaves contain little fat while seeds contain large amounts of fat.

Consideration must also be given to the ratio of polyunsaturated and saturated phospholipids. Captive chimpanzees (Genus *Pan*) were fed three different diets that each contained the same percentages of protein, carbohydrates and fat and the same number of calories but varied the ratio of unsaturated to saturated fat (Rosseneu et al., 1979). The saturated phospholipid diet increased triglyceride and low density lipoprotein (LDL) levels. Kruski (1983) found linoleate (18:2) to be the most common FA in baboons (Genus *Papio*) as it is in howlers (Clark et al., 1987), but howlers have relatively high levels of linolenate (18:3 fatty acid) (Clark et al., 1987). The relative amounts of 18:3 and 16:0 (palmitate) fatty acids have been linked in human atherosclerosis and could be a factor for captive primates as suggested by the baboon and chimpanzee results.

In changing our sifakas' diet we have tried to address some of the problems of reduced exercise and inappropriate nutrient levels of captive diets. Verreauxi sifakas eat leaves in the wild and some fruit, but they ahve not been observed to eat high fat seeds. As suggested above, their wild diets are low in fat and protein and high in fiber, yet we were feeding a captive diet that was high in fat and protein and very low in fiber. ZuPreem contains animal fat which leaf-eating primates would not ingest in their wild diets. By changing to Mazuri leaf-eaters chow, all fats are vegetable or fish in origin. The addition of fish meal may be important because it provides omega-3 fatty acids similar to those found in plants.

The amount of fiber has been dramatically increased, but the amount of fat and protein is still too high (Table 3). The high fat items such as peanuts and avocados have been eliminated and increased amounts of natural forage have been made available. Increasing the amount of fiber has in fact reduced the available protein because increasing crude fiber depresses crude protein digestibility (Glover & Duthie, 1958). Reducing protein availability is critical because excessive protein can contribute to kidney problems in prosimians (DUPC medical records).

The sifaka and other leaf-eating prosimians help shape their own diets. New types of natural forage are given to them during the spring, summer, and fall when these forages are available. If the animals eat these new species, they are added to the daily offerings until they are no longer eaten. In this fashion, we are mimicking the natural condition where the animals freely chose their foods and are not limited only to the kinds of food offered in most captive situations.

It should be noted that the wild diet of golden crowned sifakas contains a high proportion of seeds (Meyers, pers. comm.). This explains why our captive golden crowned sifakas are able to eat acorns and peanuts without gaining weight. Since their wild diet is high in fat, they are less affected by a high fat captive diet and may in fact require such a diet. This difference in wild diets points out the need for careful evaluation of the need of different captive primate species, even those as closely related as the golden crowned and Verreauxi's sifakas.

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Table 1. Daily diet per animal for DUPC *Propithecus* prior to September, 1991.

Morning

15 pieces (approx. 100 grams) ZuPreem Primate biscuits, cracked and moistened with fruit juice or honey
1/2 cup canned garbanzo beans (chick peas)
1/2 cup canned corn kernels
2-4 one inch chunks of avocado
2 cups of chopped fresh vegetables, i.e., kale, carrots, sweet potatoes, broccoli, celery, cabbage, cucumbers.
2 cups of chopped fruit, i.e., apples, oranges, tangerines, grapes, bananas, melons, pineapple, pears, mangos, pomegranates
1/2 hard boiled egg three times per week
1/2 cup white oak acorns when available
4-8 peanuts if acorns are not available

Afternoon

6-12 branches of various types of forage including sweet gum, mimosa, and sumac collected fresh from adjacent forests. During the spring, summer, and fall, new types of forage are offered on a random basis.

Table 2. Daily diet per animal for DUPC *Propithecus* after September, 1991.

Morning

42 pieces (approx. 22 grams) Mazuri Leaf Eater diet
1/2 cup canned garbanzo beans (chick peas)
1/2 ear of fresh corn is available
1 cup of chopped fresh vegetables, i.e., kale, carrots, sweet potatoes, broccoli, celery, cabbage, cucumbers.
1 cup chopped fruit, i.e., apples, oranges, tangerines, grapes, bananas, melons, pineapple, pears, mangos, pomegranates

Afternoon

6-12 branches of various types of forage including sweet gum, mimosa, and sumac collected fresh from adjacent forests. During the spring, summer, and fall, new types of forage are offered on a random basis. Acorns, peanuts, and pieces of avocado are fed occasionally as treats.

Table 3. Nutritional analysis of captive and wild diets for leaf-eating primates.

	ZuPreem	Mazuri	Wild	Peanuts	Avocado
	a	b	c	b	d
Protein %	20.0	23.0	12.4	27.6	1.7 gm
Fat %	5.0	5.0	<1	43.7	15.8 gm
Crude Fiber %	2.5	14.0	37.5	6.7	1.8 gm
Ash %	5.5	8.0	0.85	8.3	na
Alanine %	na	1.20	0.77		
Arginine %	na	1.01	0.75		
Aspartic Acid %	na	2.22	1.40		
Cystine %	na	0.27	na		
Glutamic Acid %	na	4.05	1.41		
Glycine %	na	0.69	0.73		
Histidine %	na	0.52	0.33		
Isoleucine %	na	0.99	0.53		
Leucine %	na	1.86	1.11		
Lysine %	na	1.05	0.85		
Methionine %	na	0.47	0.22		
Phenylalanine %	na	1.13	0.78		
Proline %	na	1.39	0.85		
Serine %	na	1.05	0.69		
Taurine %	na	<0.01	na		
Threonine %	na	0.74	0.61		
Tryptophan %	na	0.25	na		
Tyrosine %	na	0.86	0.65		
Valine %	na	1.16	0.72		
Amino acids Totals %		20.9	12.4		

a = ZuPreem product data, Hill's, PO Box 148, Topeka, KS 66601
b = Mazuri product data, PMI Feeds, Inc., Hanley Rd., St. Louis, MO 63144
c = Glander, 1981
d = INCAP-ICNND, 1961

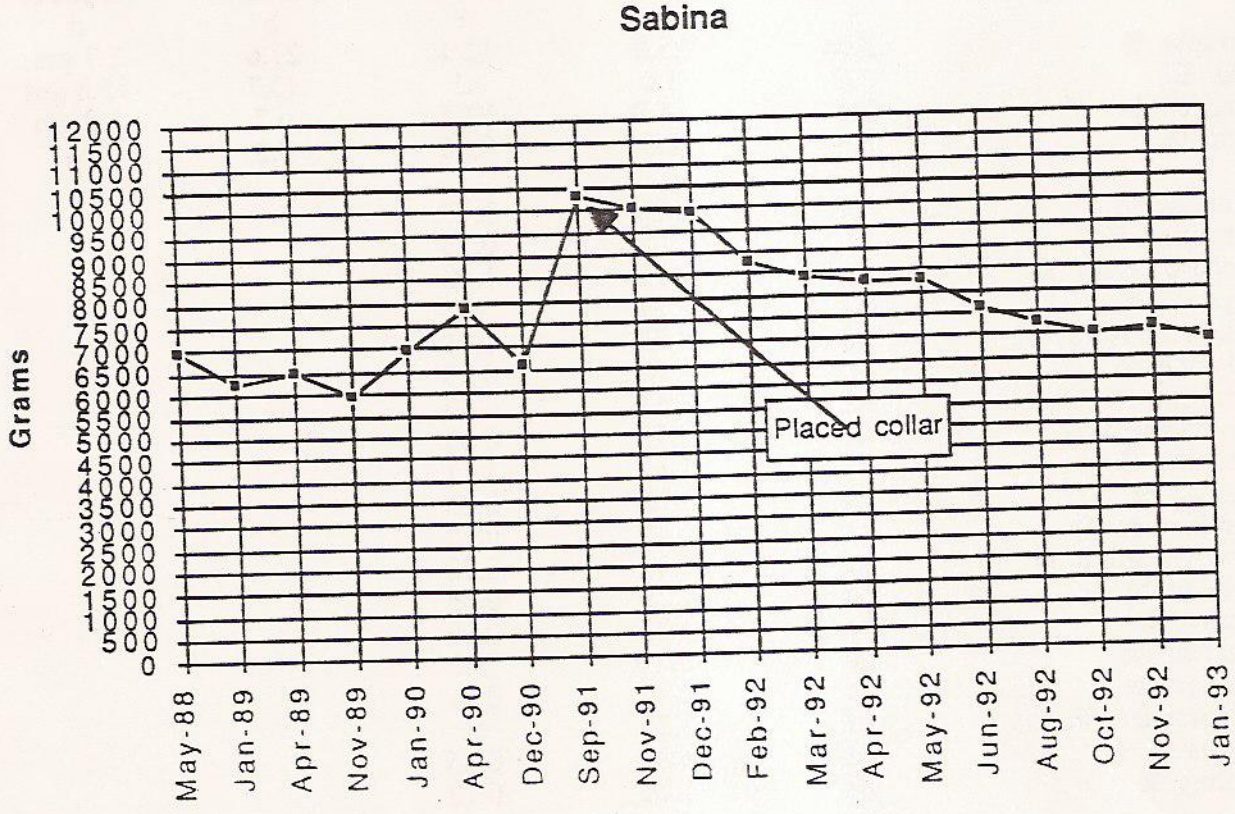

Fig 1. Weight flucuations for Sabina before and after the Invisible Fence transmitter was placed on her neck.