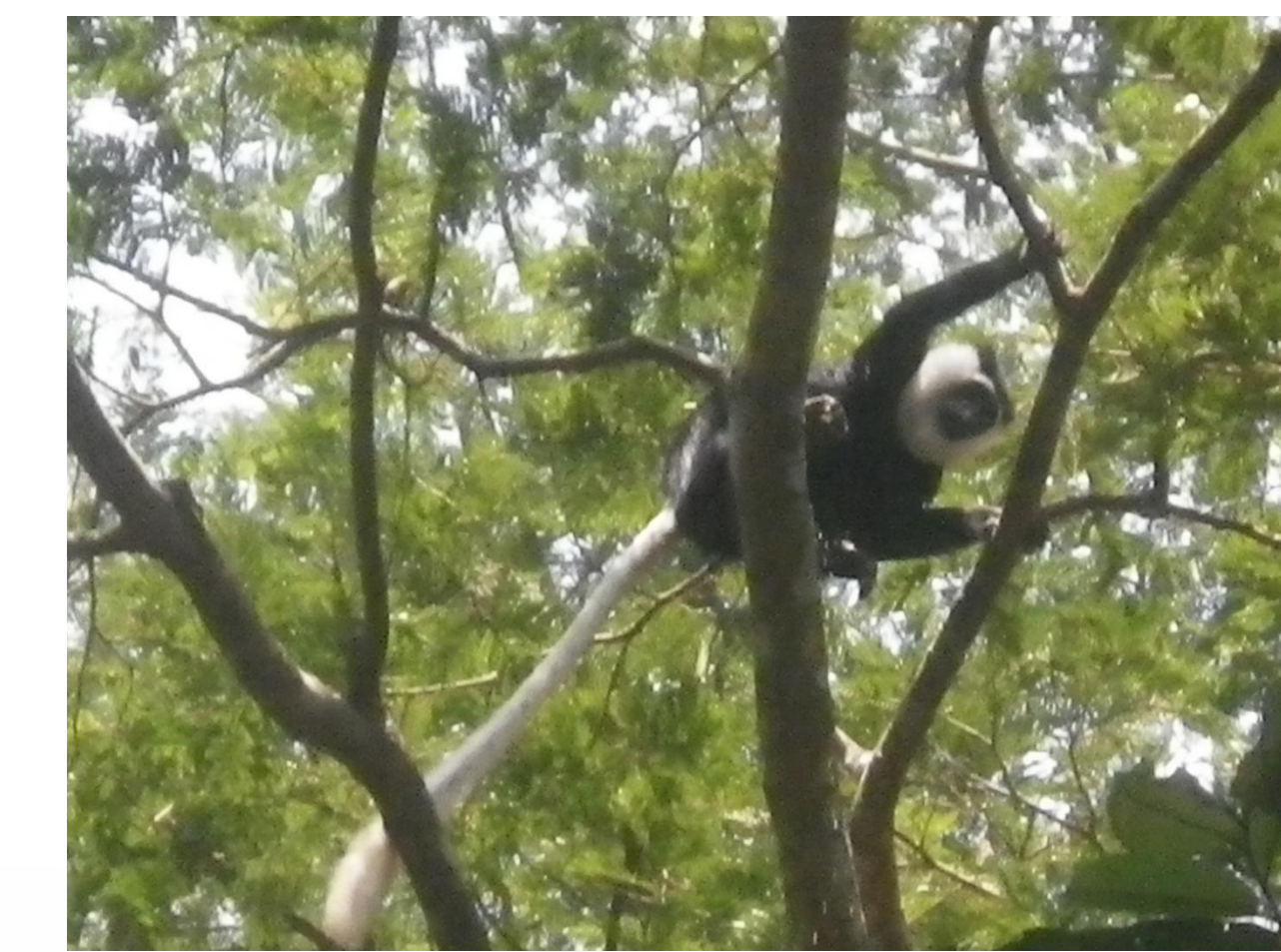


Toughness Values of Leaves as a Measure of Dietary Quality in *Ursine Colobus Monkeys (Colobus vellerosus)*

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Abstract:

A research group of eleven students and three faculty members collected data in the Boabeng-Fiema Monkey Sanctuary in central Ghana in December 2010. The study included observations of the indigenous *Colobus vellerosus* monkeys, with a focus on their dietary habits. Foraging habits were observed, and nineteen samples of food plants were collected by the group. These specimens were analyzed using a portable fracture-toughness tester, which calculated a force-displacement curve for each species to determine the work of fracture (fracture toughness). Fracture toughness is considered a key physical property in food quality analysis in primate diet. Results from the study show a dietary preference for leaves with lower toughness values. However, some samples produced higher toughness values, suggesting the additional practice of opportunistic foraging.

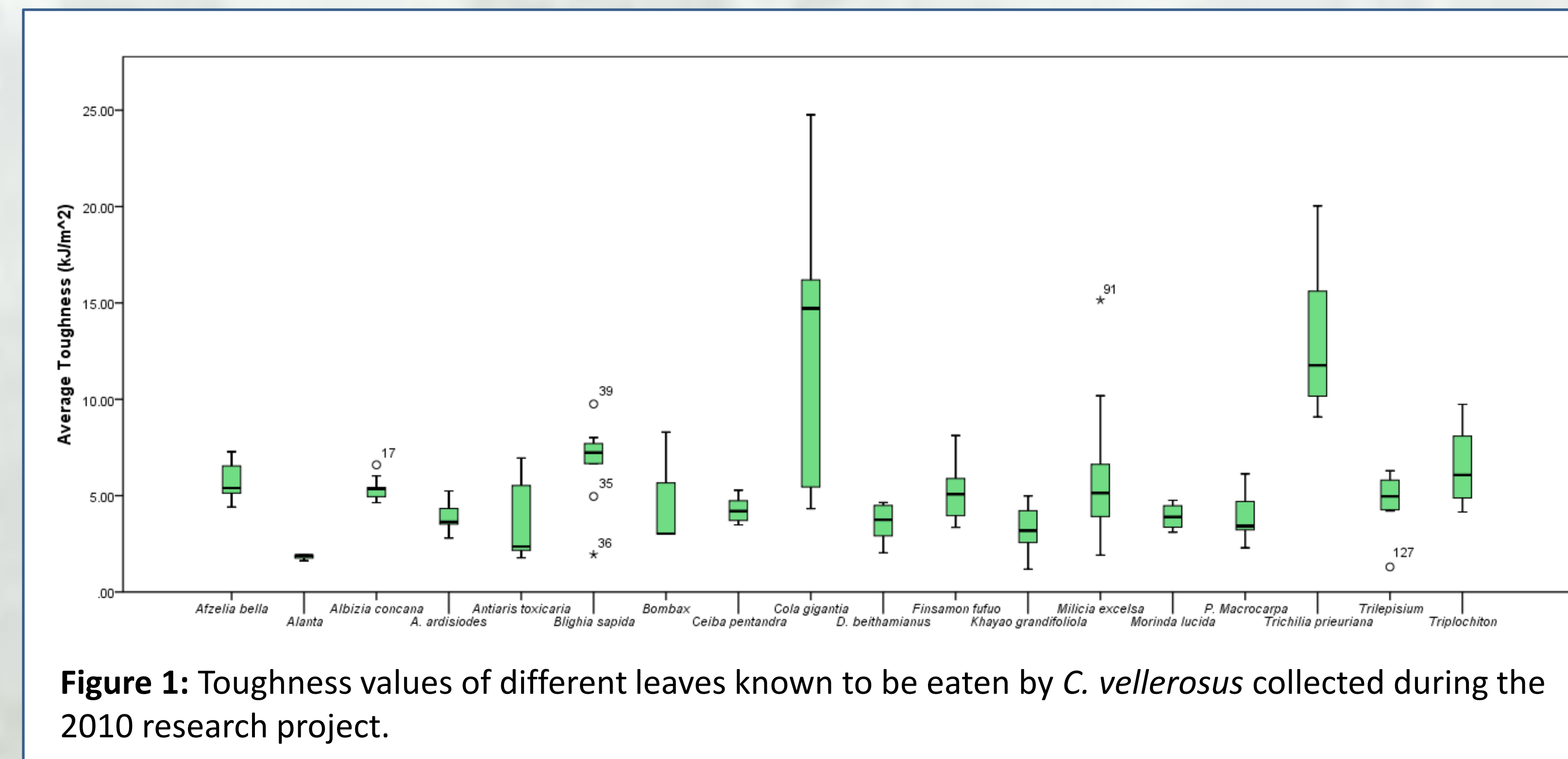
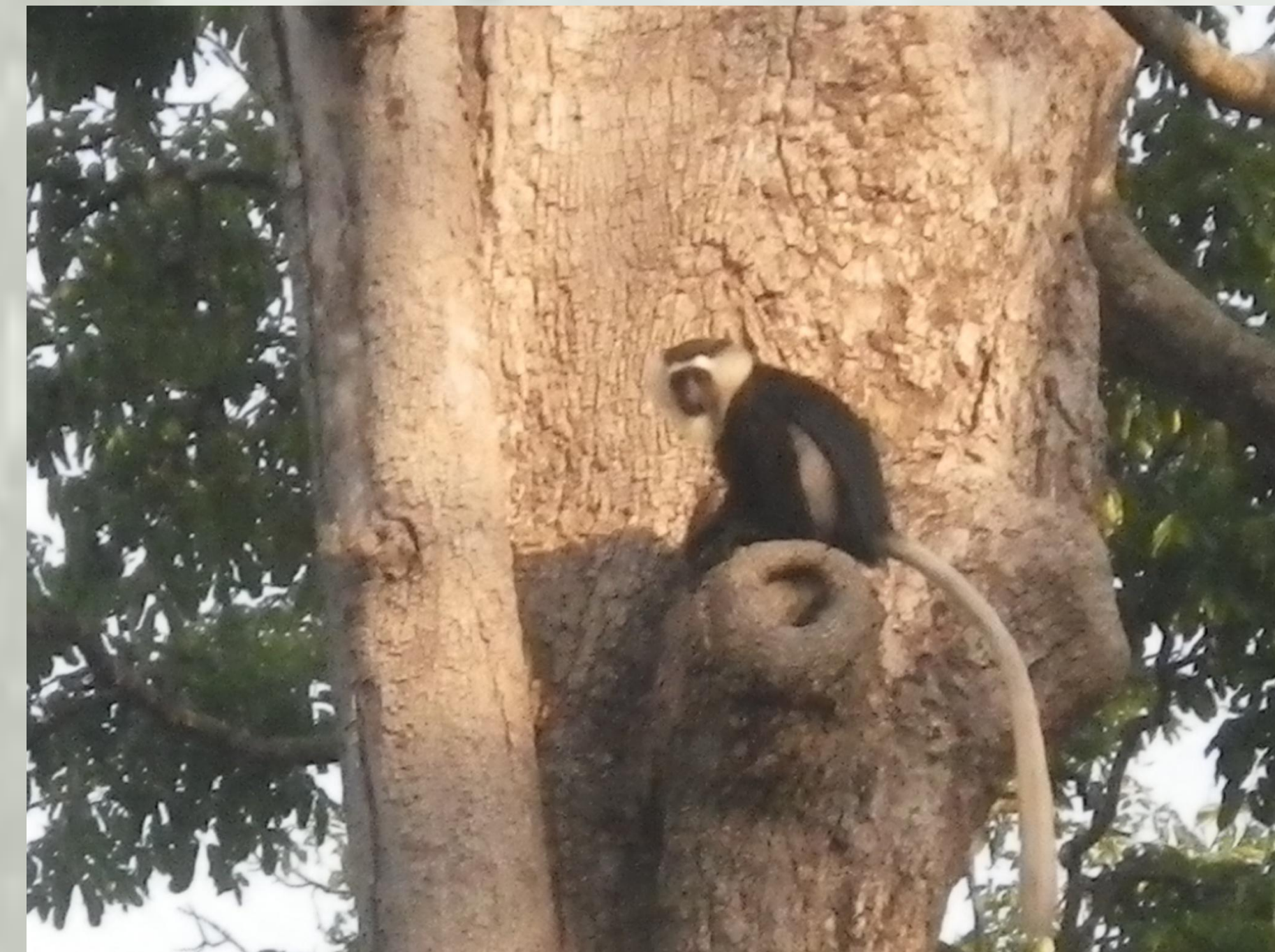


Figure 1: Toughness values of different leaves known to be eaten by *C. vellerosus* collected during the 2010 research project.

Results and Discussion:

The calculated average toughness value for the ursine colobus diet was 5.77 kJ/m², with a standard deviation of 3.86 kJ/m² and a median toughness value of 4.80 kJ/m². The range in toughness varied from 1.82 to 13.02 kJ/m². Out of the 18 samples, 13 of the specimens were below 6.00 kJ/m² toughness value. These results suggest a preference towards low toughness values. Figure 1 depicts the range of toughness in each of the tested leaves. One of the observed food specimens was a fruit, which was excluded from this chart for comparison purposes. In another study conducted by Hill and Lucas (1996) on Japanese macaques, their results suggested that the macaques chose leaves based on toughness as an indicator of nutritional value. Shown in the table below are toughness values from the diets of mountain gorillas, macaques, capuchin monkeys, and some common foods from the human diet, compared to the average recorded toughness of the ursine colobus diet.

Our findings show that the diet of ursine colobus is comparatively tougher than the diet of most other primates. These statistics are most likely due to limited amount of data collected. Further collection of fracture-toughness values of the colobine diet is necessary to better document habitat quality.

Introduction:

A research group of eleven students and three faculty members from Florida Gulf Coast University collected data in the Boabeng-Fiema Monkey Sanctuary (BFMS) in central Ghana in December 2010. The villages of Boabeng and Fiema both have cultural taboos that protect monkeys in the surrounding forest, which has led to a large population of Campbell's monkey (*Cercopithecus campbelli*) and ursine colobus (*Colobus vellerosus*). Since the mid 1970s, laws and regulations have been emplaced to protect the monkey species in the forest and establish protected lands and ecotourism efforts in the area. Research has been conducted on the ursine colobus in this location since 2000.

The main objective of our study was to obtain food specimens pertaining to the diet of the ursine colobus monkey and to analyze them with a portable fracture toughness tester (PFTT).

The physical properties of the plants and plant parts eaten such as size, taste, color, toughness, strength, and retention have been found to influence food choice and the facilitation of food resources by sympatric species (Hill and Lucas, 1996; Strait, 1997). The toughness of leaves is based on the fracture energy necessary to break a material in terms of force per displacement; it is defined as the work in Joules done when one Newton acts through one meter of material.

Our data collection served as a pilot study to initiate a long-term research project determining and comparing food choice and distribution. The toughness values of the distinct diet of ursine colobus will be compared to toughness values of multiple other primate diets. Further research will entail collecting foods eaten in the following years during other dry and wet periods to analyze any seasonal variations in the diet of ursine colobus in BFMS.

Materials and Methods:

The study took place in BFMS, which is located in central Ghana, in 2010 during the dry season. The BFMS is a protected semi-deciduous forest occupying 192 ha. Students and professors were divided into five teams. Two teams followed monkey groups throughout the morning and afternoon feeding times to observe foraging behavior and collect possible food samples. The third team was partnered with a local herbalist, and collected samples of known ursine colobus foods. The fourth team acted as runners, bringing collected samples back to field lab, where the fifth team analyzed the specimens.

- Opportunistic observation of *Colobus vellerosus*
 - Ten minute observation windows
- Collection of food plants observed to be eaten
 - Focus on individual foraging habits
 - Height in tree, area of tree, GPS location were recorded
 - Plant parts consumed were recorded
- Collection Strategies
 - Cut with tree pruning saw
 - Dropped remnant material
 - Collection of same species from more accessible sources when consumed sources are unobtainable
- Collected a total of 18 species
- Portable Fracture Toughness Tester (PFTT) used to evaluate the toughness of collected food samples.
 - Each specimen was cut six times to generate a species specific mean value of toughness
- All specimens were photographed, drawn, measured and tested for toughness within 24 hours of collection to avoid changes in physical properties due to aging.

Table 1. Comparative Toughness of Primate Diets	
Species or food item	Fracture Toughness (kJ/m ²)
<i>Colobus vellerosus</i> food items	1.82 – 13.02 average 5.77
<i>Gorilla g. beringei</i> food items ¹	0.02-5.68
<i>Macaca fuscata</i> food items ²	below 2.30
<i>Cebus apella</i> food items ³	average 1.11
Common Human foods:	
Macadamia seed ⁴	0.1-1.0
Carrot ⁴	0.44
Apple ⁴	0.05
Spring roll (briefly cooked) ⁴	0.14
Mozzarella cheese ⁴	0.07
Parmesan cheese ⁴	0.23

Literature Cited:

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4. Lucas, Peter W. 2004. Dental Functional Morphology, Cambridge: Cambridge University Press



Afzelia africana
"Papa-o-nua"
or
"Papa"
The seeds are dispensed by explosive mechanism; the sound of seed dispersal gives the tree it's local name, Papa.

