Physi-O-lympics: BITE FORCES OF CARNIVOROUS MAMMALS

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Introduction

---This is mainly a qualitative, literature-based assessment
---This project examines the skull morphology and bite force associated with diet in several carnivorous mammals compared to omnivores
---Some of the mammals are compared to non-mammalian species
---Carnivores: Cougar = *Puma concolor*, Canada lynx = *Lynx canadensis*, Bobcat = *Lynx rufus*, Grey wolf = *Canis lupus*, Coyote = *Canis latrans*, Red fox = *Vulpes vulpes,* Polar bear = *Ursus maritimus,* American alligator = *Alligator mississippiensis,* Great white shark = *Carcharodon carcharias*
---Omnivores: American black bear = *Ursus americanus*, Domestic pig = *Sus domesticus*, Human = *Homo sapiens*
---Herbivores: American beaver = *Castor canadensis,* Elk = *Cervus canadensis,* Bison = *Bos bison*
---Bite forces are typically highest in the posterior teeth (molars, premolars, carnassials) (Ferrario *et al.*, 2004)
---Mammalian carnivores vary in their levels of meat consumption and the size of prey they hunt: cougars and grey wolves often take down prey larger than themselves, while Canada lynx and coyotes tend to hunt prey smaller than themselves (Christiansen and Wroe, 2007)

Objectives

1.)---To discern if there is a correlation between skull length and bite force
2.)---To explore the relationship between bite forces and dietary needs
3.)---To examine the zygomatic breadth of skulls in relation to bite force

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Materials and Methods

---Several literature databases were used to acquire information (*JSTOR, ScienceDirect*), as well as data from books
---Key search terms included: bite force, jaw muscles, dentition, carnivore, omnivore
---Figure data is from referenced information which was adapted into tables
---Data was averaged for bite forces and in one case (Christiansen and Wroe, 2007) selected from the pressures exerted across both the carnassials and canines to gain an average
---Graphs were created in Microsoft Excel
---Photographs are of skulls in my own collection
---Alterations to figures were done in Microsoft PowerPoint

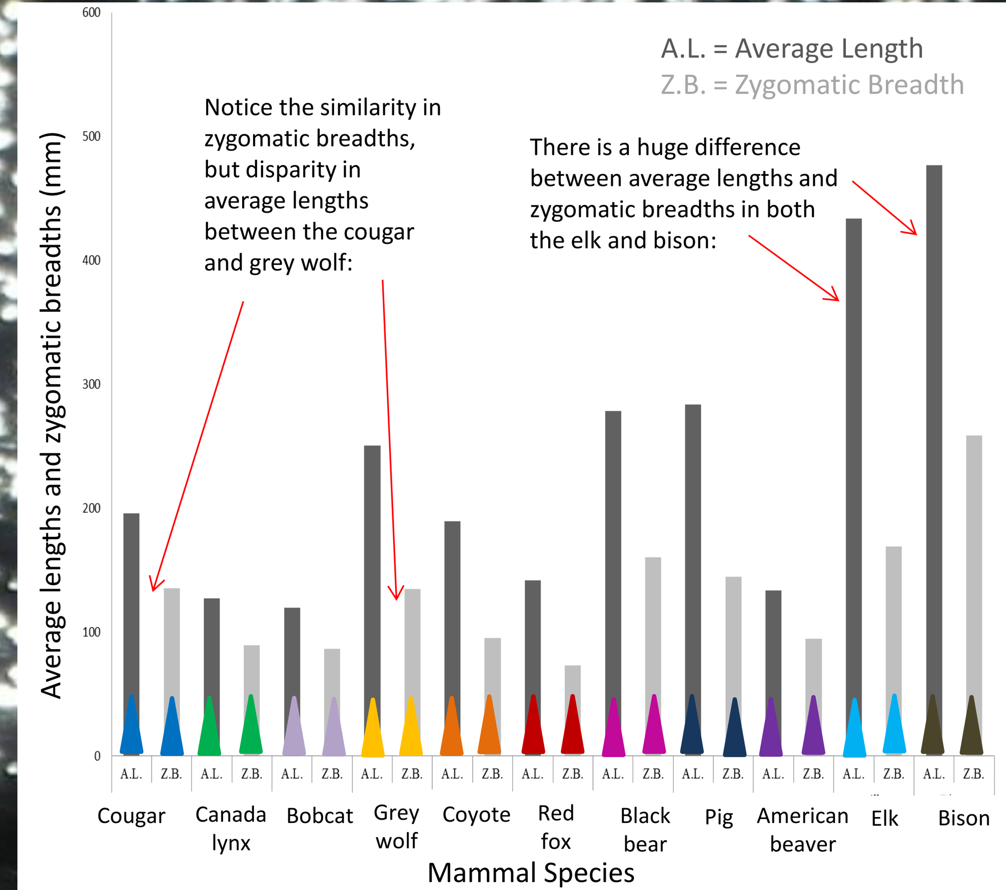

Figure 4. The average lengths (mm) and average breadths (mm) of mammal skulls across both sexes (Data adapted from Elbroch, 2006).

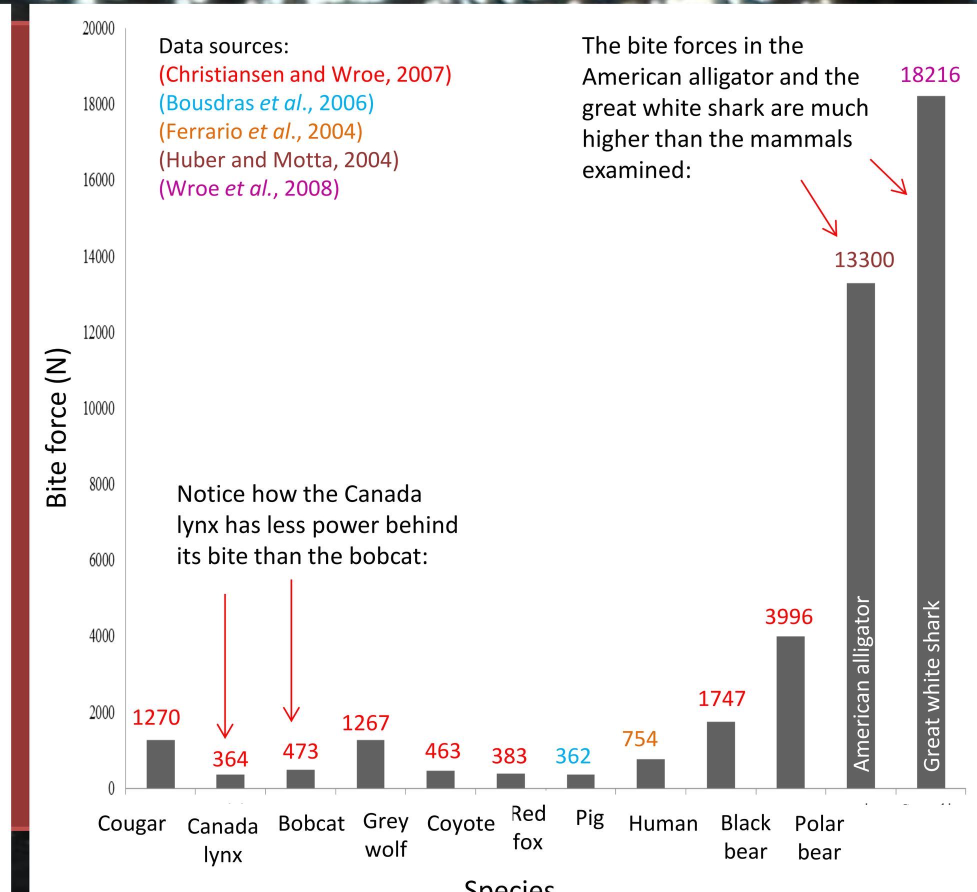

Figure 5. The bite forces of several animals (in Newtons) for comparison.

Results

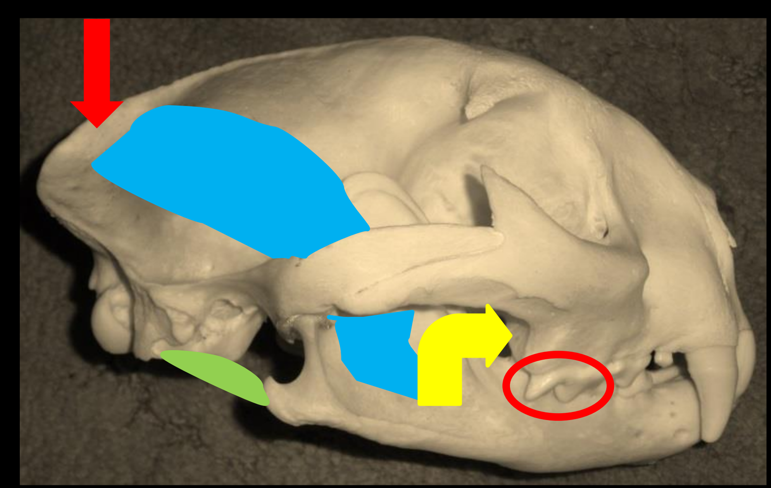

Figure 1. Primary muscles involved in opening and closing the jaw: the masseter, digrastricus, and temporalis shown on a cougar skull. (The carnassial teeth, characteristic of carnivores, are circled in red. The sagittal crest is pointed out with a red arrow.)

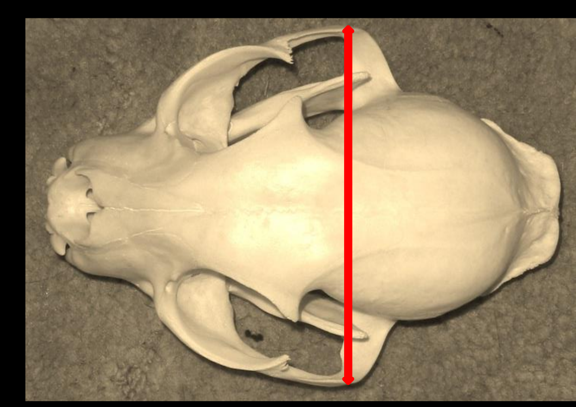

Figure 2. Zygomatic breadth, shown on a Canada lynx skull.

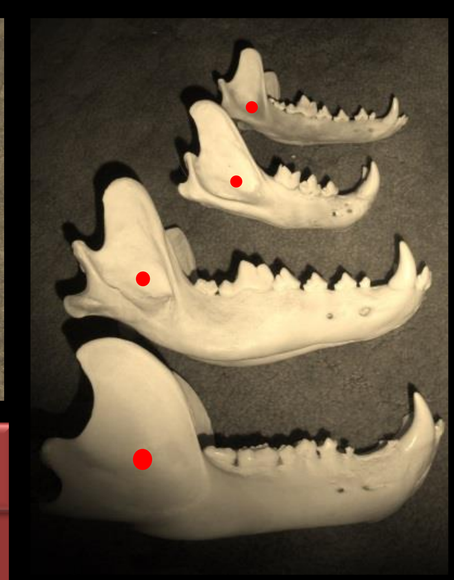

Figure 3. Notice the various depths of the masseteric fossa in mammal jaws. (Bottom to top: black bear, grey wolf, cougar, coyote.)

---The main muscles of the jaw (Figure 1) are the masseter (it closes the jaw and is prominent in herbivores), the digrastricus (it opens the jaw, and is not a large muscle), and the temporalis (a prominent muscle on some carnivorous skulls) (Kardong, 2012)
---A large sagittal crest and deep masseteric fossa are found in skulls which belong to hyper-carnivorous mammals (cougars, grey wolves) (Figure 1 and Figure 3)
---The bite force of the cougar and grey wolf are almost the same (Figure 5), but the length of the grey wolf's skull relative to the length of the cougar's skull is much longer (Figure 4)
--Humans have a higher bite force than smaller carnivores, such as the coyote, red fox, Canada lynx, bobcat, and the omnivorous domestic pig (Figure 5)
---The zygomatic breadths of several mammals are relatively close to the overall lengths of their skulls; no zygomatic breadths exceed the lengths of the skulls examined (Figure 4)
---High bite forces seem to be associated with large sagittal crests
---The smaller bobcat has a higher bite force than the Canada lynx (Figure 5)

Discussion

---Sex is not accounted for in this study
---Diet and age can influence the size of sagittal crests and zygomatic breadth on skulls--as an animal ages and develops, it puts on more muscle, and so the boney attachments for these growing muscles must become bigger as well (Elbroch, 2006); the results of this study could be skewed by the ages of the specimens studied (which are unknown)
---It would seem that felids have slightly higher bite forces than canids in this study--this may be because cougars and bobcats in particular hunt prey and eat meat more exclusively than coyotes or red foxes (Christiansen and Wroe (2007) explored this concept)
---The human's higher bite force than the small carnivores (coyote, red fox, Canada lynx, and bobcat) could be due to the larger body mass *and* the need for high pressures to grind tough vegetation (Weller, 1968)

Conclusions

1.)---In this study, some skulls with longer lengths show less comparative bite force than shorter skulls (e.g. pig skull is longer than human, has less bite force, Canada lynx is longer than bobcat, has less bite force) (Figure 4 and Figure 5)
2.)---Animals which feed upon the most meat and the largest prey have the highest bite forces
3.)---Wide zygomatic breadths are associated with high bite forces

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