

Project Sun Bear Nutrition

Applicant's Name: Student Name

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Goal/Purpose:

My goal in this project is to test hair, breath and excrement from sun bears (*Helarctos malayanus*) to determine if consumption of mealworms, the larval stage of *Tenebrio molitor*, or house crickets, *Achetus domesticus*, can be differentiated isotopically by measuring sulfur, oxygen, and hydrogen isotopes in the bear's substrates. This information is needed in future conservation efforts with sun bears in the wild to determine specific insectivory to help delineate what they consume and the adequacy of their diet.

Importance of the project:

My project will determine if carnivory from insect matter can be differentiated from other animal matter in the diets of sun bears. This information can be used in conservation efforts to ensure that the sun bears have access to necessary food resources and are getting the nutrition that they need. Sun bears are a critically endangered species which has not been widely studied in the past. Their habitat has been broken up due to human influences and a desire to stay away from areas of high disturbance. Consequently, they have been confined to small patchy landscapes. This has led to a shift in their food choices, from insects to more agricultural foods (Augeri, 2005, p. 5). Confining sun bears to wildlife reserves to protect them may be problematic if they are too insular and prevent the bears from having access to the foods they need in the right proportions. This study would also be useful to zoos that house sun bears to be sure they are getting the proper nutrition. Stable isotope analysis is important because it offers a non-invasive, accurate technique to portray what is actually assimilated into the bears' tissues as opposed to fecal studies which only tell what was ingested and is not as exact (McKechnie, 2004, p. 132). A study to identify contributions from a specific plant was done in 2003, when Felicetti et al. used stable isotope levels of sulfur and nitrogen to determine the amount of white pine nuts consumed by Yellowstone grizzly bears (2003, p. 763). There has only been one similar study done in which $\delta^{34}\text{S}$ isotopic signatures were measured in diet and tissues of pigs that were fed isotopically known diets and measured liver sulfur values (Gonzalez-Martin, 2001, p. 28). However, no study has been undertaken to determine if specific insects consumed by bears can be identified by isotopic analysis of their substrates. This is a relatively new procedure and this study will not only be useful for the sun bears's future, but also as an application for use in future animal ecology studies utilizing this stable isotope technique. It will also help us gain more information on dietary reconstruction and protein catabolism (Gannes, O'Brien, & Martinez Del Rio, 1997, p. 1274).

Main Proposal Body

We will study 12 sun bears that are currently on loan to 6 North American Zoos from the Malaysia's Sepilok Orangutan Rehabilitation Center in Sabah, Borneo. These zoos are in Honolulu, HI; Portland, OR; Chicago, IL; St. Louis, MO; Gladys Porter Zoo, Brownsville, TX and Miami, FL. From these bears, we will collect breath, hair, urine, and feces samples before we begin our experiment to determine their isotopic signatures in metabolic by-products and substrates when they are eating known diets before this study begins. The bears

will then be fed predetermined and regulated amounts of mealworms, the larval stage of *Tenebrio molitor*, or house crickets, *Achetus domesticus*, along with a bolus of corn syrup to provide a specific C4 carbon isotopic signature as a marker when insects are fed. This is necessary to determine the isotopic signatures that occur as a result of assimilated insect matter fed as a proportion of the bears' diet. Two different insects will be fed to the bears to determine how insects cause a change in the isotopic signatures. To do this, we will again collect hair, feces, and urine samples and test them for D/H, $^{18}\text{O}/^{16}\text{O}$, and $^{34}\text{S}/^{32}\text{S}$ values. Baseline breath samples will be collected on day 0, then breath obtained on days 1-7, 21 and 35 to detect the change in CO_2 levels after the C4 corn syrup spike that coincide with insect feeding. The bears' diet will be manipulated to add insect matter over 3 days during a 35-day interval, at the amount of 20%, 30%, or 40% of the diet, then the trial repeated so each insect is fed at these 3 different levels over 6 separate trials. The bears will rotate through these regimes over 35 day cycles to establish reference points for comparison with free-ranging bears.

Before testing hair samples, they will be cleaned, dried, and cut to lengths of about 1 mm. Feces and urine samples will be freeze-dried and ground in a fine powder, and drinking water will be thawed just before we will analyze it. Duplicate samples will be made and both will be weighed and analyzed for ratios of D/H, $^{18}\text{O}/^{16}\text{O}$, and $^{34}\text{S}/^{32}\text{S}$ in the manner described by Sponheimer et al (Sponheimer, 2003). CO_2 levels in breath samples will be analyzed from the exetainer tubes directly. Using a Costech thermochemical elemental analyzer, we will analyze combusted samples to separate hydrogen and sulfur levels. We will compare the data we find the standards for each element.

Anticipated Academic Outcome

I would like to publish my findings in Conservation Biology, Zoo Biology, or *Ursus* and make them available to anyone who might be involved in future conservation efforts with sun bears. I plan to present my results at the Society for Integrative Biology meetings in January 2009.

Qualifications:

I am qualified to do to this project because I have taken several biology and chemistry class in my time at BYU that have provided me with the necessary background information to begin work on this project. I have also participated in a mentored research project with two other students while attending a spring internship at the Oregon Institution of Marine Biology. We studied the effects of various predators on the movement of intertidal limpets. We preformed experiments in the lab and in the field. We also wrote a scientific paper presenting our ideas and prepared and gave a presentation to our professor and our peers.

Project Timetable

The first phase of this project will start in March 2008. Isotopic analyses will begin in July 2008 and the final paper should be done by December 2008. I plan to present my results at the Society for Integrative Biology meetings in January 2009.

Works Cited

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- Gannes, L. Z., O'Brien, D. M., & MartinezDelRio, C. (1997). Stable isotopes in animal ecology:

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Abstract:

Sun bears (*Helarctos malayanus*) are a critically endangered species. In this study, we will test stable isotope levels of D/H, $^{18}\text{O}/^{16}\text{O}$, and $^{34}\text{S}/^{32}\text{S}$ that are assimilated in sun bear hair, feces, and urine to determine if consumption of mealworms, the larval stage of *Tenebrio molitor*, or house crickets, *Achetus domesticus*, can be differentiated isotopically by measuring sulfur, oxygen, and hydrogen isotopes in the bear's substrates. This information is needed in future conservation efforts with sun bears in the wild to determine specific insectivory to help delineate what they consume and the adequacy of their diet.