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SPECIAL ISSUE Dedicated to Diabetic Animal Management

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MISSION STATEMENT
(Revised April, 2009)
American Association of Zoo Keepers, Inc.

The American Association of Zoo Keepers, Inc. exists to advance excellence in the animal keeping profession, foster effective communication beneficial to animal care, support deserving conservation projects, and promote the preservation of our natural resources and animal life.

ABOUT THE COVER

The ring-tailed lemur (*Lemur catta*) featured on the cover is Paikea, photographed by Sara Floyd of Riverbanks Zoo. His mother, Maude, is the female diabetic lemur featured on Pages 520-524. Paikea has always lived in a family group. He was born into a group with his mother Maude, Aunt Maddie and Grandmother Martha. Two males, Leo and Larry, were alternated daily in the group, one of whom was Paikea's father. He is now eight years-old and over the course of his life he has also lived in a mixed-species group with red ruffed lemurs (*Varecia rubra*).

Though a dominant female usually leads a ring-tailed troop, Paikea appears to have taken over the responsibility of leading and protecting his mother and aunt after the death of his grandmother. This is most likely due partly to their relatively older ages (24 and 25 years of age). Paikea is used to the daily routine of his mother's insulin injections. He stations on the ground below the overhead transfer door and does not interfere while Maude enters for her shot.

Ring-tailed lemurs are listed as Endangered and are only found on the island of Madagascar where they are threatened by habitat loss. Ring-tails spend much time in the trees as well as on the ground and use their strikingly striped tails for locating other members of the troop through the brush, as well as males using them for displays and "stink fighting" each other to gain dominance.

Articles sent to *Animal Keepers' Forum* will be reviewed by the editorial staff for publication. Articles of a research or technical nature will be submitted to one or more of the zoo professionals who serve as referees for *AKF*. No commitment is made to the author, but an effort will be made to publish articles as soon as possible. Lengthy articles may be separated into monthly installments at the discretion of the Editor. The Editor reserves the right to edit material without consultation unless approval is requested in writing by the author. Materials submitted will not be returned unless accompanied by a stamped, self-addressed, appropriately-sized envelope. Telephone, fax or e-mail contributions of late-breaking news or last-minute insertions are accepted as space allows. **Phone (330) 483-1104; FAX (330) 483-1444; e-mail is shane.good@aazk.org**. If you have questions about submission guidelines, please contact the Editor. Submission guidelines are also found at: **aazk.org/akf-submission-guidelines/.**

Deadline for each regular issue is the 3rd of the preceding month.
Dedicated issues may have separate deadline dates and will be noted by the Editor.

Articles printed do not necessarily reflect the opinions of the *AKF* staff or the American Association of Zoo Keepers, Inc. Publication does not indicate endorsement by the Association.

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FROM THE PRESIDENT

Dietary Challenges

A dedicated issue on the care and maintenance of diabetic animals is a timely collection when so much in our profession is focused on animal welfare. The challenges of working with animals with medical issues, however, are reduced by the advances that today's keepers have made in training and husbandry. While diagnostics are left up to veterinary staff, the long task of daily maintenance requires teamwork, ingenuity, observational skills, and problem solving. Heroic efforts by animal care staff, incorporating all the above, have made a huge impact on the longevity of the animals we care for.

The Basics

I'll veer away from the topic of diabetes and insert a general statement here: we do these things daily in the management and care of the animals we are responsible for. Last month, at the opening of the 2012 conference in Syracuse, I shared with attendees my concept of zookeeping stripped to its bare essentials. As animal care professionals we do three very simple things, all day, every day, from the instant we clock in until the end of the day:

1. We care for animals
2. We communicate
3. We solve problems

No matter what we do, whether it is transferring animals, establishing a transition diet, conducting introductions, shifting, training, crating, or even maintaining a diabetic animal, we incorporate these three things. Our daily successes rely on our ability to perform these three very simple functions and when we have difficulties or challenges, it is because one of these is somehow out of sync or off balance. And rather than site examples of how these three things are integrated so strongly into our daily routines, I think it's much more effective for you all to examine your work day and ask yourselves where these three things fit. I think you'll be amazed at how prominently they fit within our work.

Expanding a Principle

When you look at our Association, we promote those very same simple concepts in all that we do; our conference papers, workshops, and networking support that statement. What we digest from our conferences in the form of the three essentials, is hopefully taken with us to our home institutions where we can apply them to our own unique situations. At home, we apply the same three principles: we care for animals, we communicate, and we solve problems.

As mentioned in previous messages, AAZK is entering the realm of distance learning. We have recently established a partnership with NP Training Works to provide learning opportunities for all of our membership at a nominal price. We are currently beginning the development of

fundamental training modules and hope to incorporate previous workshops in advanced care by early spring. These webinars will be certificate-based and will include electronic materials and networking possibilities. We will keep you informed of our progress and direction. For those who are not able to attend conferences, access to current training and information will now become available. For those who attend conferences, you will be able to supplement your learning at your own pace.

Finding a solution to meeting the professional development needs of our membership has always been a challenge. Establishing a distance learning program where our membership can view and listen to workshops as well as receive relevant electronic materials can help solve that problem and help develop greater networking possibilities for all.

We have very complex, multifaceted roles in animal care but the principles that support those roles are very basic. Committed to advancing excellence in the animal keeping profession, professional development will be available to you all at the conference level, within the *AKF*, and now through distance learning.

At the end of the day it all comes down to one thing: we do all this, because we care for animals; as keepers, institutions, and as the American Association of Zoo Keepers.

As always, I welcome your thoughts and input. E-mail me at bob.cisneros@aazk.org , I would love to hear from you.

Bob Cisneros

A Special Issue Dedicated to Diabetic Animal Management. Photo by Sara Floyd, Riverbanks Zoo

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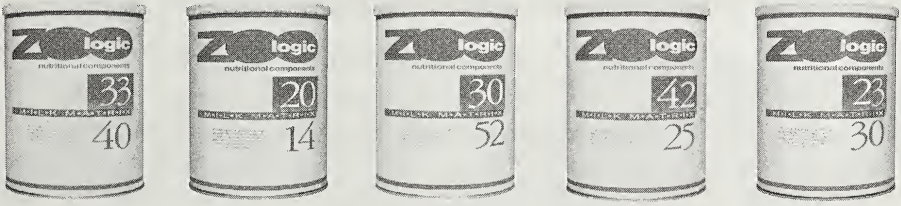

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COMING EVENTS

Post Your Upcoming Events here — e-mail shane.good@aazk.org

December 3-7, 2012
Training and Enrichment Workshop for Zoo and Aquarium Animals
Hosted by Moody Gardens in Galveston, TX, Active Environments and Shape of Enrichment are proud to present the Sixth Training and Enrichment Workshop for Zoo and Aquarium Animals. The workshop will present an array of topics relating to the behavioral management approach to caring for captive animals, with a focus on environmental enrichment, positive reinforcement training techniques, and the problem-solving process. For more information e-mail dolsen@moodygardens.com or go to enrichment.org.

February 27 - March 2, 2013
21st Annual Conference of the International Association of Avian Trainers and Educators
Hosted by Tampa's Lowry Park Zoo, Tampa, FL. For more information go to: iaate.org/iaate-annual-conference/2013-conference

April 14-19, 2013
ABMA Annual Conference
Toronto, Canada
Hosted by the Toronto Zoo at the Delta Chelsea Hotel, Toronto. For more information, go to theabma.org.

April/May 2013
Chimpanzee Meeting and Husbandry Workshop
Please Save the Date: The Chimpanzee SSP and the Houston Zoo are hosting the next Chimpanzee Husbandry Workshop to take place April 30 – May 2, 2013. The Chimpanzee SSP meeting will precede the workshop on April 29, 2013. Stay tuned for more information.

May 5-9, 2013
Eighth Biannual Rhino Keepers' Workshop
Hosted by San Diego Zoo Global. For Call for Papers and more information contact laubery@sandiegozoo.org

May 20-23, 2013
World Crocodile Conference
"Living with Crocodilians" 22nd Working Meeting of the IUCN — SSC, Crocodile Specialist Group. For more information and registration, go to: csgsrilanka.com/

July 8-12, 2013
Zoos and Aquariums Committing to Conservation (ZACC)
Hosted by Blank Park Zoo, Des Moines, Iowa. The conference will bring together colleagues from the field and zoos in an informal setting to network, share ideas and support one another in our shared commitment to conservation. Registration is available at blankparkzoo.com/index.cfm?nodeID=48429&audienceID=1. Contact Jessie Lowry with questions at jrlowry@blankparkzoo.org.

September 22-26, 2013
AAZK NATIONAL CONFERENCE
Hosted by North Carolina Zoo and North Carolina AAZK Chapter, Asheboro, NC
For more information go to:
ncaazk.com/2013nationalconference.htm

October 13-17, 2013
WAZA Annual Conference
Hosted by Disney's Animal Kingdom. For more information go to: waza.org

October 15-18, 2013
ICEE — International Conference on Environmental Enrichment
Hosted by the National Zoological Gardens of South Africa at the Kwalata Game Ranch, South Africa. For more information, go to nzg.ac.za/icee2013

National Conferences

AZA

2013 - Kansas City, MO - September 7-12
2014 - Orlando, FL - September 12-17
2015 - Salt Lake City, UT - September 17-21

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AAZK

2013 - Asheboro, NC - September 22-26
2014 - Orlando, FL - September 8-12
2015 - St. Louis, MO - Dates TBD

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— AAZK ANNOUNCES NEW MEMBERS —

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Stacey Freeman, Toronto Zoo (Canada)

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Mark MacNamara, Fauna Research, Inc., Red Hook (NY)

RENEWING CONTRIBUTING MEMBERS
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Ft. Wayne Children's Zoo, Ft. Wayne (IN)
Northeastern Wisconsin Zoo, Green Bay (WI)
Turpentine Creek Wildlife Refuge, Eureka Springs (AR)
Amarillo Zoo, Amarillo (TX)
America's Teaching Zoo at Moorpark College, Moorpark (CA)

THANK YOU!

The AAZK Board of Directors and Staff sends their sincere appreciation to the Audubon Chapter for sponsoring this month's issue of the *Animal Keepers' Forum*. The Chapter made a special contribution designated for the *AKF* with their re-charter materials. It is the special contributions of our Chapters that allow our Association to continue to grow, expand your professional development opportunities, and reaffirm our commitment to your flagship conservation programs. Our thanks goes out to the Audubon Chapter for sponsoring this month's *AKF*, and to all of the Chapters that support the Association throughout the year.

Behavioral Husbandry Committee Seeks New Members

BHC NEEDS YOU!

Do you have a strong background in training or enrichment? Are you a motivated AAZK member who wants to give more to the organization? Do you have the drive and enthusiasm to do more with your knowledge and expertise? The Behavioral Husbandry Committee (BHC) is looking to recruit new members!

For the first time since the Animal Training Committee and the Enrichment Committee merged to become the BHC, we have openings for new committee members. To apply, please submit a letter of interest along with your resumé and a writing sample to Julie Hartell-Denardo at jshartell@yahoo.com.

CALENDARS FOR SALE!

The International Rhino Keeper Association (IRKA) and the International Rhino Foundation (IRF) produced the 2013 Rhino Conservation Calendar with pictures submitted by rhino supporters from around the world! The sale of the 2013 Rhino Conservation Calendar will assist the Rhino Foundation of Indonesia (Yayasan Badak Indonesia or YABI). YABI oversees the management of the Sumatran Rhino Sanctuary (SRS) on Sumatra, a captive breeding program for the species. You may be familiar with the SRS because on June 23, 2012, the first baby was born at the SRS, a male named Andatu, who is featured in the 2013 Rhino Conservation Calendar. The calendars are being sold for $26 each (including shipping) with all proceeds going towards covering the core costs of the SRS: staff salaries, vehicle running costs, keeper & veterinary costs, veterinary supplies, non-browse nutritional supplements, & facility maintenance. If you are interested in purchasing a calendar to help the IRKA's and IRF's cause, please visit rhinokeeperassociation.org or e-mail IRKACalendar@gmail.com.

CALL FOR PAPERS

For Dedicated Issue of *Animal Keepers' Forum* – Multi-species Bird/Ungulate Habitats

The challenges we face in building sustainable zoo populations while creating dynamic habitats require innovative solutions. Ungulate and bird curators, managers and keepers have much to gain by collaborating together to explore ways to maximize our limited exhibit space. Increased space for our program species, more dynamic and more naturalistic exhibits to benefit our animals and our visitors, and diversification of keeper skills are just some of the benefits of multi-species bird/ungulate habitats.

We encourage those interested to submit manuscripts for consideration to be included in this dedicated issue. Possible topics could include, but are not limited to:

Reproduction/neonatal care	Feeding/nutrition
Veterinary care	Exhibit design
Pest control	Introductions of new animals
Staff communication	Benefits of Hoofstock/Bird multi-taxa habitats
Birds 101 for Hoofstock Keepers/Managers	Hoofstock 101 for Bird Keepers/Managers
Training/enrichment	Species selection

Papers should be submitted electronically, in MS Word only, to **shane.good@aazk.org**. Please use Times New Roman font (10 pt. text body). Please put "Bird Ungulate Issue" in the subject line of your e-mail. Papers should be no more than 10 pages in length. Any charts and/or graphs should be submitted in their native program (i.e. Microsoft Excel, Word, etc.). Photos submitted electronically should be high-resolution (minimum 300 dpi, 1 MB, 900 x 600 pixels) jpg or tiff files. Photos, charts, and graphs should be submitted as separate files and not be embedded in the manuscript. Be sure to include proper photo credit and a suggested caption for each photo. Please reference the complete set of *AKF* submission guidelines at aazk.org/akf-submission-guidelines/.

Be sure to also include your complete contact information including name, address, e-mail and a daytime phone where you may be reached if we have questions concerning your submission. Also be sure to include your facility and your job title at that facility.

Deadline for submission of articles for this special issue is **February 1, 2013.**

Special Call for Papers:
Dedicated Issue on Gorillas

All papers on gorilla husbandry and conservation welcome.
Deadline for submissions is February 1, 2013.
See above for submission guidelines.

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Diabetes Mellitus in Zoos

Pam Dennis, DVM, PhD, Dipl. ACZM
Veterinary Epidemiologist
Cleveland Metroparks Zoo

Diabetes mellitus in humans has increased dramatically in the past several decades. Approximately 20% of the population of the United States has diabetes, with 90-95% of the cases being type 2 diabetes mellitus (T2DM).[1] Type 2 diabetes is also known as non-insulin dependent diabetes because the body can still produce insulin, but the cells do not respond to the insulin properly. According to the World Health Organization at least 285 million people worldwide have diabetes today, and that number is expected to increase to 500 million by 2030. Insulin resistance is an important feature of T2DM, and may represent the earliest metabolic abnormality in the development of T2DM.[2]

Normally, when a person eats a meal, glucose is absorbed into the bloodstream from the digested food. Glucose in the bloodstream signals the release of insulin from the pancreas. Insulin's role is to move glucose out of the bloodstream into cells, where it can be used for energy. If there is a lot of glucose in the bloodstream then more insulin is released, a condition known as hyperinsulinemia, or higher than normal amounts of insulin in the bloodstream. Hyperinsulinemia can progress to a state of impaired glucose tolerance, in which the cells are not responding normally to the presence of insulin, that is they are resistant to insulin. This failure to respond to insulin creates a situation in which the fasting glucose levels are higher than normal. If this condition persists, there can be sufficient damage to cells resulting in an inability of the pancreas to respond normally to high glucose levels in the bloodstream. The result is a state of hyperglycemia (too much glucose in the bloodstream) and a relative or absolute decrease in insulin levels.[1] This condition is known as type 2 diabetes mellitus.

In humans, the genetic basis for T2DM has not yet been identified, but there is strong evidence that modifiable risk factors such as obesity and physical inactivity are the primary nongenetic determinants of the disease.[3] Studies in humans have shown that maintenance of an optimal body weight, a healthful diet, and regular physical activity reduce the risk for diabetes.[4]

In humans, insulin resistance occurs as part of a group of cardiovascular-metabolic abnormalities often referred to as "metabolic syndrome" or "insulin resistance syndrome".[5] The metabolic syndrome in a patient is defined as having at least three of the five criteria: abdominal obesity as determined by increased waist circumference, increased triglycerides, reduced HDL, increased blood pressure, and increased fasting plasma glucose.[6] The World Health Organization considers insulin resistance to be a principal component of the metabolic syndrome.[7] Humans with metabolic syndrome have increased risk of developing heart disease, type 2 diabetes mellitus (T2DM), polycystic ovary syndrome, and sleep disturbances.[7] As part of the Great Ape Heart Project, we are currently investigating whether insulin resistance is a component of the heart disease seen in zoo-housed great apes.[8]

Different populations of humans also manifest insulin resistance at different body weights. South Asians and other populations that exhibit insulin resistance while being only mild to moderately overweight (body mass index <25 kg/m^2) are considered to have primary insulin resistance. Even with cases of primary insulin resistance, weight gain appears to enhance insulin resistance and metabolic syndrome.[6] Establishing criteria by which to assess obesity for species housed in zoos is difficult. While some parameters to define a body mass index (BMI) or methods of assessing obesity have been established for a few old world primate species[9,10] and chimpanzees[11], objective assessment of body condition remains challenging for most nondomestic species. While there is no universal definition of obesity in animals, research demonstrates that average mid-life body weights have been increasing over the past several decades among species as diverse as laboratory primates, domestic cats, and feral rats.[12]

Insulin resistance has not clearly been characterized in species other than humans, although insulin resistance is a topic of increasing interest in the zoo animal health arena. Insulin resistance has become

well-characterized in the domestic horse. Insulin resistance in the horse has been associated with laminitis, pituitary adenomas, hyperlipidemia, exertional rhabdomyolysis, and reproductive problems.[13] It is currently recommended to avoid rapid consumption or excessive feeding of grains and molasses (starch and sugar) to reduce the risk of chronic metabolic disorders associated with insulin resistance in the horse.[13] If grain is required to sustain higher performance, more frequent smaller meals rather than few large meals are indicated. In the zoo world, insulin resistance is currently being investigated in a species distantly related to the horse, the black rhinoceros.[14]

Dairy cattle also show effects of insulin resistance, with a strong association between insulin resistance and the development of fatty liver. Overfeeding and obesity in the dry period are associated with the development of these health problems.[15] Additionally, insulin resistance is associated with an increased occurrence of dystocias (difficult labor and delivery of calf), premature delivery, and oversized calves. In humans and domestic livestock, obesity and insulin resistance in the mother are associated with increased risk of stillbirths or infant death.

In humans, fasting blood glucose is often measured as an indicator of T2DM risk. Overt diabetes is classified as a fasting blood glucose level $\geq$ 126 mg/dL in humans. In non-human primates, fasting blood glucose concentrations are about 20 – 30 mg/dL lower than humans (average human fasting blood glucose = 85 mg/dL). Thus the impaired fasting glucose range of 100 – 126 mg/dL used in humans may actually indicate overt diabetes in other primate species. Diagnosis becomes even more challenging when we venture farther away from primates.

A recent survey[16] found that nearly 30% of responding AZA institutions housed at least one diabetic primate in their current collection. The majority of reported cases were Old World monkeys (51%) but all major taxonomic groups were represented. The study highlighted the fact that there is currently no standard procedure for diagnosing, monitoring, or treating diabetes in zoo-housed nonhuman primates. Additional work is needed to evaluate risk factors associated with T2DM, as well as to develop clear standards for diagnosis, treatment, and monitoring.[16]

In humans, high calorie diets and limited exercise have been identified as risk factors for the development of T2DM. With relatively high caloric density diets and sedentary lifestyles, zoo animals may experience similar conditions that could predispose them to the development of diabetes. We need to look to what is known about other species, including humans, as well as to what is known regarding the natural history of the animals in our care, to inform us regarding management practices that can help us understand and prevent diabetes.

With so much uncertainty about diabetes in our zoo animals, it is challenging to know what we can do to help prevent this disease. It is likely that efforts to encourage increased activity in our animals will be beneficial. Increased activity helps maintain good muscle tone and healthy body weight, both traits that should reduce the risk of developing diabetes. Developing enrichment techniques that encourage increased activity and that are not food-centric will also keep animals active and improve health. Adhering to prescribed diets is important to maintain good nutrition and healthy body weight. Weighing your animals routinely and monitoring those weights regularly to detect unexplained changes in body weight is an important tool to monitor health. When feasible, training your animals for awake blood sampling can provide useful information for assessing health. While routine health exams under anesthesia are an important part of an animal's overall health care, the ability to collect a blood sample by a skin-prick for blood glucose monitoring, or a full sample by venipuncture, can significantly aid in the detection and monitoring of diabetes. The stress of immobilization and the use of some anesthetic drugs can complicate diagnosis of diabetes, so when possible, having a blood sample collected without these complicating variables can make diagnosis easier. Urine is another body fluid that can provide useful information for detection of diabetes in some species. Training your animals to allow routine urine sample collection provides an additional tool to assist in health monitoring. Lastly, encourage your institution to support and participate in research aimed at understanding diabetes and other health problems of our animals. It is only by working together that we will be able to understand and ultimately prevent diabetes in our animals.

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AAZK Board of Directors

CALL FOR NOMINATIONS

The American Association of Zoo Keepers has opened its Call for Nominations for the 2013 Election for the Board of Directors. Serving on the AAZK Board of Directors presents a perfect opportunity to take on a leadership position in AAZK and within the zoo profession. It offers you the opportunity to have a voice in the contemporary issues of our industry. It allows you to hone your skills in leadership, project management, team building, and working with a diverse group of individuals who are dedicated to professional animal care and conservation. If this sounds like a great opportunity to you, then now is the time to run for the AAZK Board of Directors!

Nomination forms will be due at the AAZK Administrative Office by February 28, 2013.

The nomination forms, and the criteria for nomination can be found in the Members' Only section of **aazk.org**. The 2013 Election will be done electronically, so you need to go to **aazk.org** to vote. Additionally, your Professional Membership status must be current and you must be registered on the Members' Only section of **aazk.org**. Here are the key dates of the Election:

- February 28, 2013 – Nomination forms are due at the AAZK Administrative Office
- April 1, 2013 – Viewing of candidate profiles opens in the Members' Only section of **aazk.org**
- April 15, 2013 – June 1, 2013 is the official voting period
- Results of the 2013 Election will be announced after the verification of ballots, approximately June 10, 2013.

Management of a Diabetic Golden-Bellied Mangabey
(Cercocebus chrysogaster)

By Dawn Stone, Animal Keeper, Jason Wark, PhD Candidate and Research Assistant,
and Dr. Pam Dennis, Veterinary Epidemiologist
Cleveland Metroparks Zoo, Cleveland, OH

Introduction

Golden-bellied mangabeys are an Old World monkey species that has not been studied in the field. Very limited documentation can be found on this endearing primate. The captive population in the United States consists of 16 animals (7.9) in five institutions, and a mere 45 worldwide.

Cleveland Metroparks Zoo has a female golden-bellied mangabey, Janet Lee, who has been diagnosed with diabetes. In the past, the zoo has also housed another diabetic female, the mother of our current male (Brandon). Upon acquiring Janet Lee and diagnosing the diabetes, it has been Cleveland Metroparks Zoo's goal to manage the disease through training, medication, and diet.

Overview of Diabetes

Diabetes mellitus is a disease characterized by abnormal insulin production or utilization, ultimately leading to increased blood glucose levels. In humans, diabetes is categorized as type 1 or type 2, depending on the production or utilization of insulin. Type 1 diabetes is when the body does not produce insulin, a hormone needed to convert sugar, starches and other food into energy. Type 2 diabetes is when the body does not produce enough insulin or the cells ignore the insulin.

Insulin is necessary for the body to be able to use glucose for energy. When food is consumed the body breaks down all of the sugars and starches into glucose. Insulin transports glucose from the blood into the cells. When glucose builds up in the blood instead of going into cells it can lead to diabetic complications (American Diabetes Association). When glucose in the blood reaches a high enough concentration, the kidneys can no longer reabsorb all of it, and it spills over into the urine.

Janet Lee

Janet Lee arrived at Cleveland Metroparks Zoo (CMZ) on 9 October 2007. She was brought to the zoo as a companion for its lone male golden-bellied mangabey and was quarantined in our hospital area. Janet Lee had been diagnosed with diabetes during her pre-shipment exam at the sending institution, but given the few available animals for pairing with Cleveland's lone male, CMZ agreed to accept the animal with this medical condition. Three days after arrival, hospital keepers submitted a urine sample that showed high ketone and glucose levels. Ketones in the urine (ketonuria) is a condition seen when the body produces excess ketones as an alternative source of energy. Ketones are produced when the body starts breaking down fats instead of sugars for energy. Production of ketones is a normal response to a shortage of glucose, meant to provide an alternate source of fuel from fatty acids. Ketonuria can occur during unregulated diabetes mellitus.

Veterinarians at Cleveland Metroparks Zoo initially attempted to manage Janet Lee's diabetes with oral medication. She was given Metformin® (125mg orally twice daily) and Glipizide (5 mg orally once daily). Glipizide stimulates the release of insulin from the pancreas. Metformin® has three functions: it slows absorption of sugar from the small intestine, it reduces the rate of glucose production by the liver (gluconeogenesis), and it enhances the sensitivity of cells to insulin. During this time, the only diagnostic test we could do to monitor her glucose was through urine tests. Janet Lee consistently had glucose in her urine, suggesting that the oral anti-diabetic medications were not working adequately to manage her diabetes.

Hospital keepers, along with veterinary technicians, began attempting injections on 27 November 2007. They first began with an injection of 1 IU of saline that she accepted in her right hip. The following day she received her first dose of insulin (Protamine Zinc insulin 4 IU IM once daily). Insulin injections were started despite the lack of sufficient behavioral training because oral anti-hyperglycemic medications were not working, and the presence of ketones in her urine caused concern of possible diabetic ketoacidosis. Diabetic ketoacidosis is a potentially life-threatening condition in which the lack of insulin results in metabolism of fats to ketones, metabolic acidosis, dehydration, and electrolyte imbalances.

Insulin injections were stopped on 13 December 2007 due to unreliability in giving the insulin injection. The hospital keepers and veterinary technicians continued working with Janet Lee with the help of a training consultant to strengthen the behavior.

Glucometer

Initial blood glucose readings were done using an Alpha-TRAK® glucometer (Abbott Laboratories). This glucometer was specifically designed for veterinary use with domestic cats and dogs. The Alpha-TRAK® glucometer was giving inconsistent readings, so we switched to a Freestyle® glucometer (Abbott Laboratories). The Freestyle® glucometer was designed for use with humans and provided more consistent blood glucose levels as compared to the Alpha-TRAK® glucometer.

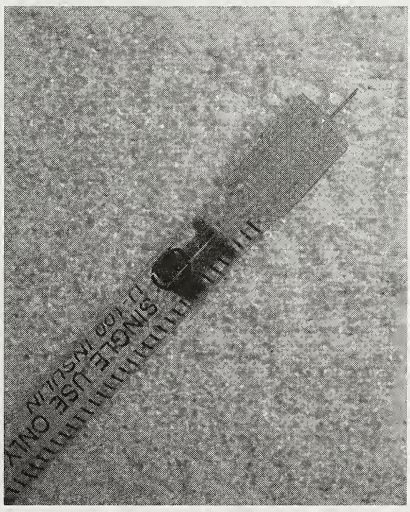
Training for Insulin Injections

The ability of having Janet Lee receive insulin injections and voluntary glucose checks was imperative and operant conditioning was used in training the behaviors. Janet Lee came to Cleveland with training but keepers still started with basics and established a bridge using a whistle. The whistle is the bridge of choice with new behaviors for these keepers. With the whistle, behaviors seem to be easily shaped because of the consistency and sharpness of the bridge.

The behaviors of hip and shoulder presentation to the caging were shaped while a capped syringe was in sight. The insulin, protamine zinc was to be given as an intramuscular injection in the muscles of the hip. Shoulder was trained as well so that multiple areas would be available if needed. Keepers were doing five short sessions a day beginning 24 February 2008 and the behaviors took a few short days to shape. It is when keepers picked up the syringe that Janet Lee would pull away from caging and not have her body completely against the wire. The act of injecting Janet Lee previously when the behavior was not solid caused some set back in the current training.

It took about a week before she let us put a capped insulin syringe up to her. Keepers decided to work this behavior as slowly as she needed with the cap on the syringe. Over time the cap was cut back to expose a very small portion of the needle instead of taking the cap off entirely. Initially the needle was rubbed across her skin. This caused her to back away at first but when she did hold for the needle touching her she was jackpotted with sugar-free candy.

Over time, the needle was exposed more by cutting the cap back gradually and instead of just touching her with the needle, keepers would poke her with the needle. This did cause a little regression at first but because of the amount and consistency of sessions it lasted only a day or two.



Syringe cap cut back.
Photo by Dawn Stone

On 3 April 2008 Janet Lee began receiving 1 unit of saline IM in her hip in preparation of insulin injection. By 11 April 2008 keepers were injecting four units of saline BID and on the 12th tested her blood glucose with an Alpha-Trak® reader that read HI and did not register.

The first dose of insulin was given on 13 April 2008. She received two units of protamine zinc (PZI) IM in her right hip. Blood glucose was taken prior to injection and read 407 mg/dl. The behavior of getting blood glucose samples from her toes was not trained in the formal sense of the word. All of the training emphasis had been placed on training for insulin injections, and only when we realized that insulin injections were truly about to happen did we fully appreciate the need for blood glucose monitoring. As this was our first case of treating diabetes with insulin injections, the veterinarians were wary of treating without any ability to monitor blood glucose, so insisted that blood glucose monitoring behaviors become incorporated into the training protocol. Keepers had been working the behavior of hand and foot presentation through caging but had never incorporated the testing instruments until the day of the first insulin injection. Fortunately Janet Lee was a willing participant in the training, and the behavior was readily shaped to facilitate routine blood glucose monitoring. In hindsight, we appreciate the importance of detailed communication of expectations and maintenance of open lines of communication between veterinary staff and keeper staff in cases requiring intensive clinical management.

Diet

The diet from her sending institution was Mazuri® Primate Maintenance Biscuit (70g), endive (180 g), carrot (35 g), yam (35 g), yellow corn (18.5 g), green peas (18.5 g), apple (35 g), red or green grapes (35 g) and banana (35g). To decrease the amount of simple sugars, the diet was changed to

Golden-bellied mangabey Janet Lee, getting her toe pricked by Animal Keeper Dawn Stone.
Photo courtesy of Amanda Fawcett, Animal Care Intern, Cleveland Metroparks Zoo

Marion® Leaf Eater Biscuits (200g) Hi-Maize Resistant Starch (125g), green beans (80 g), broccoli (80g), summer squash (80g), sunflower seed kernels (56g), and endive (680g). The Mazuri® biscuit and Hi-Maize resistant starch combination was a biscuit available at the zoo as part of an ongoing study examining the effects of increased dietary fiber on gorilla (*Gorilla gorilla)* health. The biscuit was chosen for Janet Lee as a means of increasing the dietary fiber in her diet as well as providing resistant starch. Resistant starch is a starch that is not digested in the stomach but is fermented by bacteria in the large colon, providing nutrition without increasing blood glucose levels.

In June 2008, her diet was adjusted to remove the Marion® Leaf Eater Biscuits to further reduce the amount of sugar in her diet. The diet was changed to canned black beans, no salt added (200g), Hi-Maize resistant starch (125 g), green beans (80g), broccoli (80g), summer squash (80g), sunflower seed kernels (30g), endive (340g), chia seeds (28g) and vitamin D (400IU). Chia seeds were added to the diet as they have been shown in humans to help regulate blood glucose levels.

In December 2008, Janet Lee was included in a diet study examining the behavioral effects of dietary konjac and fenugreek used to ameliorate diabetes in our golden-bellied mangabey and Hamadryas baboons (*Papio hamadryas*). We hypothesized that the addition of fenugreek and konjac to the diet of the diabetic animals will ameliorate the hyperglycemia, resulting in increased activity levels more closely resembling the activity levels of the clinically normal animals. Monitoring activity levels of the animals prior to and following the addition of konjac and fenugreek to the diet would provide a non-invasive means of assessing the effect of this dietary supplement. Medicinal plants have been used for centuries to treat diseases, and are the basis of many of our modern-day drugs. Fenugreek, a spice commonly used in Indian and Asian cooking, has been shown to have an anti-diabetic effect in dogs, rats, and mice. It also has an anti-hyperglycemic effect in humans with type 1 (insulin dependent) and type 2 (non-insulin dependent) diabetes.[1] Konjac-mannan, a fiber derived from the root of the konjac plant (*Amorphophallus konjac*), has been used for centuries in Asia as a food. More recently, it is used in food processing as a stabilizer and gelling agent. It has a "generally recognized as safe" (GRAS) status in the United States.[2] Konjac fiber has been shown to help control hyperglycemia in type 2 diabetes in humans.[2] While we did not see significant changes in the behavior of Janet Lee during this study, the dietary supplement did appear to have a stabilizing effect on her blood glucose and the supplement was incorporated into her daily diet.

Diets in the zoo were evaluated in 2009 and in October 2009 this diet was adjusted to account for the fact that the animal consumed less food than was offered. The animal's current diet is canned black beans, no salt added (50g), Hi-Maize resistant starch (8 g), green beans (65g), broccoli (65g), summer squash (65g), sunflower seed kernels (15g), endive (200g), chia seeds (6g), fenugreek (4g), konjac (18g), and vitamin D (400IU).

Birth Control

During the quarantine health exam she was implanted with a birth control implant of melengestrol acetate intramuscularly in the left shoulder. MGA (melengestrol acetate) implants are a common birth control in primates and implants can function for up to two years. MGA is a synthetic progestin, and side effects of its use can include weight gain. MGA implant was selected based on its proven success as a contraceptive in primates including mangabeys. Following the quarantine period, Janet Lee was housed in an enclosure adjacent to the male mangabey until her diabetes could be managed, at which time she would be housed with the male.

Once Janet Lee was consistently receiving insulin injections, it was still challenging to regulate her blood glucose at levels within the range of 200-250mg/dl. One consideration was that the MGA implant was interfering with normal insulin regulation. As Janet Lee was not currently housed with the male, it was decided that the MGA implant would be removed to eliminate any adverse effects of the implant on diabetes management. Janet Lee went through multiple estrus cycles, and it did appear that the implant may have had adverse effects on her diabetes management. Determining this

effect with certainty is difficult, as other management changes including diet changes were occurring concurrently. Surgical sterilization was considered as a possible birth control option but there was concern about diminished wound healing response due to the diabetes. A decision was made to try Deslorelin®, a GnRH agonist used as a contraceptive implant in other species, but never tried in female golden-bellied mangabeys. The implant was placed and Janet Lee's reproductive cycle was monitored by watching for estrous swellings through several cycles to confirm the success of the implant before Janet Lee was introduced to the male.

Future Studies

There is very little known about diabetes in captive primates and even less known about the golden-bellied mangabey species in general. Cleveland Metroparks Zoo is attempting to find answers to some of the questions regarding diabetes in zoo primates.

Janet Lee's glucose levels are often in range of a human's level (80-120) but it is unclear whether this is the normal range for a golden-bellied mangabey. Keepers decided to train her male companion (Brandon) for voluntary blood glucose checks to see the blood glucose levels in a non-diabetic animal. To our surprise his readings were low with a fasting blood glucose average of 64 $\pm$ 14 mg/dl. This male is on the same diet as Janet Lee only a larger quantity.

Another question to consider is the role that sex plays in diabetes in the captive mangabey population. Based on previous research, it appears that female mangabeys are more likely to be diabetic than males. As stated earlier, we have had two golden-bellied mangabeys at this zoo that have had diabetes. Janet Lee being one and Brandon's mother the other; coincidence or a concern in captive primates?

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Inca the Kinkajou – Successful Management of a Diabetic Kinkajou *(Potos flavus)*

By Liz Toth, Associate Curator of Live Animals and Kinkajou SSP Coordinator and
Heather Fuchs, Assistant Curator of Live Animals, Boonshoft Museum of Discovery, Dayton, Ohio

Overview

For the past eight years the staff members of the Live Animal Department at the Boonshoft Museum of Discovery have provided daily care for a kinkajou with diabetes. Management of the kinkajou, named Inca, includes twice daily injections of insulin. When Inca was diagnosed with diabetes and eventually needed injections of insulin twice daily it seemed like providing these injections and keeping his diabetes under control would be a difficult undertaking.

History

Inca was born at Bird Haven, in Elmhurst, Illinois, in September of 1990 and came to live at the Cincinnati Zoo in December 1990 at the age of three months old. Not much is listed in Inca's records about how he was raised, but he was probably hand-raised with the intention of having him be handleable enough to be used for education programs. When he was transferred to the Cincinnati Zoo he was one of several kinkajous used for education programs.

Inca was neutered in May of 1991 and for the most part had an uneventful life as a program animal. In 1999 Inca was listed as surplus and Cincinnati Zoo informed us that he had bitten a keeper on the wrist and that they were surplusing him because he was not as predictable as they needed him to be as a program animal.

We were already familiar with Inca because Associate Curator Liz Toth had the opportunity to work with him while employed at the Cincinnati Zoo prior to coming to work at the Boonshoft Museum. We intended to use Inca for our education programs in a small theater at the Museum and felt that we could work with him enough to get him usable again. We were prepared to make the commitment to handling Inca regularly, but we did not anticipate the challenge that was ahead with getting him diagnosed and treated for diabetes.

The Problem

In September of 2000, less than six months after we acquired him, Inca started showing aggressive behavior. He would lunge out of his nest box and jump onto the mesh door of the enclosure. This typically occurred as the door to the enclosure was being opened. We assumed this was due to territorial behavior, so Inca's enclosure was enlarged to twice the size. The enclosure is a Corners Limited Inc. enclosure with mesh on the ceiling and front. Ropes, branches, and a nest box were used as cage furniture and daily enrichment was a goal we strived for. Screeching and growling at keepers was recorded several times in the daily report. Inca had been used as a program animal within the building, but at this time we discontinued using him for programs because we were worried about his unpredictable behavior. In addition to the changes in behavior, Inca was losing some weight. This behavior went on for sometime and Inca was treated for several respiratory infections. Starting in February 2003, vomiting was occasionally noted, as was skipping feed and increased drinking and urine output, but these symptoms were inconsistent. Inca gained quite a bit of weight in the first year we had him. For the first six months of 2000 his average weight was 4.2kg, and we had a goal of lowering his weight to at least 3.5kg. We weighed Inca once a month and his average weight in 2003, the year prior to diagnosis, was 3.0kg. His diet was a weight reduction diet and the amount

of weight he was losing, because it was gradual, was not alarming until the end of 2003 when Inca weighed 2.9kg. In December 2003 we began weighing Inca weekly, and he was continuing to lose weight even though he was on a maintenance diet.

Diagnosis and Initial Treatment

Inca was tested multiple times by our vet and a consulting vet during 2002 and 2003. He also had an exploratory surgery where biopsies of the liver, spleen, stomach and intestines were taken, but a definitive diagnosis was not reached. Diabetes was considered a possibility but because Inca's bloodwork was in the normal range, we did not receive a diagnosis of diabetes until May 2004. Prior to the official diagnosis Inca had been treated with antibiotics multiple times and prescribed a pancreatic insufficiency enzyme called Viokase to see if this would help, but Inca refused to eat his diet with the enzymes on top. After the diagnosis we began managing Inca's diabetes with oral Glipizide, but that was not successful and he continued to lose weight. In February 2005, Inca reached his lowest weight of 2.2kg, and our vet prescribed twice daily injections of insulin. At the time, Inca was fairly unpredictable in his behavior and we were unsure how the injections would go. We started the injections with a two person team; one keeper to hold Inca and the second keeper to give the injection. With our small staff, working on different schedules and in different parts of the building, it was difficult to carve out the time it took to carefully restrain Inca without sparking an aggressive reaction. Inca had never been fond of gloves and always became upset if someone tried to pick him up with gloves, so we decided he would remain calmer if we did not use gloves to restrain him. This method needed to be revised when Inca nipped one of the keepers on the wrist. We tried a fairly thin leather glove with heavier wrist protection, but Inca still did not like the feel of the gloves. The second pair of gloves we used, a fingerless wrist protector, seemed to give us the dexterity we needed. Inca was satisfied and it still kept our wrists safe.

Diet Modifications

Inca's diet was altered to include Purina Veterinary Diets DM Feline formula, both dry kibble and canned formula, instead of an Iams Lamb & Rice Dog chow. Two meals were provided, instead of the one meal he had been receiving, to stabilize his blood sugar. Fruits with a high glycemic index were limited in the diet and more foods with a low glycemic index were provided, including vegetables like cauliflower, broccoli, green beans, brussel sprouts, and mushrooms. Inca was used to eating the typical fruits given to kinkajous in captivity, such as bananas, apples, oranges, and grapes, and did not prefer the vegetables we gave him. Avocado was also included in his diet, because it was a food that he enjoyed with a low glycemic index, and at this point we wanted to make sure Inca didn't lose much more weight. Enrichment was modified to include non-food-based activities, but when food-based enrichment was used, items from the new diet were selected.

We were not sure why Inca developed diabetes, but he became overweight after we received him, even though we were providing him with the same diet he was given at the Cincinnati Zoo. Kinkajous have a tendency to become overweight in captivity (Wright, 2009). This tendency to become overweight in captivity could be due to their lower than normal metabolic rate (Ford) and difficulty with replicating their diet in the wild (Wright, 2009). Nutrient requirements of kinkajous have not been well-studied (Wright, 2009).

Disease Maintenance

Each day Inca was removed from his enclosure and handled twice a day for his injections. In the beginning not all of the injections were easy to give, and Inca was not always cooperative. Inca's behavior improved over time. With treatment of his diabetes and consistent handling he no longer showed the unpredictable and aggressive behavior that he had previously. Improved behavior also meant it was easier to administer Inca's insulin injections. We reduced the team of two to one staff member to give Inca his injection in the morning when he was sleepy and typically cooperative. For

the one staff member method the injection could be given to Inca while he was in his hammock or nest box. He was still being removed from his enclosure for the evening injection when he was more active. Removing him from his enclosure twice a day was a priority for us when we thought he would be returned to use as a program animal, but by this time plans were being discussed for a kinkajou exhibit for Inca.

Inca was off exhibit and not being used for programs for several years, but plans were being made for a nocturnal exhibit in the new Discovery Zoo that would include kinkajous. We were excited that Inca would have more space and be contributing once again to our educational mission, but knew the switch to the new exhibit would present some new challenges. We gradually introduced Inca to the new exhibit over a period of a week and the new kinkajou exhibit, complete with night vision goggles for visitors, opened in September 2010. Inca enjoyed his new exhibit and had much more space, but with the changes came concerns that we would be able to adequately manage his diabetes. The exhibit was large and that meant increased activity. Would we be able to reach him in the tall enclosure if he did not want to be reached? Inca would now be on a reversed lighting cycle. Would the behavior we were counting on to give him his injections change? In addition, a new female kinkajou was in the enclosure, separated from Inca by a mesh wall, and we were not sure how this would affect Inca's behavior. With the challenges these changes presented, overall management of Inca's diabetes has gone much more smoothly than we could have anticipated. With the reversed lighting, Inca is fairly groggy in the morning for his first insulin injection. A small amount of food is immediately provided to him then, and the rest of his food is either provided on his plate or scattered throughout his enclosure for him to eat when the lights go out two hours later. Later in the day Inca is waiting at the door of his enclosure to receive his evening insulin injection. Currently, Inca's diabetes is maintained in the fair range. He had one diabetic episode where he became unresponsive early in 2011 and needed immediate veterinary treatment. We have been working to get him back into the good range, where he had been holding fairly stable since diagnosis. Over the course of his treatment Inca was sedated every six months to a year, or more often if needed, to check his blood sugar to make sure his diabetes was being adequately controlled. Inca now remains calm enough that he can be hand-restrained to draw blood to check his blood sugar, rather than sedating him for blood draws.

Figure 1. Heather Fuchs administering Inca the kinkajou's morning injection of insulin while he is resting in his hammock in his new exhibit.

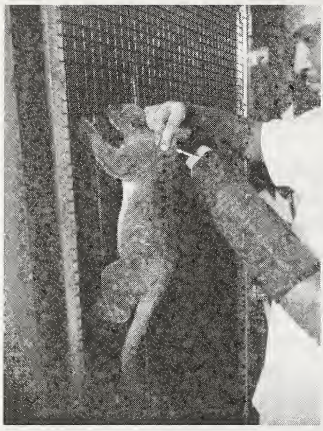

Figure 2. Steven Mallory administering Inca the kinkajou's evening insulin injection while Inca positions himself on the inner door to his enclosure

Conclusion

Inca is currently 21 years-old and is considered old for a kinkajou by many standards, although many kinkajous have lived into their late 30s (AZA Kinkajou Studbook). He currently receives 3 units of Humulin N insulin twice a day. Inca has lenticular sclerosis in both eyes that is probably unrelated to his diabetes, so his vision is limited. Inca also takes Soloxine to help manage hypothyroidism and fur loss.

When Inca was first diagnosed with diabetes we did not know what the outcome would be; eight years later our animal care staff can look at Inca's survival as a testament to their dedication. During Inca's treatment period we have had six to seven staff caring for the animals. Of these six or seven people, only a core of four to five staff members were trained to inject Inca with his insulin. Rabies prophylaxis series was required for staff working with Inca due to strict enforcement of rabies policy in our county. Also, a working relationship with Inca was required, as even though his demeanor was fairly calm at this point, he was more cooperative with keepers he was familiar with.

Acknowledgements

Thank you to the staff of the Live Animal Department at the Boonshoft Museum of Discovery for their dedication to providing the highest level of care for Inca. Special thanks to Dr. Kris Hall, our veterinarian, for his medical expertise in the treatment of Inca.

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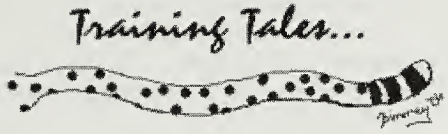
The AAZK Behavioral Husbandry Committee Presents



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Using Training to Help Treat Diabetes in Non-human Primates: The Importance of a Flexible Shaping Plan and Good Communication for Training Success.

By

Mylisa A. Whipple, Primate Keeper
Saint Louis Zoo
Saint Louis, Missouri

Introduction

It can be a challenge to treat any animal that is diagnosed as a diabetic, and non-human primates are no exception. Treatment can be constrained by a variety of factors such as the environment, social situations, and the personality and temperament of the individual being treated, just to name a few. Every situation is different, and every animal is different. But across the board, two of the most important things required to successfully treat that animal are to have a well thought out, but flexible training plan and to keep an open line of communication between all the people that are involved in the care and management of that animal including, keepers, veterinary staff, and nutrition staff.

In the past few years, keepers at the Saint Louis Zoo have been involved in the training and treatment of two different monkeys, both diagnosed with diabetes. Though they were different species and their situations and personalities were also quite different, a similar approach was used to treat both of them. The same flexible shaping plan was even adapted to train them both in order to better treat their diabetes.

Case 1: Bozo

In 2005, the Saint Louis Zoo housed 1.4 Hamadryas baboons (*Papio hamadryas*). The male, named Bozo, was diagnosed with diabetes. Keepers had observed Bozo showing signs of weakness when he walked, noticed sticky urine on the floors of the baboon enclosure, and observed the female baboons lapping up puddles of Bozo's apparently sweet urine. These observations suggested that something was going on with Bozo's health and ultimately led to the veterinary work-up that resulted in this diagnosis. In collaboration with the zoo's veterinarians and nutritionist, Bozo's diabetes was originally managed using oral medication and diet. In order to test his glucose level, Bozo was trained to urinate on cue so that glucose levels could be tested in a sample of his urine. The shaping

plan for this required a keeper to observe Bozo until he urinated and then the behavior was captured using a whistle as a bridge the instant he started to urinate. He was immediately rewarded with a jackpot item (preferred food item) and the verbal praise, "Good Pee." After initially capturing this, the training progressed to calling him into his holding cages and using the verbal cue "Bozo, Pee." After giving the verbal cue, he was then observed until he urinated, which was then followed immediately with the bridge, a jackpot item, and the verbal praise, "Good Pee." Eventually, Bozo made the connection and would visibly try to urinate once he heard the verbal cue "Bozo, Pee." The success of this training allowed for regular testing of glucose levels in his urine.

Based on the progression of Bozo's symptoms, the veterinarians decided that Bozo needed to start receiving insulin injections in order to manage his diabetes. Because he was not injection trained, he initially had to be darted with insulin daily. Injection training of Bozo was started so that he would not have to continue to undergo the stress of being darted for any longer than necessary.

A squeeze cage was custom built by one of the Zoo's welders to use for this training. It was installed as a permanent part of one of the baboons' holding cages. The outer dimensions of the squeeze cage were 92 cm in width, 104 cm in height, and 64 cm in depth. It was composed of a metal frame with the front wall, back wall, and ceiling made out of metal chain link fencing material similar to that of the front wall of the existing holding cage. It had two aluminum doors that could be completely removed when not needed. The squeeze mechanism was a moveable plexi-glass wall with a metal frame that could be pulled using a handle by a keeper from outside of the cage and could be locked into place as needed.

The author became Bozo's primary trainer and was charged with developing a shaping plan that would include squeeze cage-training and injection-training. After researching examples of squeeze cage and injection-training shaping plans from other institutions and getting advice from other animal trainers, a shaping plan was developed that would work best for the situation and included multiple options that could be used depending on how the training was progressing.

Figure 1. Bozo receiving and injection of insulin

Once the shaping plan was approved, Bozo's training started. The shaping plan included an acclimation period, followed by several training options for how the squeeze cage could be used during the training. Depending on how training progressed, one or more of these options could be skipped. The first option was to use the squeeze cage as a narrowing tunnel or chute in which the space that he was asked to enter was simply narrowed each time prior to him entering it, until his hip and callosity were close enough to the front wall to begin injection training. The second option was to be used if he did not want to stay in the narrowed cage for longer periods without being closed in. This option included working towards closing the doors of the squeeze cage on both sides of him. First he would be trained to allow one door to close and then the second door would be added in. The third option was to be used if the hip and callosity were still not close enough to the front wall. In this third option the training would involve actually working towards using the squeeze mechanism to "squeeze" Bozo into the position needed for the next step of his training. Once proper positioning of Bozo's hip and callosity was achieved, the final step in the shaping plan, injection-training, would follow. The injection-training portion consisted of several steps including desensitizing him to the presence of a syringe, touching him with a capped syringe, touching him with needle, poking him with the needle, and then injecting him with saline (in place of insulin).

The first step in the training plan, to acclimate the baboon group to the squeeze cage, began in mid-July, 2007. In Bozo's case, the second and third options of the shaping plan were never needed, and the training process went rather quickly. By the end of August, Bozo was accepting hand injections of insulin.

Up to this point, the squeeze cage and injection-training was only used to give Bozo his insulin injections. Urine-training was the method being used to obtain glucose measurements. However, Bozo began to have trouble with the urine-training (he was having difficulty urinating on cue even though he was clearly trying). Because of this and the lack of accuracy with urine glucose tests it was decided that his squeeze cage-training could also be used to obtain blood samples for blood glucose testing. This method of sampling would be a more accurate measurement of his glucose levels. Blood samples were obtained by using a needle to lance the skin of his callosity and then testing a drop of his blood with a blood glucose meter. Unfortunately, the test strip of the blood glucose meter was too short to reach the drop of blood on his skin, so the blood drop had to be collected on the plastic sleeve of the syringe in order to be tested. By the end of September, his blood glucose was successfully tested using this method. At the beginning of October, these behaviors were transferred to secondary trainers.

Bozo's training was a success for both the trainers and for Bozo, in that it made it easier to treat his diabetes. As mentioned earlier, the animal's situation and personality can affect how its training progresses. Fortunately, Bozo was the dominant animal in his group, he was already comfortable being separated from the girls for short periods of time, and he was a highly food-motivated individual. Because he was a diabetic, the typical rewards we used for him that were nutritionist-approved included the limited fruit from his diet and a small amount of mixed nuts or peanuts. Some sugar-free treats were tried as jackpot reward items, but Bozo did not like them so the fruit portion of his diet was used as his jackpot items. Because Bozo was eager to train for these items, his training progressed even more smoothly.

In March 2008, Bozo started showing signs of weakness in that he was having trouble walking. He was immobilized for blood work and given fluids. In order to prevent him from having to be immobilized for fluids daily, attempts were made to give Bozo fluids subcutaneously using his trained squeeze cage behavior. The plan was to have a veterinary technician and one of Bozo's trainers work together to get him into his normal training position and then administer the fluids subcutaneously. Bozo was amazing and allowed fluids to be given in this manner for several days. Unfortunately, despite these efforts Bozo's health continued to decline and it was decided that Bozo should be humanely euthanized on April 15th, 2008. Because Bozo had been an amazing animal that loved to train, he accepted an injection for anesthesia in the squeeze cage just as if he was being trained for his insulin.

Figure 2. Bozo receiving subcutaneous fluids

It was not stressful at all, but rather calm and normal for him. Once anesthetized, the veterinarian was able to humanely euthanize him. The training program had successfully prolonged and improved his quality of life.

Case 2: Ike

The 4.0 lion-tailed macaques (*Macaca silenus*) housed at the Saint Louis Zoo were moved to the exhibit that once housed the baboons in January 2011. Because they were an aging group and the squeeze cage was located in one of their holding cages, the squeeze mechanism would be a valuable tool in helping with future medical procedures. Acclimation to the squeeze cage began in March with the goal of working towards injection training each of the macaques.

The shaping plan from Bozo's training was easily adapted for this new training endeavor. However, one of the lion-tailed macaques, Ike, was diagnosed as a diabetic in May. The keepers had noticed sticky, dried urine on the exhibit floor. A urine sample from Ike was tested with a urine glucose test strip and the results showed high glucose values. The diagnosis of diabetes followed a veterinary work up. As with Bozo, it was decided to try and treat Ike using oral medication and diet first. It also became a priority to get him squeeze cage and injection-trained to help with his treatment.

Ike was already used to being separated from the other members of his group and because of the training that was already started he was used to entering the squeeze cage at a fairly narrow width. From this point, training continued following the same shaping plan that had been used with Bozo in the past.

Ike's shaping plan once again included several options for how the squeeze cage could be used during

Figure 3. Trainer using squeeze mechanism

the training, and these options could be taken or skipped depending on how the training progressed. Starting with the first option, Ike was asked to enter the cage at narrowing depths until it was as narrow as it could be, yet still allow him to enter the squeeze cage comfortably. However, because Ike's hips are much narrower than that of a baboon, both the second and the third options in the training plan had to be used.

The second option included steps working towards closing Ike into the squeeze cage. The steps involved putting the doors back on the cage, then working towards closing one door while he was in the cage, then closing both doors while he was in the cage, and finally lengthening the amount of time he was closed in the cage. The third option included steps working towards actually squeezing the cage down so that his hip and callosity area could be easily reached by the trainer for both lancing and injections. The steps for this included getting Ike used to the movement of the squeeze mechanism by narrowing the area he was in by small increments, and lengthening the time he was "squeezed." Once Ike was desensitized to the squeeze and his body in the correct position, progress could be made towards the final steps in the shaping plan. This included lancing/injection-training for both blood glucose testing and insulin injections.

By the end of September, Ike allowed his blood glucose to be tested. By mid-October, he was reliably allowing his blood glucose to be tested daily. This allowed for a secondary trainer to be trained to obtain blood glucose measurements from Ike as well. By mid-November Ike was accepting injections with saline (in place of insulin). This behavior was transferred to the secondary trainer and soon after, other primate keepers were trained to be secondary trainers as well. It was important that several keepers were able to train Ike so that blood glucose measurements could be taken daily and that injections could be done daily if needed in the future. Because of the importance of consistency in training, a protocol was written that included the steps to Ike's training, the schedule for his daily training and medications, and any other important information regarding his treatment and training. This protocol was posted near the squeeze cage so that it could be easily referred to and updated as needed.

As with Bozo, Ike's situation, personality, and preferences were added components that had to be considered when planning his training. Ike was the second most dominant animal in his group and unlike Bozo he was not as trusting of keepers. But like Bozo, he was a food-motivated individual. Another difference between Bozo and Ike was that Ike liked sugar free treats, so his nutritionist-approved rewards for training consisted of a small amount of peanuts, the fruit from his diet, and sugar free jack pot items including red licorice, Hershey's York Peppermint Patties® and a variety of flavors of sugar-free powder drinks.

A further complication that did not occur with Bozo was that Ike started developing cataracts, which occurred after he had already been training for some time. Training had to be adjusted slightly for this because the cataract in his right eye was worse than in his left. It seemed that Ike preferred to have his left side facing the trainer during training sessions.

At the present time, Ike's diabetes has been managed with diet and oral medication. But, if Ike ever needs to start receiving insulin injections, it can be done right away because he has already been injection-trained. The keeper staff keeps track of Ike's blood glucose levels, his diet, his weight, and any changes to his treatment on a chart and that information is transferred into a computer. A weekly update is sent to the primate keeper and management staff, the veterinarians and the nutritionist.

This ability to share information has helped everyone work efficiently and effectively to help give Ike the best care possible.

Conclusions

These two cases have shown that it is possible to learn from past training experiences in order to improve how similar situations are handled in the future. Though there were differences between Bozo's and Ike's cases, a similar approach and shaping plan were used, but they were adapted to meet the needs of the animal care staff and the needs of the individual animals. Also, it has really helped that an open line of communication was maintained between our primate keeper and management staff, the veterinary staff and the zoo's nutritionist. It has been an opportunity for everyone to work together as a team to combine their knowledge and expertise in order to meet the needs of the animals.

Acknowledgements

Special thanks are in order for the Saint Louis Zoo's veterinary staff, animal nutrition staff, and primate keeper and management staff, past and present. Photographs were provided courtesy of Joe Knobbe, Zoological Manager of Primates at the Saint Louis Zoo.

Questions and Comments

Please feel free to contact the author via e-mail at whipple@stlzoo.org for further information about the shaping plans and protocols that are discussed in this article.

Comments by Kim Kezer:

Sometimes it "takes a village" to reach our training goals. This is very much the case in this *Training Tales* article. Opening lines of communication and fostering collaboration among those departments involved with caring for the animal helps to set up the training program for success. Reaching out to other institutions about their equipment and approaches aids in developing well thought out, flexible shaping plans. It is essential to include in your plan to teach keepers in the area to be secondary trainers once the behavior is established to insure consistent, daily training. Our author did an excellent job sharing how they created and adapted their plan for the needs of the individual animal, which improved the quality of life and also helped in reducing stress when an end of life decision was made. I believe this *Tale* of training non-human primates with diabetes reinforces to all of us the need for sharing and collaboration both within and outside of our institutions. Congratulations on your success and sharing your wonderful *Training Tale* with us.

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Diabetes Management in a Troop of Ring-tailed Lemurs

By Sara Floyd
Riverbanks Zoo and Garden

Photo by Sara Floyd, Riverbanks Zoo

In May of 2006 at the Riverbanks Zoo, 1.1 ring-tailed lemurs (*Lemur catta*), Leo and Maude, were diagnosed with diabetes. Over the course of the next weeks and months the keepers developed a husbandry routine to try to ensure that proper medical care was provided to both animals.

Keepers first began to notice signs of a possible problem during the day-to-day routine. This prompted them to inform and consult with the veterinary staff. The animals appeared not to be well-groomed. Their fur seemed disheveled and unkempt, which is unusual for lemurs living in a social group. In addition, the other lemurs in the group (an additional 1.2 ring-tailed lemurs) were observed to be licking up and drinking urine from both animals. This was apparently due to the excess of sugar being spilled into the urine.

The vet staff had keepers collect urine samples from both animals daily, when possible, to run urine glucose strip analyses. The lemurs' urine glucose levels consistently read much higher than normal and so medical checkups were performed to test blood glucose levels. At this point diabetes was confirmed for both animals.

In order to maintain both animals in a healthy state, keepers needed to train Leo and Maude for insulin hand-injection, make modifications to the barn, alter their husbandry routines and have the vet staff rework their diets.

Oral medication was tried for a brief time to try to help stabilize their blood sugar levels while injection-training was taking place. It was helpful to the keepers to have this phase of treatment so that more time could be taken to establish strong training routines before actually having to inject either animal and risk regression.

The ring-tailed lemurs' diet underwent several significant changes due to the onset of diabetes. Because the troop is free-fed the majority of their diet, and in an attempt to hopefully prevent other individuals in the troop from developing the illness, the vast majority of the fruit was removed from the daily diet. A small container of grapes and banana is delivered twice a week to the barn to be used for training and for rewarding the lemurs after their injections. Canned primate diet, which had previously been a small percentage of the whole, became the main ingredient to the daily diet. Different types of greens (including kale, lettuce, green beans and cucumber) were increased or added to the diet. The troop was also receiving lemur-sized Marion biscuits, but those were removed due to higher sugar content. Hi-Fiber sticks were substituted in their place. The animals did not find these as palatable, so to try to encourage their consumption, as well as due to a few older animals with damaged teeth, keepers lightly soak the biscuits, making sure only to use enough water to be completely soaked into the biscuits. If too much water is used and the excess has to be drained, one can lose most of the nutrients that coat the biscuits by washing them off. The timing of the feedings also changed. As with most animals, the troop was receiving a morning and an evening diet. In an attempt to even out their glucose levels throughout the day, both animals' canned primate diet was divided up and fed in four different feeding sessions throughout the day. Session one was first thing in the morning when Leo and Maude received their morning injection, around 0900. The second feeding was close to 1130. The third feeding was immediately following lunch and the final session occurred at the afternoon shift, when they received their final shot. Since the animals were housed in a troop, keepers found it easier to divide up the diets for all of the animals in the lemur troop and to do four group feeding sessions a day. It also can decrease group food aggression if all animals receive part of their diet at each feeding, whether or not they are diabetic, rather than just feeding one or two animals.

The lemur holding was evaluated to determine the best location for the individuals' insulin injections. The overhead transfers provided a small area where animals could be isolated from the group and with which the animals were already very familiar and comfortable. The maintenance department installed two ports, in the floor of the transfer and one of the sides, to allow keepers to reach into the transfer to give the shot. A slot was also created next to the ports to allow a divider to be inserted, thus dividing the transfer into an even smaller section. This gave the keepers an isolated space approximately one cubic foot in size in which to inject the animals individually.

Training was broken down into a few steps. Firstly, the keepers had to station the lemur, individually, in the overhead transfer so that they did not have to contend with the other individuals. This was fairly simple since both animals were very used to moving through the transfers. Once they were shut in, the lemurs were fed through the mesh at the end of the transfer that would serve as the injection site. Keepers then worked on sliding the plexi divider into place with the lemur remaining stationed at the end of the transfer. Both lemurs adjusted quickly to sitting still while the divider slid completely into place, and they were rewarded at each step.

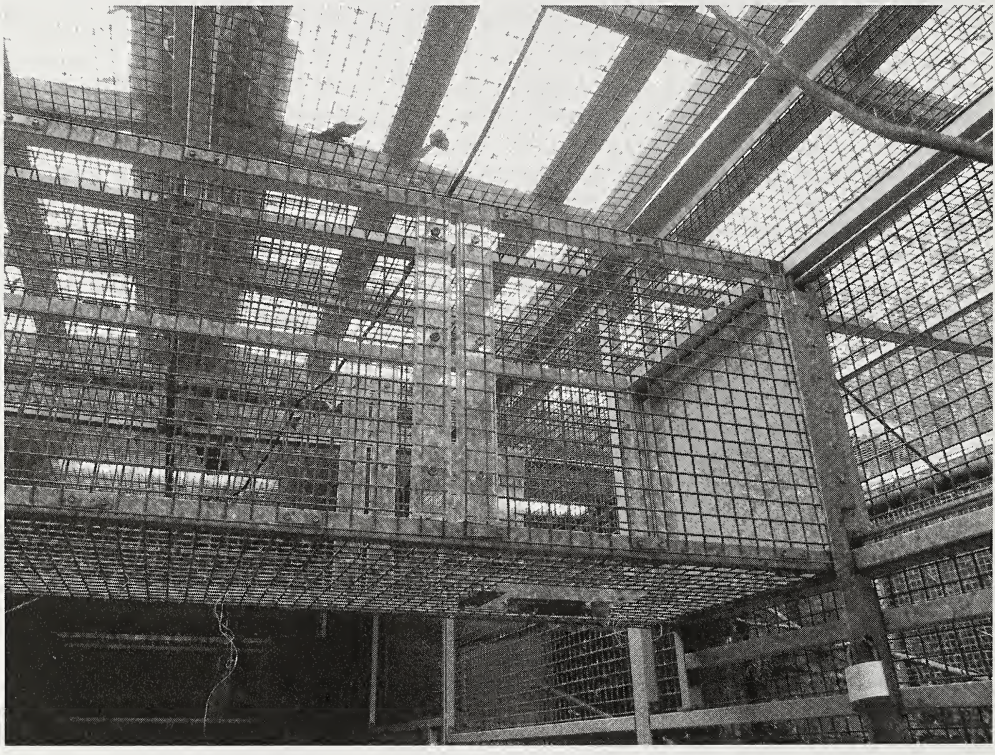
Due to the fact that the keeper staff had not previously dealt with injections, the vet staff provided instructions on how to perform the injection and they also shaved a small area on each lemur (on Leo's leg and Maude's hip) to allow easier access to their skin and to enable the keepers to see and feel more accurately what they were doing.

Keepers practiced handing the lemurs their food through the ports to decrease any nervousness the animals may have had about a keeper's hand coming into the transfer with them. Neither lemur had a strong proclivity to bite which helped training move quickly. A different individual may need additional training or an altered set up to ensure the keeper's safety. The training for the two animals went slightly differently from this point due to the differences between their personalities. Leo was more calm and allowed the keepers to inject the skin that could be tented along the back of his thigh, from below, as he was sitting in the overhead. He adjusted quickly and did not appear to be affected negatively by the shots.

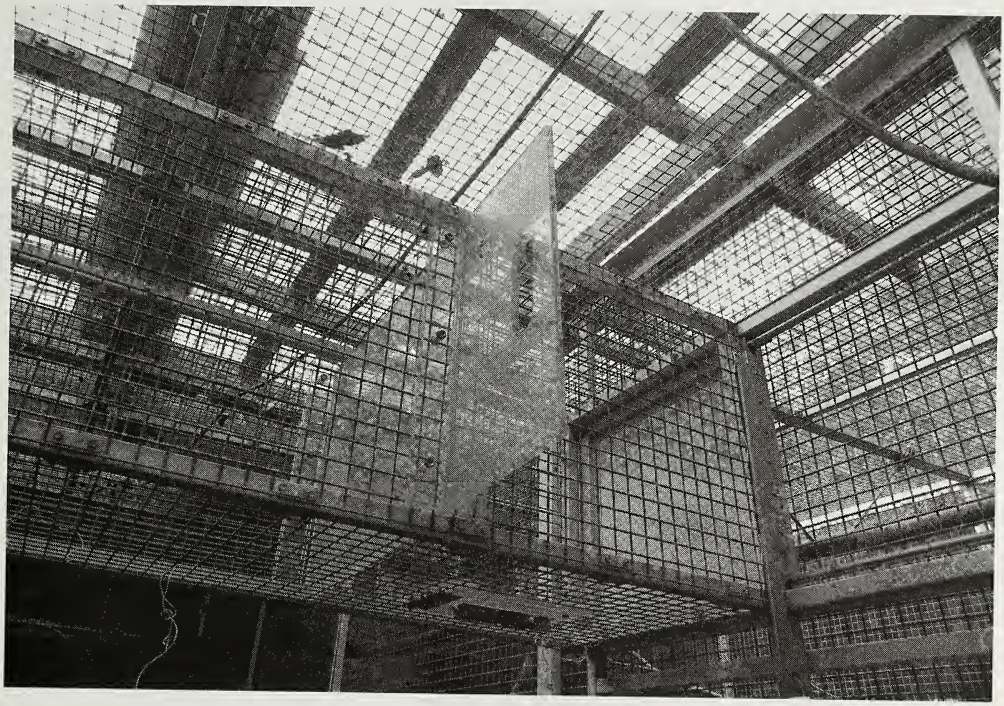
Maude was more challenging. She exhibited anxiety at the beginning of her injection training and did not want to sit still once shut into the overhead. Keepers would shut her into the smaller section and offer her portion of canned primate to eat and focus on while the injection was happening. However, it was found that if the keeper took too long to make the injection and she finished her food, she would immediately stand up and start to move around, preventing injection until she reseated herself. The solution that keepers came up with during her first weeks of training was to have a keeper on one side of the transfer shoot focusing on the injection, while a second keeper stood on the other side of the transfer and held Maude's attention, slowly breaking apart and smashing the canned primate between their fingers to feed her through the mesh. This slowed her down and kept her attention off of the injector. Once this calm behavior was established and the keepers increased the speed and efficiency of giving the injection, the second keeper no longer needed to hold Maude's attention and was removed.

In both cases, the lemur was immediately rewarded after the injection with a piece of fruit from their training container. The removal of fruit from the diet helped immensely with injection training because the reward of a grape became much more special to the lemurs, once grapes were scarcer.

Both Leo and Maude quickly learned to shift into their overhead transfers, station while the divider was inserted and sit eating while given their insulin shot and because of this their glucose levels became much more manageable. The main challenges encountered in the training were the differences in personalities between the animals, which translated into differing levels of cooperation and anxiety in the overhead transfer during the first stages of training, as well as finding the physical positioning inside the transfer that the lemur was most comfortable in for the injection. For example, Leo tended to move where the keepers wanted him and was usually injected in the extra skin around



The overhead transfer.



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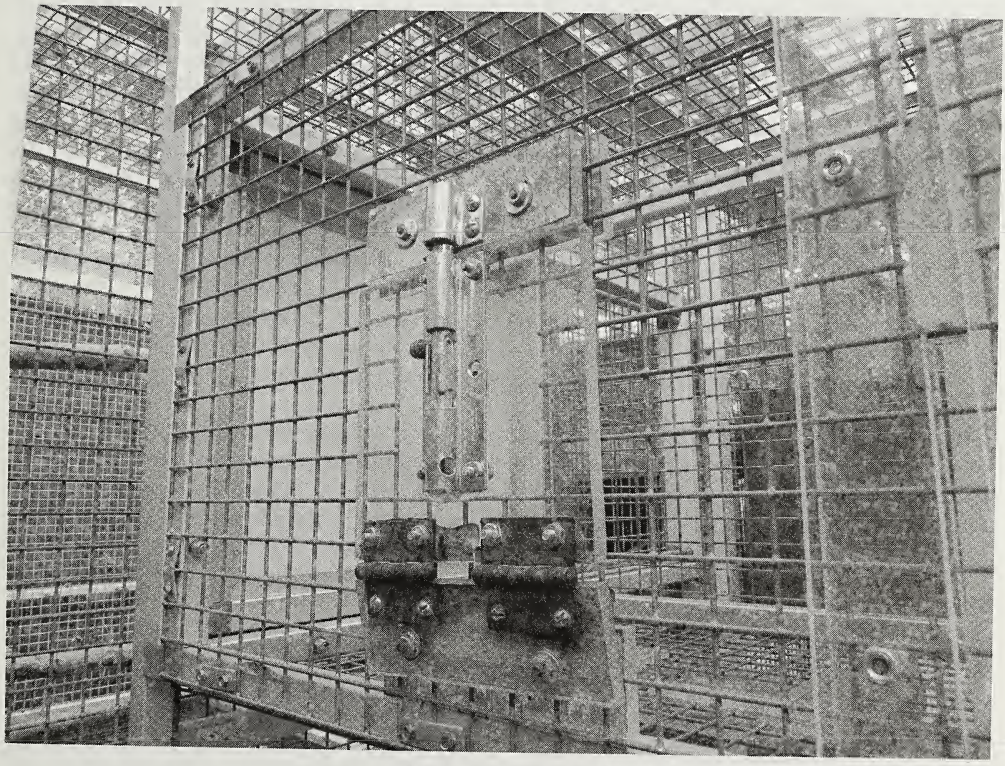

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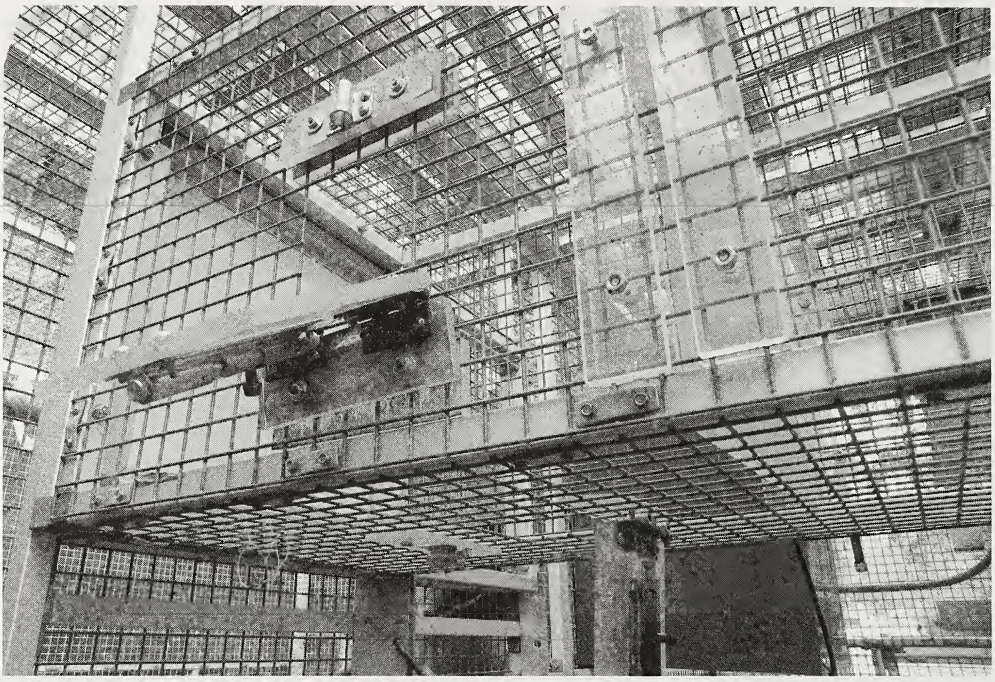

Both ports open.

his leg, while Maude was only comfortable sitting facing towards the divider and having the keepers inject her along her right hip/ leg. Another challenge was the weather. The lemur holding consists of mesh walls and ceilings and a partial overhang for shelter, which meant that keepers and lemurs alike had to contend with the elements and the need to keep the insulin bottle cool while it was in use. Without a refrigerator at the barn, keepers had to construct a "cooler" for the insulin bottle, consisting of a Tupperware® container and an ice pack, to attempt to keep the insulin at a consistently cool temperature. This was particularly important during the hot summer months. The insulin bottle was taken down to the barn for each injection in case the shot did not go in or the needle bent somehow before injection and another dose had to be quickly pulled up. Because the barn was not completely covered, keepers laid pieces of Plexiglas® on the roof above the transfer so that during rainy weather the lemur could come up to get their injection without getting wet. During the winter a heat lamp would be hung in the hallway, pointing towards the transfer to keep the lemur warm while they were separated from the group. Keeping the animals as comfortable as possible while inside the transfer was very important for establishing and maintaining their trained behaviors.

Once the behavior was established, the daily maintenance included frequent testing of Leo and Maude's urine with glucose strips, blood glucose checks during medical examinations as well as periodic blood draws using hand-restraint. It was also important to establish a minimum length of time that had to elapse between injections. Since both animals were only being injected twice daily, once at the morning shift and one in the evening, and since the zoo doesn't have second shift keepers, it was important to ensure that the injections were as far apart as they could be so that the insulin lasted as much of the day as possible. Injections are given by 0900 in the morning and no earlier than 1630 in the afternoon. If keepers go home early on holidays or when bad weather closes the zoo, someone still returns to give the injections at the specified times.

The management of two diabetic lemurs in a mixed-gender troop presented many challenges when the issue first arose. However, by combining diet changes, urine testing and insulin injections, those challenges were met, allowing Leo and Maude to maintain their health and to continue to live in their normal social groupings.

Use of voluntary restraint for glucose testing and insulin therapy of a female Guinea baboon *(Papio papio)* diagnosed with diabetes mellitus.

By
Erin Black, Zookeeper II
Kansas City Zoo
Kansas City, Missouri

Abstract

Born in 1987 at the Indianapolis Zoo, Wendy, a female Guinea baboon (*Papio papio*), moved to the Kansas City Zoo in 1995, and in 2007 was diagnosed with diabetes mellitus. Wendy immediately began oral medications to stabilize her diabetes, and a training plan was put in place with the goal to begin insulin injections to even better regulate her diabetes. Using operant conditioning and voluntary restraint, Wendy was trained to present her arms to trainers for twice daily blood glucose testing and insulin injections. The introduction of insulin has resulted in a better quality and prolonged life for Wendy.

Background

Wendy was born at the Indianapolis Zoo in 1987 and moved with several other baboons to the Kansas City Zoo in 1995 for the opening of the new Africa Exhibit. Wendy has mobility issues as well as many physical traits attributed to inbreeding such as: an underdeveloped digit, under bite, and in-coordination. Before Wendy's diagnosis, three other baboons residing at the Kansas City Zoo had been diagnosed with diabetes and began treatment. Celsie, the only remaining of the three, was the first at the Kansas City Zoo to be completely trained for insulin therapy.

In 2007, zoo keepers noticed Wendy presenting many of the physical symptoms of diabetes previously observed in other diabetic baboons at the facility. Animal health staff tested Wendy's blood and confirmed the zoo keepers' suspicions. Tests showed improper glucose metabolism over the last several months and she was diagnosed with diabetes mellitus. Wendy was immediately started on the oral medication Glipizide to control her diabetes. Later, Wendy was prescribed Avandia, another oral diabetes medication, in addition to Glipizide.

Training Procedure

Upon diagnosis, keepers trained Wendy to station on a milk crate and urinate on cue so urine glucose and ketone levels could be tested to determine the effectiveness of her current oral medications. Keepers used one LW Scientific, Inc.® one parameter urine reagent glucose strip and one Bayer® Ketostix® or JorVet URS-1K urine reagent strip to test urine. The next step was to begin restraint training. First, Wendy was introduced to the restraint device, referred to as a bar. In the beginning, Wendy was trained to use the same bar as Celsie, however due to challenges during training, keepers built a bat that had a different color and shape specifically for Wendy. Once Wendy was comfortable with the bar being placed in front of her, training began.

The goal was to train Wendy to grasp the bar and continue to hold until bridged. To begin, Wendy was baited to touch the bar by holding food rewards above the handle while being cued visually and verbally. Eventually the bribe was removed and Wendy was just cued. Training Wendy to grab the bar was a slow process due to available staffing and general time restrains. The most difficult aspect of training this behavior was getting Wendy to not only touch the handle but continue to hold the handle until bridged to release. Wendy inconsistently touched the bar and when she did she would either immediately let go or forcefully shake the bar.

In September of 2009, primary training of Wendy was handed over to two new trainers. Two people were made primaries so that despite staffing or daily duties, Wendy could be trained twice a day, every day, leaving another keeper available to work with Celsie. Twice daily training had an extremely positive impact on Wendy's overall training. During this transition Wendy was also introduced to her new bar. For unknown reasons Wendy did not show the same aggression towards her new bar as she did towards Celsie's.

The trainers began working Wendy to hold the bar for longer periods of time. Initially Wendy only offered her right arm during all training sessions and did not understand bribes for her left arm. After a short time, Wendy was grasping and holding the bar more consistently (Fig. 1). Next, trainers desensitized her to having her hand and the outer side of her forearm touched and rubbed. Once this was allowed, trainers needed to trim the long hairs on her arm for better access to the skin for blood testing and injections. Trainers first used child-safe scissors, with rounded tips to avoid any injuries, to trim the hair as low as possible. Then Wendy was introduced and desensitized to the use of a Schick® Intuition® razor.

Once a patch of hair was completely shaved, blood testing and injection-training began. Trainers used an Accu-Check® Active glucometer and Accu-Check® SoftClix lancet pen (Fig. 2). Wendy had to become comfortable with the lancet pen's presence, then to it touching her, next applying pressure,

Fig. 1. Wendy cued to hold restraint bar.

and lastly discharging the pen so it pricked the skin. Wendy surprisingly had little reaction to the actual prick of the lancet, but the noise it made often startled her. Wendy allowed complete use of the lancet pen after about four training sessions. Wendy's blood glucose levels were tested during both daily training sessions when possible. All urine and blood results were recorded and reported to Animal Health staff to assist in determining treatments. During this time trainers began desensitizing

Wendy to the injection process over a number of sessions. First, a blunted needle was used, then a sharp poke with an intact needle, next a quick insertion of the needle into the skin, and lastly use of injections with saline. Once Wendy reached the saline injection stage, trainers were required by Animal Health staff to inject at least five units of saline two times a day for three days in a row before starting insulin. After nine successful days in a row, Wendy received her first dose of insulin on 14 October 2009.

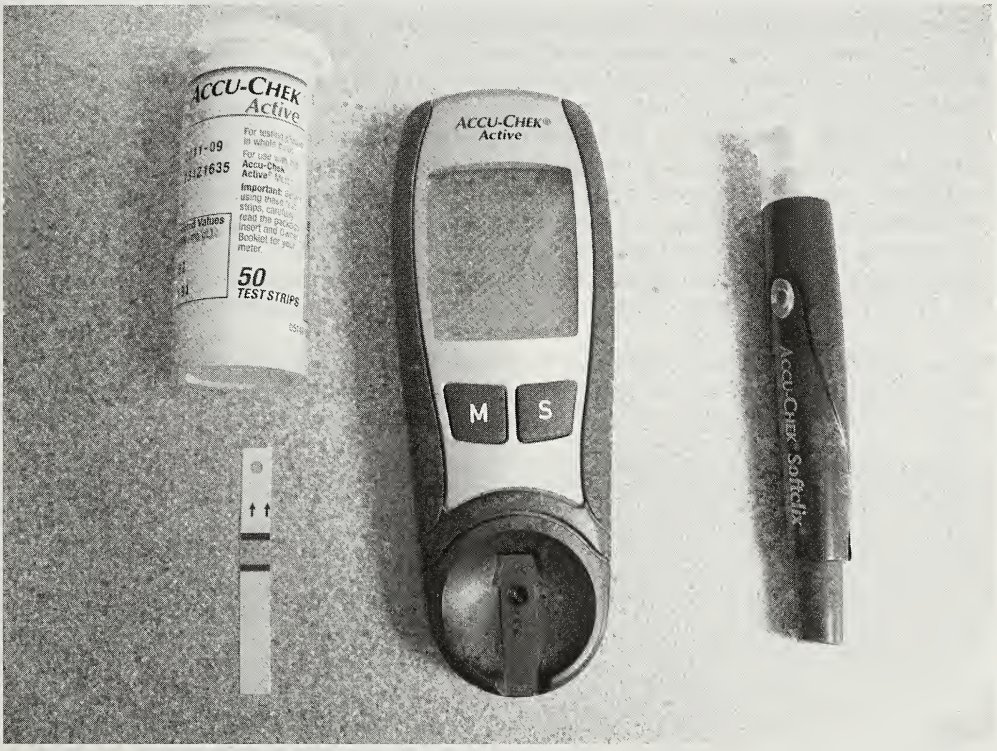

Fig. 2 Accu-Chek equipment

Challenges

Over the course of Wendy's training, zoo keepers faced several challenges. First, separating the baboons for training can be difficult depending on the animal's status in the group. Trainers at Kansas City Zoo separated Wendy and Celsie for every training session so the more dominant, aggressive baboons would not interfere. Wendy and Celsie are the two most subordinate and usually were not stressed by the twice daily separation. Had Wendy and Celsie been more aggressive towards keepers, every stage of their training would have been exceedingly more difficult.

The second and largest challenge to overcome was Wendy's personality. Wendy is a very gentle and patient baboon, but she is also very aloof. In some regards her personality was perfect for such training. She is rarely, if ever, aggressive with keepers and is very food-motivated. This made working up close with her much easier. However, introducing new items or people to Wendy can

often surprise her or put her off. Her first reaction to almost every new object she encountered was to become agitated and walk away. But if the trainer still had rewards she would come back immediately, keeping a close eye on the new object. Trainers had to introduce new objects slowly.

Keeping Wendy's natural instincts in mind, trainers also needed to remember baboons are threatened by direct eye contact, smiling and raising of the eye brows. When Wendy had a breakthrough in a behavior, trainers had to remember not to get too excited or risk upsetting Wendy or Celsie. When Wendy first began training to urinate on cue, trainers had to wear sunglasses because she absolutely would not tolerate them watching her. Now, during all training sessions keepers maintain calm steady voices, move smoothly and slowly, and keep eyes averted.

Before zoo keepers made a second bar specifically for Wendy, she shared a bar with Celsie. Because Celsie was already undergoing insulin therapy, she was trained first, received her insulin injections, and then the bar was passed to Wendy's trainer. However, Celsie was very possessive of the bar and would follow it to Wendy's station and crowd Wendy off of her crate. A few ideas were offered to mend the situation. The first plan keepers decided on was to paint one side of the bar base red to correspond to Celsie's crate, which was red, and the opposite side green to correspond to Wendy's crate. This meant each color would act as a station specific to each baboon. However, this also meant one trainer still had to wait on the other before proceeding. There was also the issue of Wendy's aggression towards Celsie's bar. Keepers built a new restraint bar for Wendy so there was no waiting, but they did not anticipate that Wendy would cease her aggressive tugging of the restraint handle (Fig. 3). Prior to the new restraint bar, no definitive ideas had been discussed to abolish this behavior.

As mentioned, to be able to test blood and begin injections, the patch of hair on the outer side of Wendy's arm needed to be trimmed and shaved. Shaving needs to be done about every three days or it becomes extremely uncomfortable to shave. As with all other new objects, zoo keepers followed

Fig. 3. Wendy's restraint bar on the left, Celsie's restraint bar on right.

the same steps to introduce the razor to Wendy. When shaving Celsie, she often becomes upset and slaps the razor out of the trainer's hand. The same reaction was anticipated from Wendy; however she generally doesn't seem to mind being shaved.

When trainers began testing Wendy's blood, they initially had trouble getting blood samples after using the lancet pen. Vet staff suggested using a warm, damp paper towel applied to her arm in conjunction with light massaging to increase circulation. This helped increase the frequency of blood samples collected for testing. Blood collection also became easier once Wendy started insulin therapy. Though occasional massaging is still used, there has been almost no need for a damp paper towel since insulin therapy began. Trainers also limited the number of times the lancet pen was used per session to avoid upsetting either baboon. If a suitable blood sample could not be collected after the allotted number of lancet pokes, Animal Health staff is contacted for further treatment instructions.

After overcoming issues obtaining blood, trainers then had issues beginning injections, but not from Wendy. Initially the needles trainers were using had red caps. The syringes used for Celsie's insulin also have red caps. Celsie was unexpectedly territorial of the syringes. When Wendy's trainers produced the syringe from training the caddy, Celsie would crowd Wendy off her crate and attempt to hold Wendy's bar. As a temporary fix, new syringes with an orange cap were issued. Because syringe brands are specific to the brand of insulin used, the orange-capped syringes could only be used for saline, not Wendy's insulin. During the first weeks of Wendy's insulin therapy, trainers used permanent marker to color the red cap. Eventually, Celsie paid less attention to Wendy's syringes and altering the caps was no longer necessary.

Another challenge trainers encountered was staffing. The primary trainers were not always scheduled to work the baboon routine and therefore had to make time in their daily routines for twice daily training at two very specific times of day. Once Wendy was successfully accepting insulin daily, the remaining zoo keepers on the Ruwenzori Team needed to begin working with Wendy so any Team Member could train her. Because Wendy already knew the rest of the staff, integrating new trainers into the sessions was achieved quickly and with few problems. Any new members to the team are integrated slowly at Wendy's pace.

Finally, there were two issues that needed to be addressed to avoid future challenges. The first was location of Wendy's daily shots. Location of shots needed to be rotated each time to avoid the build-up of scar tissue. The overall injection area was divided into five locations and rotated with every injection.

Second, as the team learned with Celsie, scar tissue can build up within a few short years. Celsie was initially trained to only offer one arm for testing and injections. As soon as Wendy began working with new zoo keepers she began training to offer her left arm to avoid the same situation Celsie was in. Wendy had to go through all the same training steps on her left arm as before. The process went much faster and within a short period of time Wendy was accepting insulin in both arms. Now injections rotate between the five locations and both arms.

Acknowledgements

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by Becky Richendollar, Senior Editor

Identifying the Poop

Analyzing feces can give veterinarians and other zoo researchers a lot of information about reproductive status, stress levels, and health by analyzing an animal's hormone levels. Often we are asked to collect fecal samples for studies at our own institutions or for researchers at other zoos and universities. Ultimately, all of the information we can discover about our animals will benefit them so keepers are usually happy to help collect feces for research purposes. In animals that are housed with conspecifics, it is important for us to be able to identify which poop comes from which animal, which is when we use fecal markers.

Bison (*Bison bison*) feces and the mysteries within. *Photo by Becky Richendollar*

Recently, a survey was conducted to try and discover just how prevalent the use of fecal markers is in AZA zoos. In addition, an experiment was carried out on fourteen different species to determine which fecal marker works best in each species. For the purpose of the survey, the researchers separated the fecal markers into five types: seeds and grains; fruits and vegetables; food colorings and dyes; chemical and other markers; and glitter and plastic beads.

Of the institutions responding to the survey, 64% said they do use fecal markers. The most commonly used fecal marker was seeds and grains, followed by food coloring and dyes. Chemical markers, and fruits and vegetables were used less. The least commonly used were particulate markers (glitter and plastic beads). Overall, fecal markers were most commonly used in primates and carnivores.

The second half of this study involved using the actual fecal markers in different species and tracking their transit time through the GI tract as well as their efficacy as a fecal marker. Individuals from fourteen species were selected, three from the Class Aves, three from Reptilia, and the remaining eight species were mammals. Six different fecal markers were tested (food coloring, baker's paste, nontoxic glitter, plastic beads, blueberries, and cooked corn or white rice). Not all fecal markers were tested on all species, based on the recommendations of the vets at the institution.

The researchers identified at least one successful fecal marker in thirteen of the test species but were unable to identify a fecal marker for the giraffe. The research showed that food coloring (dyes and pastes) are the most successful markers in a variety of species. However, particulate markers such as grains or plastic beads can be used in species with short, simple GI tracts. Following is a table listing the fourteen test species, as well as how much of each fecal marker was used and the transit time through the GI tract. In categories marked "NT" the fecal marker was not tried due to vet input.

Practical Applications for Zoo Keepers:

Using the table, keepers can make informed decisions about what fecal marker to use and when the most optimal time might be to find marked feces in the enclosure.

With due caution, keepers with similar species may wish to apply the information in this table to their own animals.

Species	Food Coloring (Green)	Baker's Paste (Blue)	Glitter (Green)	Beads (Various Colors)	Blueberries	Cooked Corn or Rice
Chicken	0.1 ml, 2 days	1 drop, 1 day	8 tsp glitter, 5 days	NT	3 berries, not found	NT
Chinstrap Penguin	0.1 ml, 4 days	.04 ml, not found	NT	NT	NT	NT
Radiated Tortoise	0.25 ml, 1 day	.04 ml, not found	NT	NT	NT	4 tsp corn, 3-4 days
Black tree monitor	0.01 ml, 2 days	.005 ml, 3 days	NT	NT	NT	NT
Mexican beaded lizard	NT	.02 ml, 4 days	NT	NT	NT	NT
Debrazza's Monkey	0.25 ml, 2 days	0.15 ml, 3 days	0.25 tsp, 3 days	6 beads, 2 days	6 berries, not found	NT
Serval	0.33 ml, 1 day	NT	NT	NT	6 berries, not found	0.5 cups rice, 3 days
African Lion	0.5 tsp, 1 day		1 tsp, 1 day	2 tsp pink beads, 1 day	5 berries, 8 days	0.5 cups rice, 1 day
Amur Tiger	0.5 tsp, 1 day	NT	NT	NT	NT	NT
Jacob's four-horned sheep	3 tsp, 3 days	0.75 ml, 4 days	12 tsp, not found	NT	NT	NT
Giraffe	NT	NT	NT	NT	2 cups, not found	2 cups corn, not found
Sichuan takin	2 Tbsp 2 days	0.5 Tbsp, 2 days	NT	NT	NT	NT
Pony	2 Tbsp, not found	1.5 ml, 5 days	NT	NT	NT	NT
Southern three-banded armadillo	0.06 ml, 8 days	0.03 ml, 7 days	NT	NT	NT	NT

*Table adapted from (Fuller, Margulis, and Santymire, 2011)

To View the Complete Article:
Fuller, G., Margulis, S.W., and R. Santymire. (2011). The Effectiveness of Indigestible Markers for Identifying Individual Animal Feces and Their Prevalence of Use in North American Zoos. *Zoo Biology* 30: 379-398.

Enriching Zoo Bears

One of the earliest examples of zoo keepers using enrichment to enhance their animals' lives comes from the year 1252, when the polar bear (*Ursus maritimus*) keeper at the Tower of London menagerie would walk the bear down to the river Thames for salmon fishing. Obviously, we would never walk our polar bear anywhere these days, but the author of this article emphasizes that keepers often have the best ideas for enrichment for their animals. Even those items that have not been rigorously scientifically tested, the authors say, can be greatly beneficial to the bears based simply on keeper observation of their behavior.

Grizzly bear enrichment.
Photo by Dana High, North Carolina Zoo

While bears for a long time were thought to be unintelligent, zoos now realize that bears require a complex and stimulating environment to thrive. Mixed-species exhibits can be one way to achieve this. Exhibits pairing Grey wolf (*Canis lupus*), Corsac fox (*Vulpes corsac*), Lynx, or Rhesus macaque (*Macaca mulatta*) with bears have been reported as successful. In addition, South Lakes Wild Animal Park in the UK has a mixed-species exhibit that encompasses spectacled bears (*Tremarctos ornatus*), Brazilian tapir (*Tapirus terrestris*), Capybara (*Hydrochoerus hydrochaeris*), Spider monkeys (*Ateles sp.*), Brown capuchins (*Sapajus apella*), and short-clawed otters (*Aonyx cinerea*). Any time a different species can be housed safely with a bear species it can enrich the enclosure's inhabitants.

The author mentions a study published in 1978 that found that female bears are more active than male bears, which possibly creates the need for differing levels of enrichment depending on the gender of the animals in your collection. The study also found that larger enclosures lead to more successful breeding and less stereotypical behavior, especially in polar bears.

The author goes on to discuss several positive enrichment strategies, including an automatic scatter feeder and offering substrate so the bears can engage in natural nest-building behavior.

Practical Applications for Zoo Keepers:

Once again, know your species and your individuals when planning your enrichment.

Research enrichment ideas by contacting other bear keepers, as they are your best sources of information.

Use scientific methods to confirm the success or failure of your enrichment devices when able, but don't stop enriching because you don't yet have data to back up your ideas.

To View the Complete Article:
Law, G., and A. Reid. (2010). Enriching the lives of bears in zoos. *International Zoo Yearbook* 44: 65-74.

CONSERVATION STATION

Madagascar Conservation

By Cathy Schlegel, Zoo Keeper
Minnesota Zoo, Apple Valley, MN

In the fall of 2010, I was fortunate enough to make a dream journey to Madagascar. I had wanted to go there for years, especially since I started working with lemurs as a zoo keeper 10 years ago. But I did not just want to visit as a tourist, I wanted to help lemurs in their natural habitat. I wanted to see lemurs in the wild and help with conservation so that other people would be able to see them in the future.

I started my journey with a Google search - "Lemur Madagascar Volunteer." Several different

organizations came up, and I decided to go with one called Azafady. No experience was needed to volunteer, and no age restrictions. They are based in the southeast part of Madagascar and they work directly in the field with lemurs. The focus of the module I participated in is to investigate the impact of forest fragmentation on lemur, reptile and amphibian populations by collecting data in the littoral (coastal) forests in Sainte Luce, situated in south east Madagascar. There is a fee for volunteering. I was there for four weeks and it cost a little more than $1,400. They will help you fundraise, providing materials and advice. They even have a lemur costume you can wear! The plane flight was another $2,500. That's a lot when you are on a Zoo Keeper's budget.

I was very lucky to have the option to ask for a grant from the Minnesota Zoo's Ulysses S. Seal Conservation Grant program. This grant is available to full time zoo staff to help fund projects all over the world. These projects are something that the staff member chooses, whether it is helping to pay for radio collars or sending a staff person across the world to help in conservation. The Zoo awarded me funding to partially cover my trip, and thankfully my co-workers were okay with me taking a long stretch of time off. I never could have gone without them covering for me!

I spent a lot of time preparing for my trip, researching the area and the species I would be working with, buying all the needed equipment for a month living in the bush, and getting all those vaccines you need in order to travel to Madagascar. Finally the time came, and I was off. As my plane started to descend over Madagascar, I was so thrilled to think that there were lemurs in those forests! And I was going to get to see them! Arriving in the capital, Antananarivo, was an amazing experience. The new sites and sounds, and seeing how people live and go about their day is one of my favorite things about travelling. I had already booked a small room in a hotel in the city and as soon as I checked in and rested a bit I went out to get a feel for the city. I had planned my trip with a few extra days at the beginning and about a week and a half at the end for extra travelling, so I was able to wander the city for several days before catching my next flight to Fort Dauphin, where Azafady has its Madagascar base. I met the other members of my group and off we went to camp.

The road to Sainte Luce is rough. Very rough. It is about a 65 kilometer drive, and can take anywhere from three to five hours. We were driven in an open-sided truck with hard metal seats along the sides and all our stuff in the middle. It was usually easier to just lie across all the supplies than it

was to try and stay in your seat over all the rocks and potholes. Of course, we also needed to get out occasionally so the truck could cross a bridge with a little bit lighter load.

The small village of Sainte Luce has no running water and no electricity. We got our washing water from a well and drank rainwater. We slept in tents, ate our meals in an open-sided long house, and showered with a bucket and a cup. We ate rice for every meal, along with beans or vegetables, and the occasional fish or portion of Zebu (*Bos primigenius*) meat. There were sand fleas on the ground that we had to pick out of our feet on occasion, but most of the insects were spectacular.

But what I was waiting for of course was to see a lemur in the wild. When I finally did see one, on my first day in the forest, I actually had tears in my eyes. I had never seen such an amazing site. And that same scene played out almost every day, several times a day! Getting to walk out into the forest, and just find lemurs, eating, resting, moving around in the trees, doing all the things that lemurs do, was the most amazing thing! And every time we saw lemurs, we recorded data. We would take the GPS location of the lemur, habitat information, such as the type and size of tree they were sitting in, how high they were, the canopy cover and the sex of the animal. We would also record behavioral data using ethograms. I loved sitting in the forest for hours watching them, even if all they were doing was sleeping!

The littoral forest in and around Saint Luce is greatly fragmented. Large areas have been cleared for farming and grazing. Azafady is trying to determine changes in population in relation to these forest changes. The information we gathered about the areas we found lemurs in helped to determine the makeup of the fragments to determine what they require and prefer about the habitats. We also got to start the first long-term research on the Southern Wooly Lemur (*Avahi meridionalis*). This is a newly recognized species and is thought to be found only in Sainte Luce and Andohahela, a national park in southeastern Madagascar.

We also looked for other animals, frogs, lizards, geckos, chameleons and snakes, to name a few! When we found these animals, we recorded their location, as well as what type of habitat they were found in, like in a stream, on a log, or in leaf litter. There is a critically endangered gecko in Sainte Luce, (*Phelsuma antanosy*). It is thought that they have specific habitat requirements for egg-laying

and usually use a single species of *Pandanus* palm that is found in Sainte Luce.

I also helped make up a lesson plan for the school children that lived in the village. We taught them about habitats, and why different animals need to live in different types of habitats. And, in order to help the adults in the village use up to 75% less wood when cooking over an open fire, we built clay stoves to contain the heat and cut down on smoke.

Some of my most interesting finds were at the outhouse. The "loo" was down a grassy path behind the trees. It seemed like almost every day I found something on a trip there. Once it was a scorpion eating a cockroach, and there were several geckos, moths and butterflies, a snake, and a few frogs too. I learned to take a camera with me wherever I went. And I do mean wherever.

Azafady has several different projects in and around Sainte Luce. They are involved in community health, such as building latrines and encouraging hand washing. They build schools and teach children, promote livelihood through training in agricultural techniques, and they deliver information about preventing HIV and STD's.

My trip to Madagascar was one of the most memorable things I have ever done, I am very lucky to have been able to travel to such an amazing country and help out some of the world's endangered primates.

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