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Paleobiology

Reconstructing life from the past

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How do we know what organisms were like in the past?

- Functional morphology
- Paleohistology and physiology
- Biogeochemistry
- Body mass and its implications
- Paleoecology

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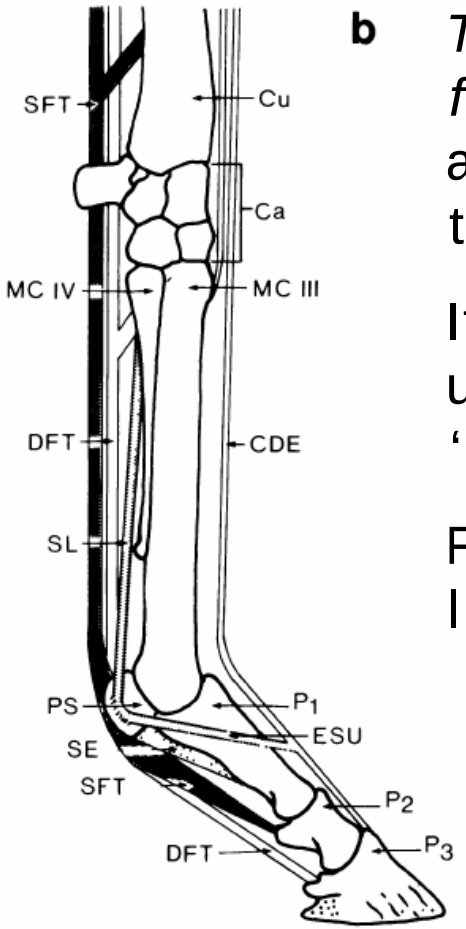
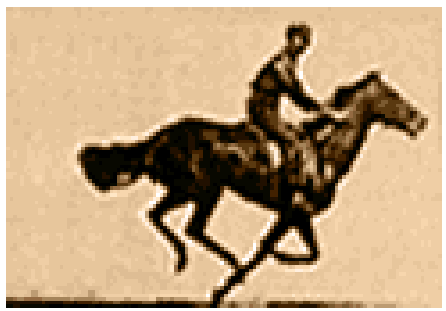
Functional Morphology



The study of the relationship between form and function. Form refers to the anatomy of organisms, and function is how the anatomical parts interact with the environment during the life of the organism.

If the relation between form and function is well understood, the life function of organisms can be 'read' from their fossilized parts.

Form and function are best understood in groups with living representatives.



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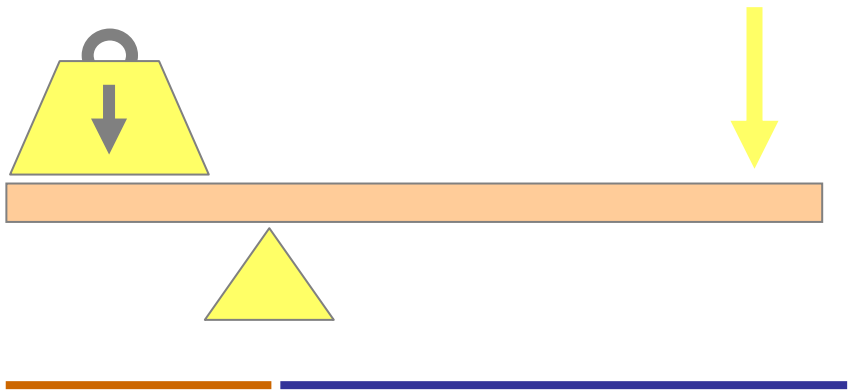
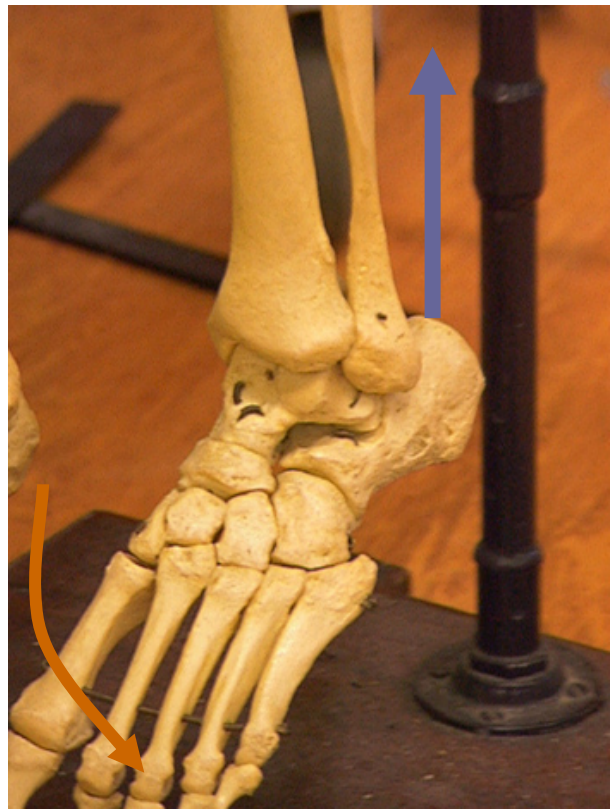
Levers

and simple biomechanics



Moment arm of load Moment arm of effort



Effectiveness = MA of effort / MA of load

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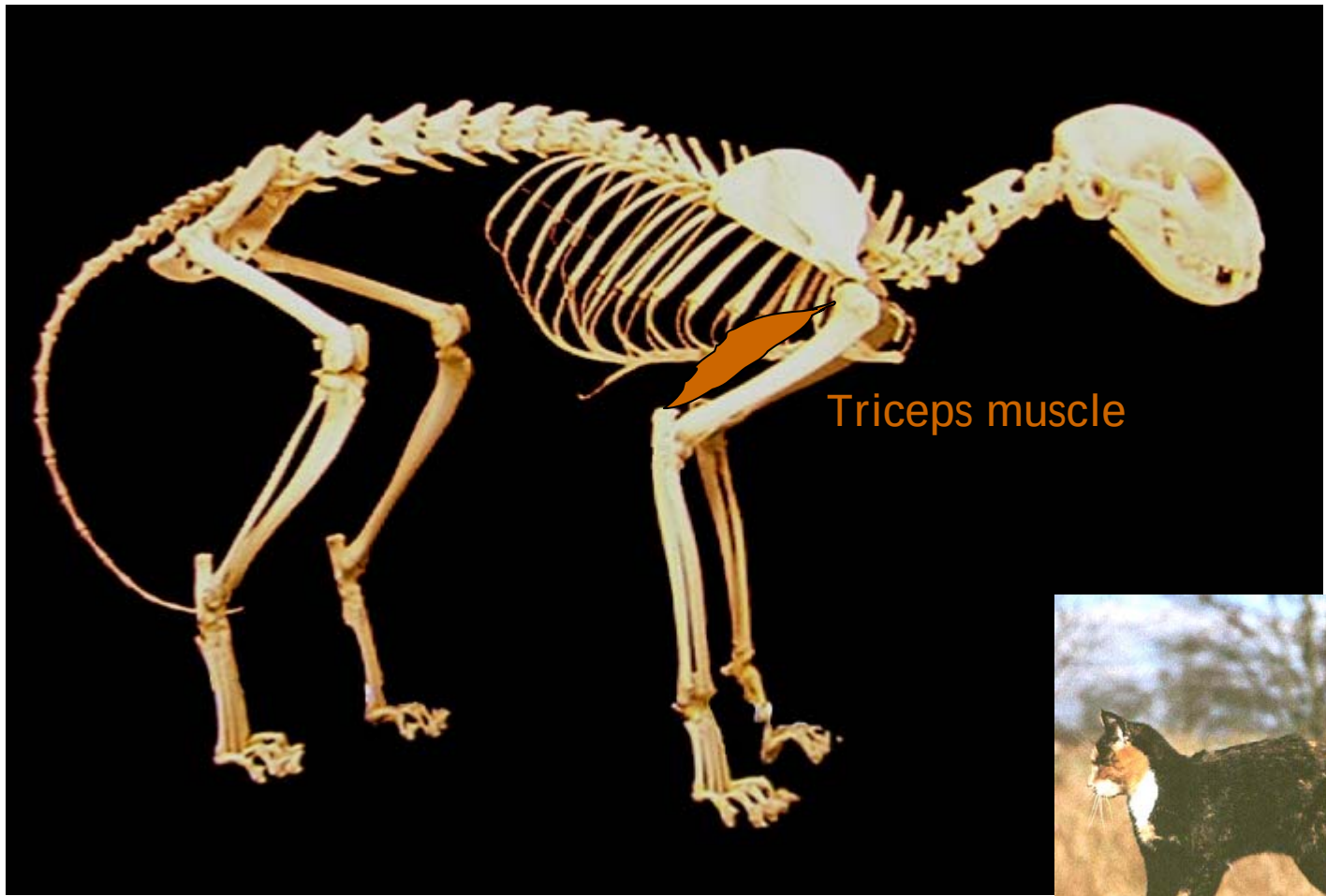
A cat's elbow…



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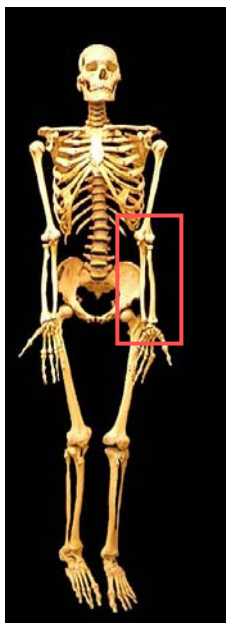
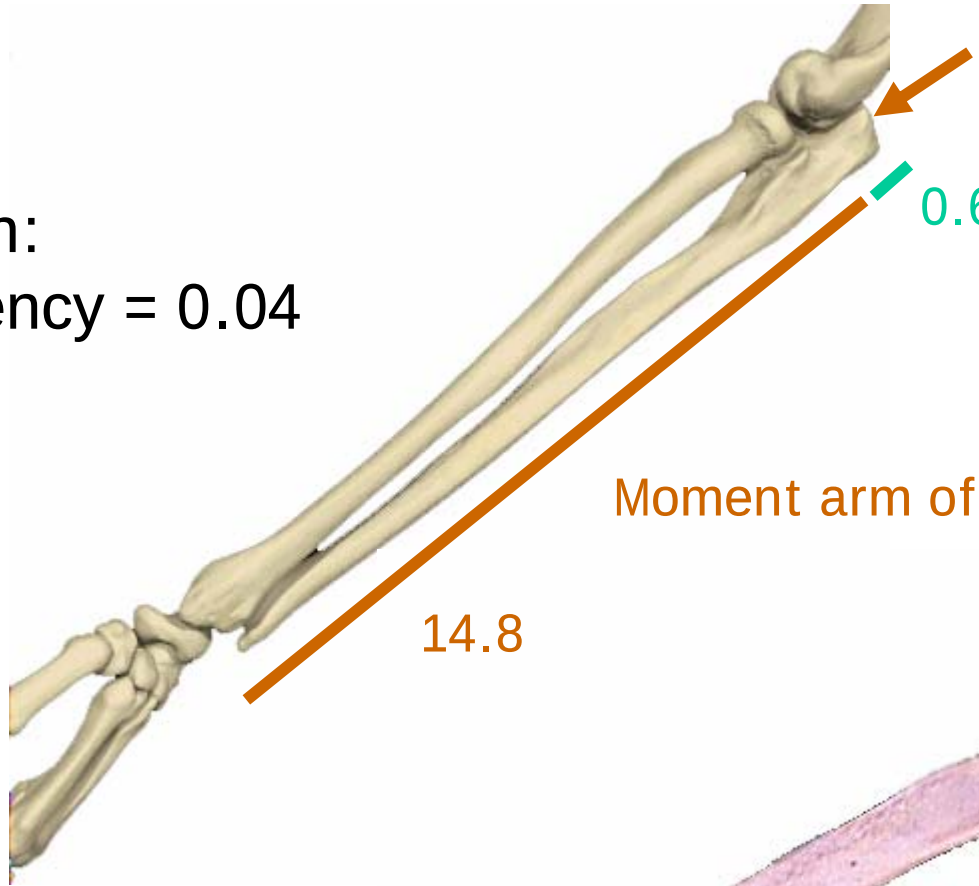
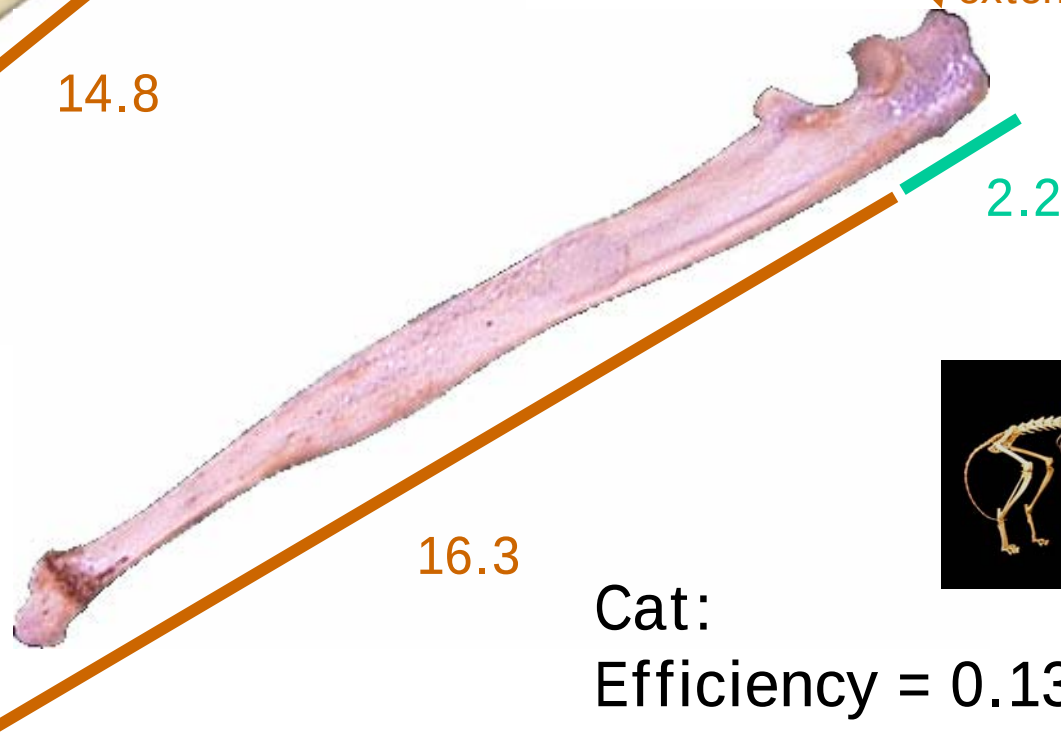
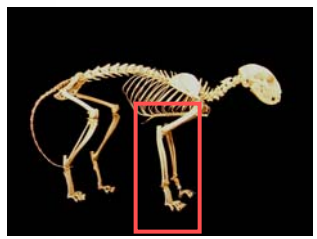
Human:
Efficiency = 0.04









Cat:
Efficiency = 0.13

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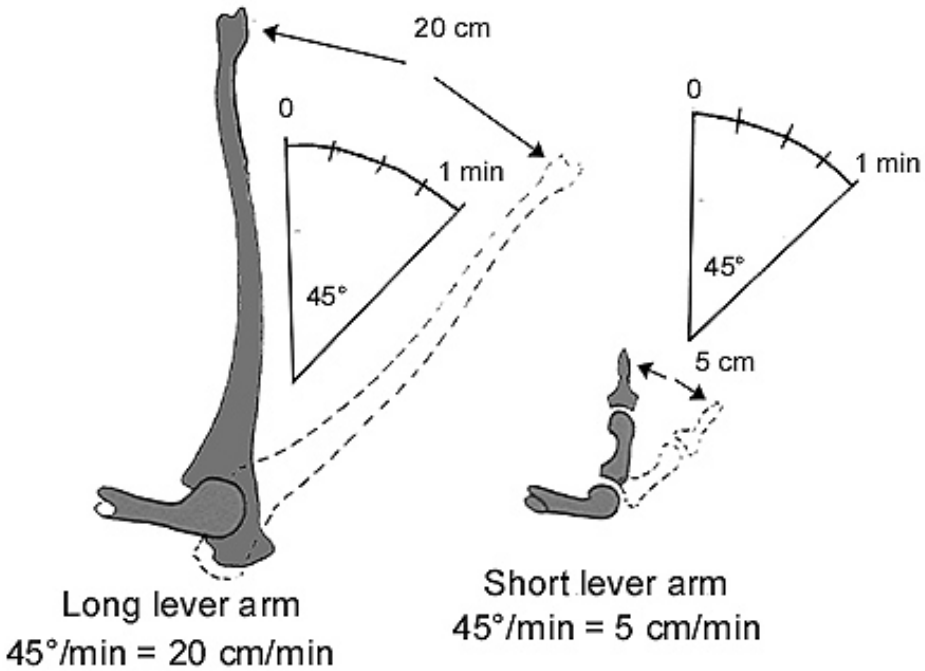
Speed of movement



The longer a segment, the faster the tip moves for the same muscular contraction

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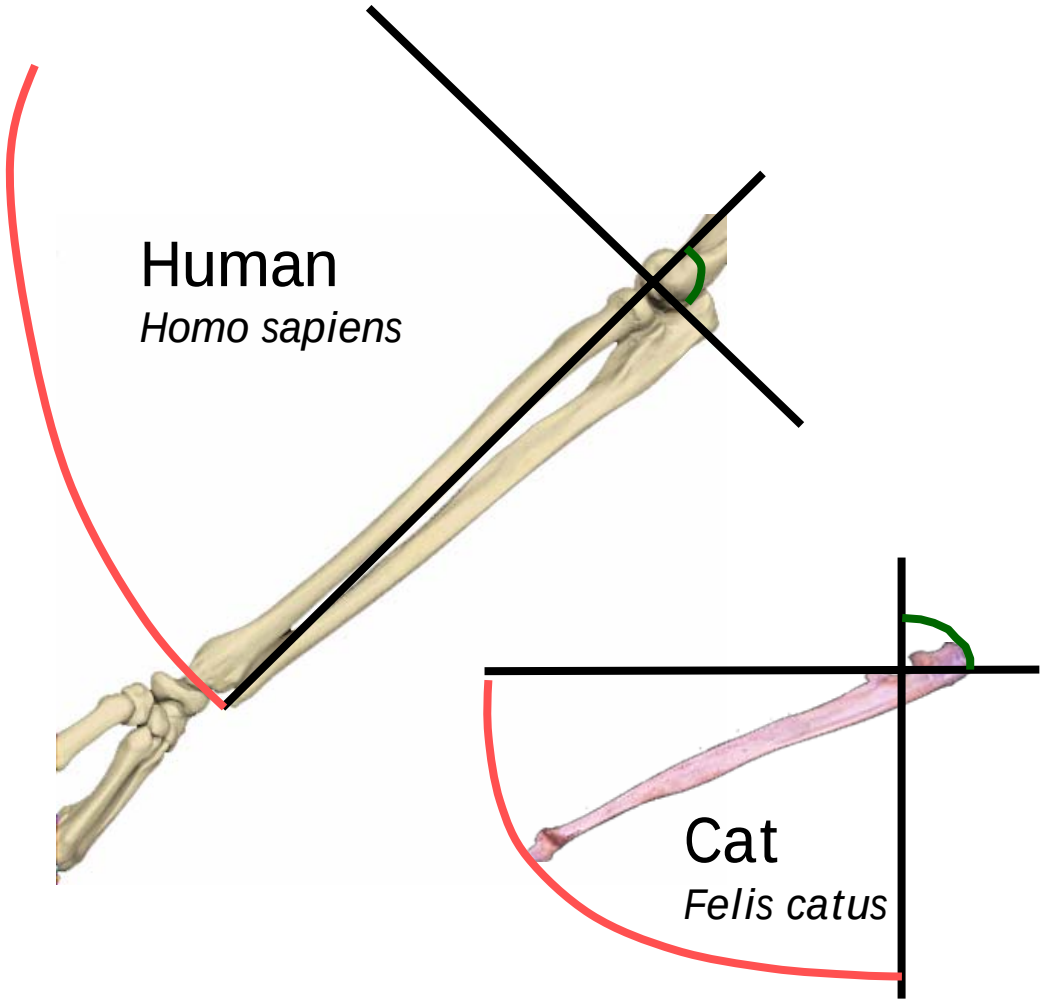
Humans get more movement at the hand for less muscular contraction than cats.

The speed of human hand movement is faster, but weaker than that of cats.



Muscular movement (green line) relative to manus movement (red line) in humans and cats

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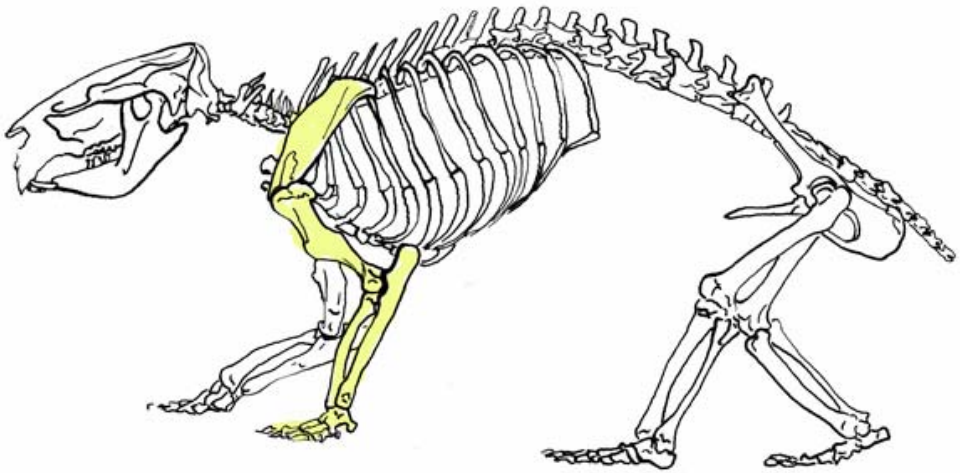
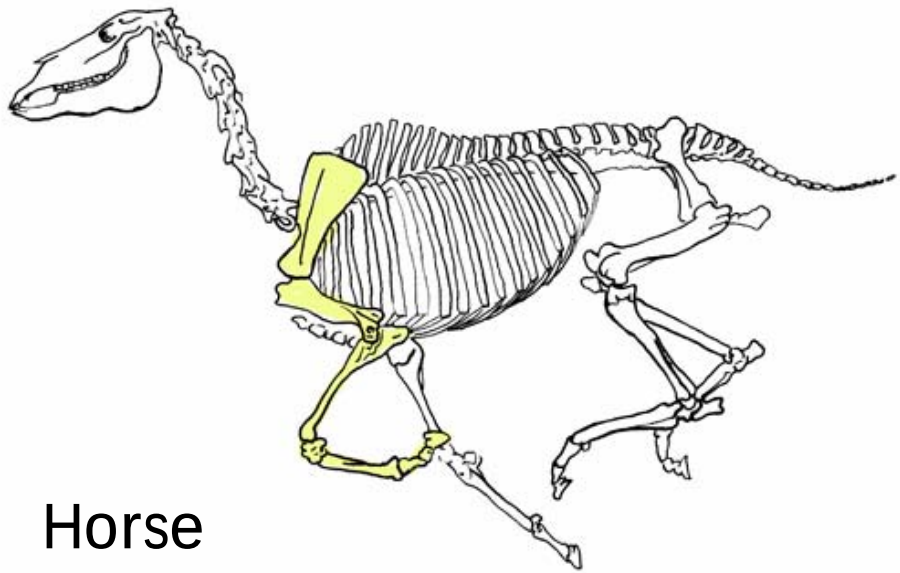


Wombat
Fossorial



Horse
Cursorial

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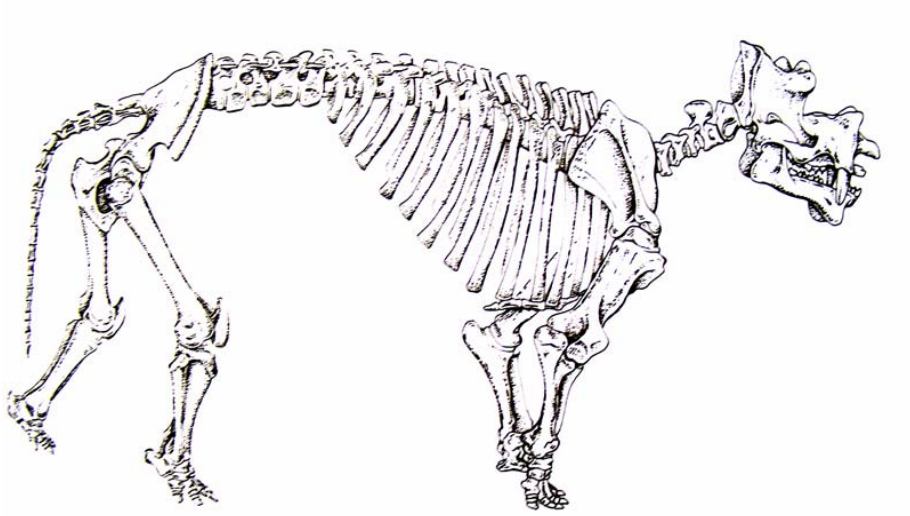
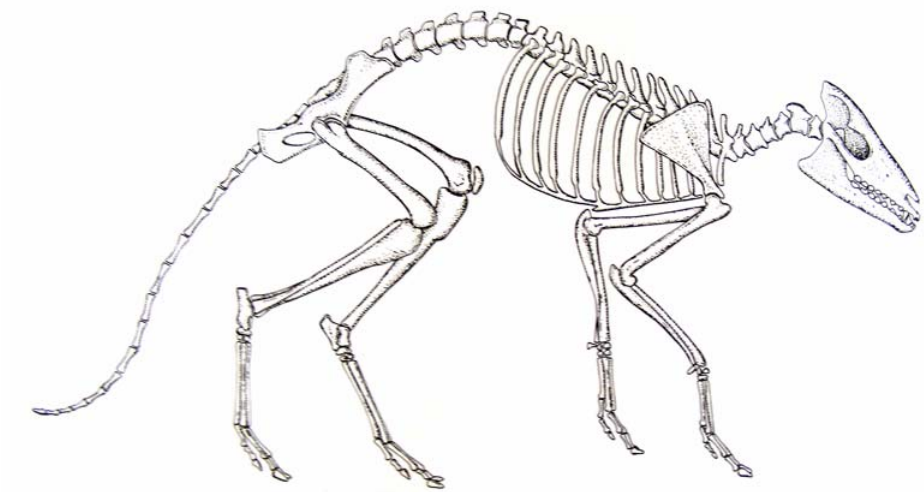
What kind of animals were these?



Uintatherium
Eocene mammal



Diacodexis
Eocene mammal

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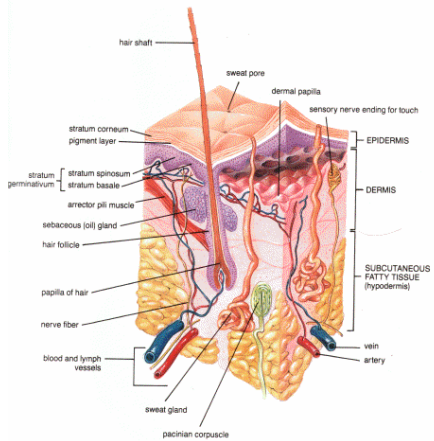
What about physiology, behavior, and soft anatomy?

- Direct study of evidence from the fossil record
- Indirect study by phylogenetic extrapolation from living organisms



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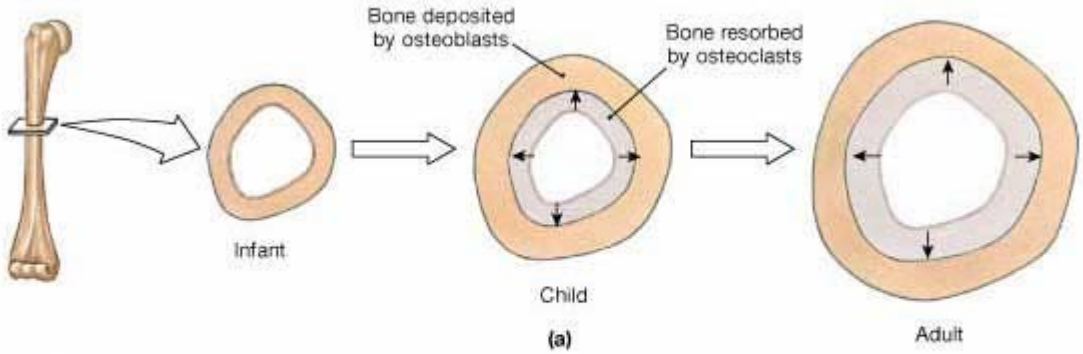
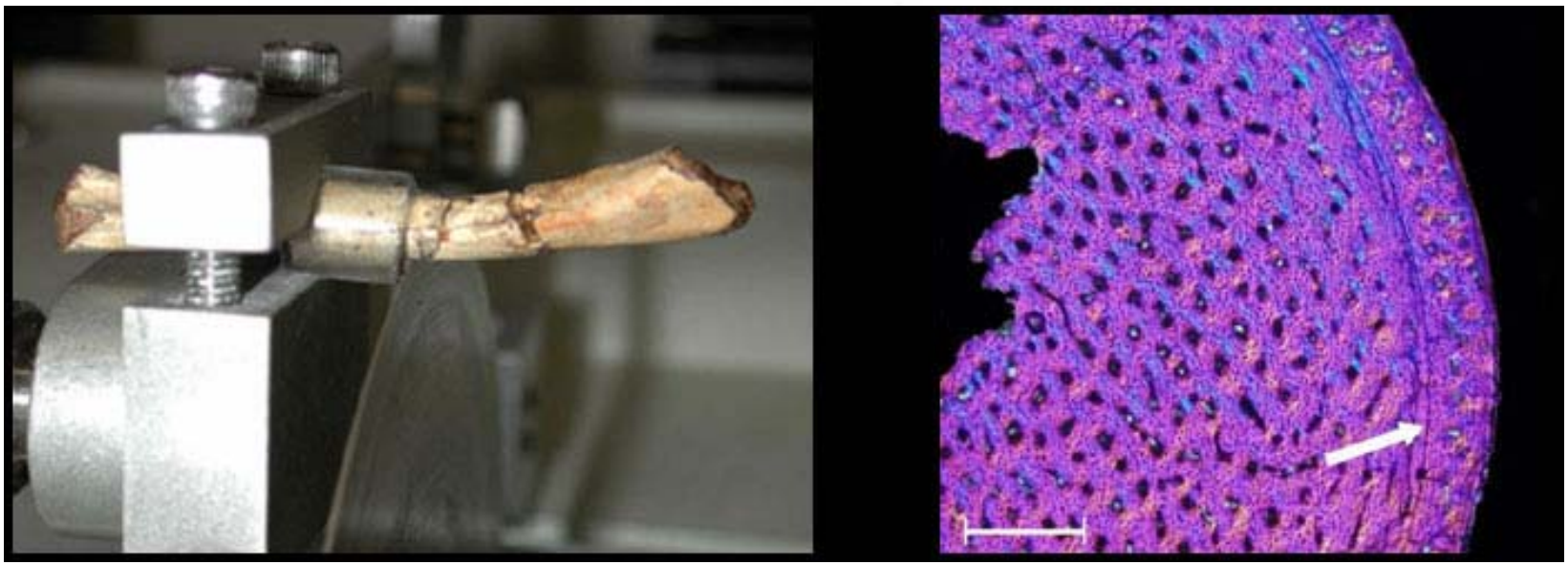
Paleohistology and physiology

Bone growth and individual age in fossils





Rib of the dinosaur *Shuvuuia* (left) and a growth line (right).

From Erickson et al., 2001. (www.bio.fsu.edu/erikson/).

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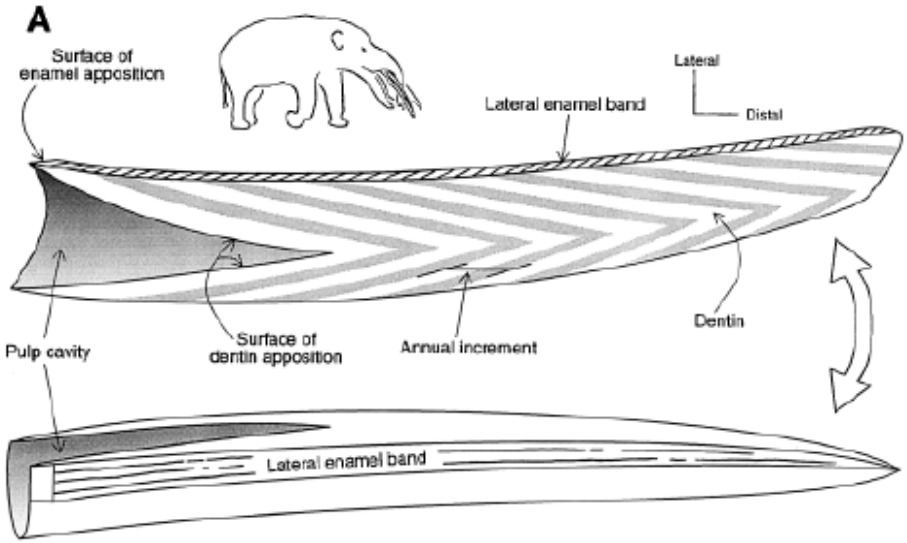
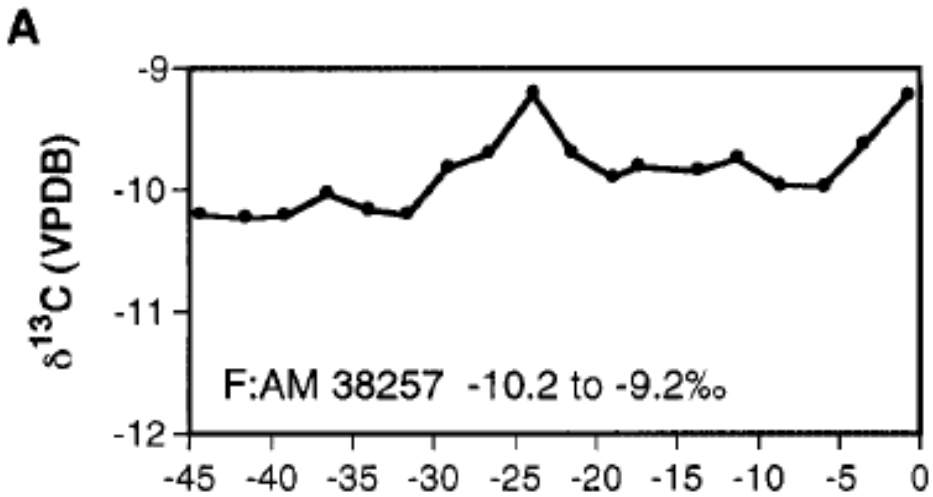
Stable isotope geochemistry

Carbon isotopes can indicate what type of plants were eaten.

Oxygen and carbon isotopes can indicate temperature and seasonality.





Fox and Fisher, 2001. *Palaios* 16: 279-293.

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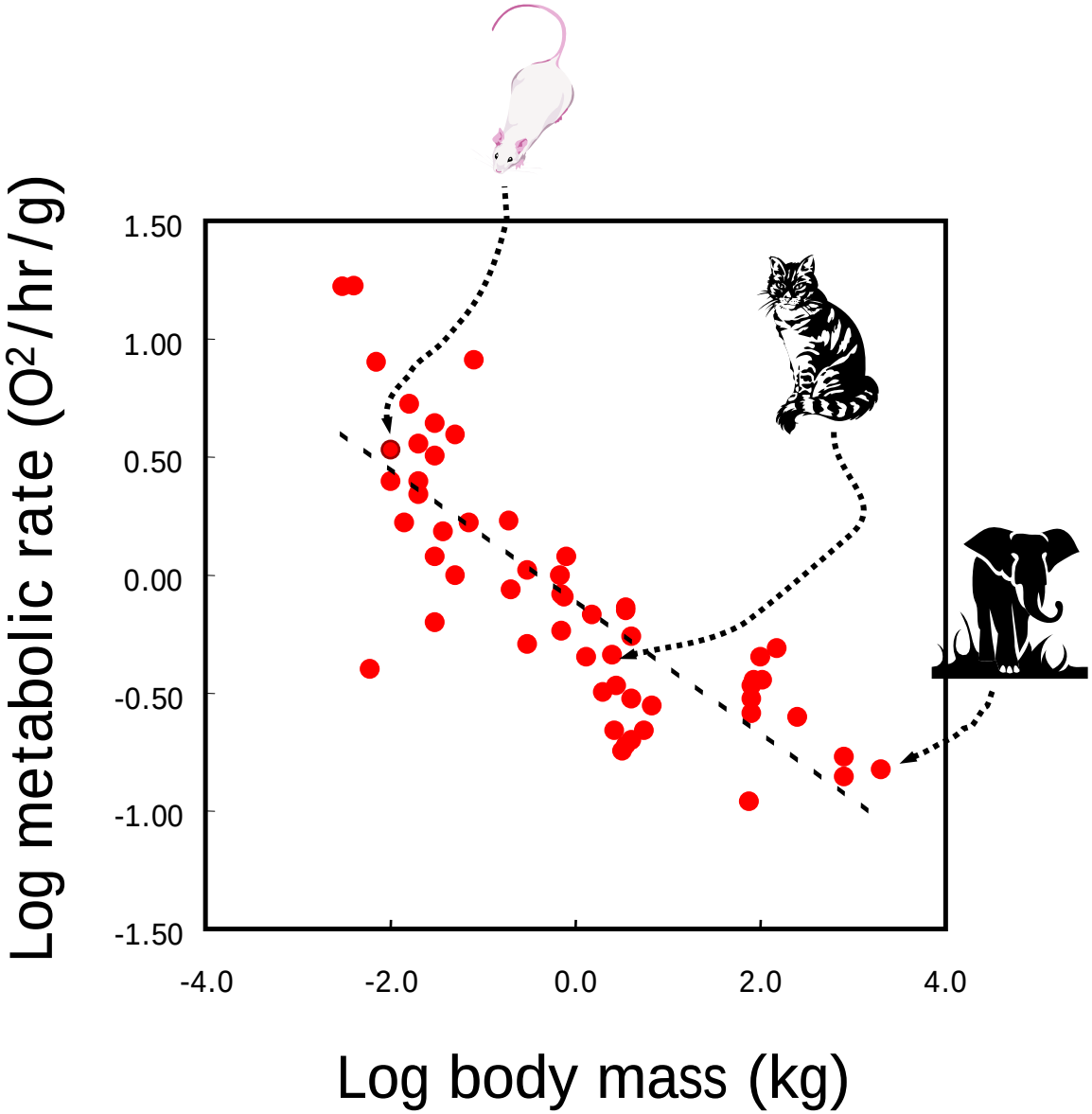
Metabolism and Body Size

Metabolism is directly related to body size, and dietary needs are directly related to metabolism.

Small animals need high calorie diet, large mammals can do with a low calorie diet.



Data from Eisenberg, 1981

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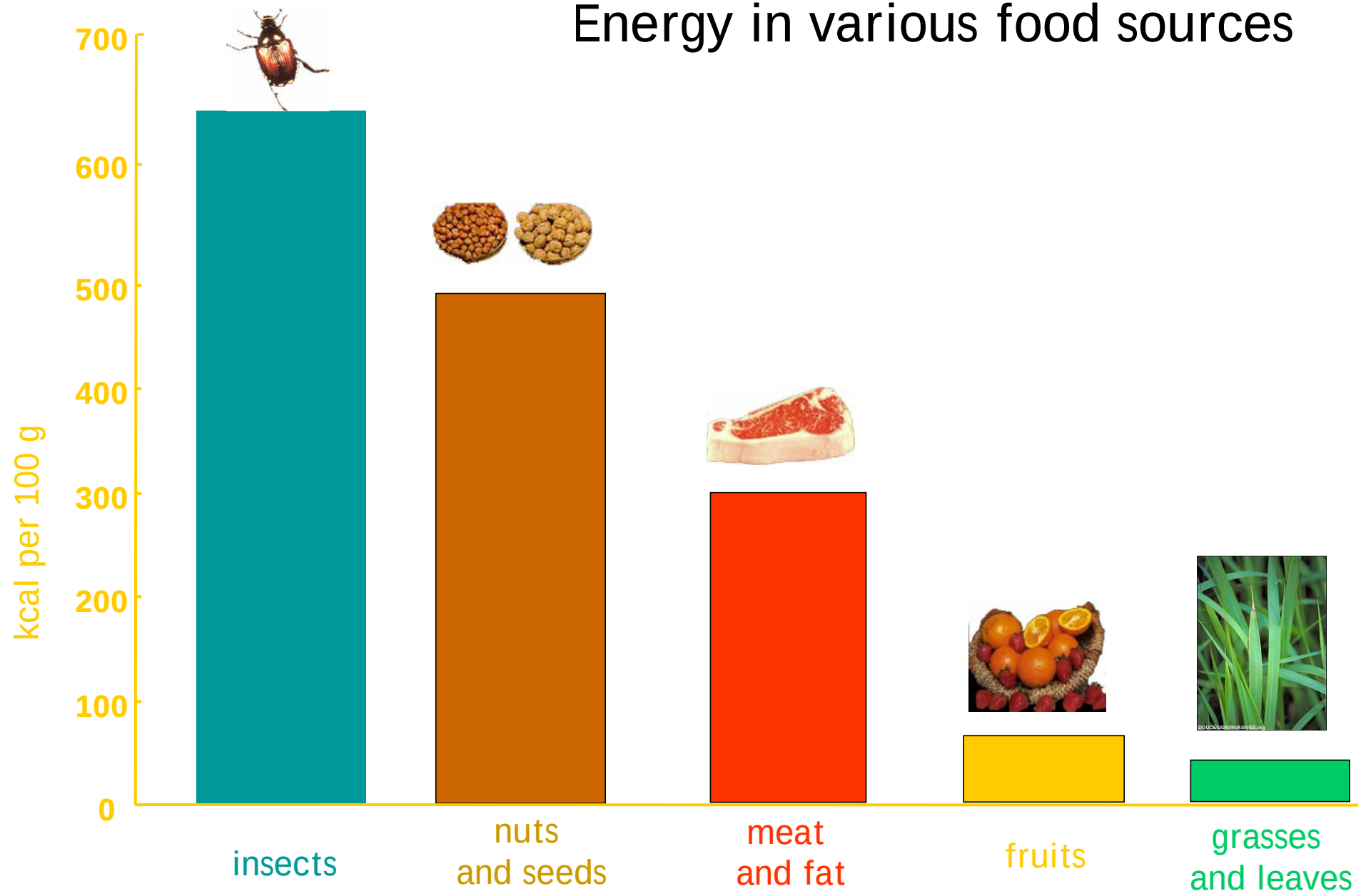
Energy in various food sources



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Small mammals have high metabolic rates, therefore they must eat high-calorie food

Large mammals have low metabolic rates, therefore they *can* eat low-calorie food (although they have to eat lots of it).

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Insectivores:

- small body size
- sharp, shearing dentition
- Jaw joint above tooth row

Carnivores:

- medium body size
- large canines
- sharp, shearing dentition
- Jaw joint level with tooth row

Granivores:

- small body size
- ever-growing incisors
- grinding molars and premolars
- Jaw joint above tooth row

Herbivores:

- large body size
- grinding cheek dentition
- cropping incisors
- Joint above tooth row

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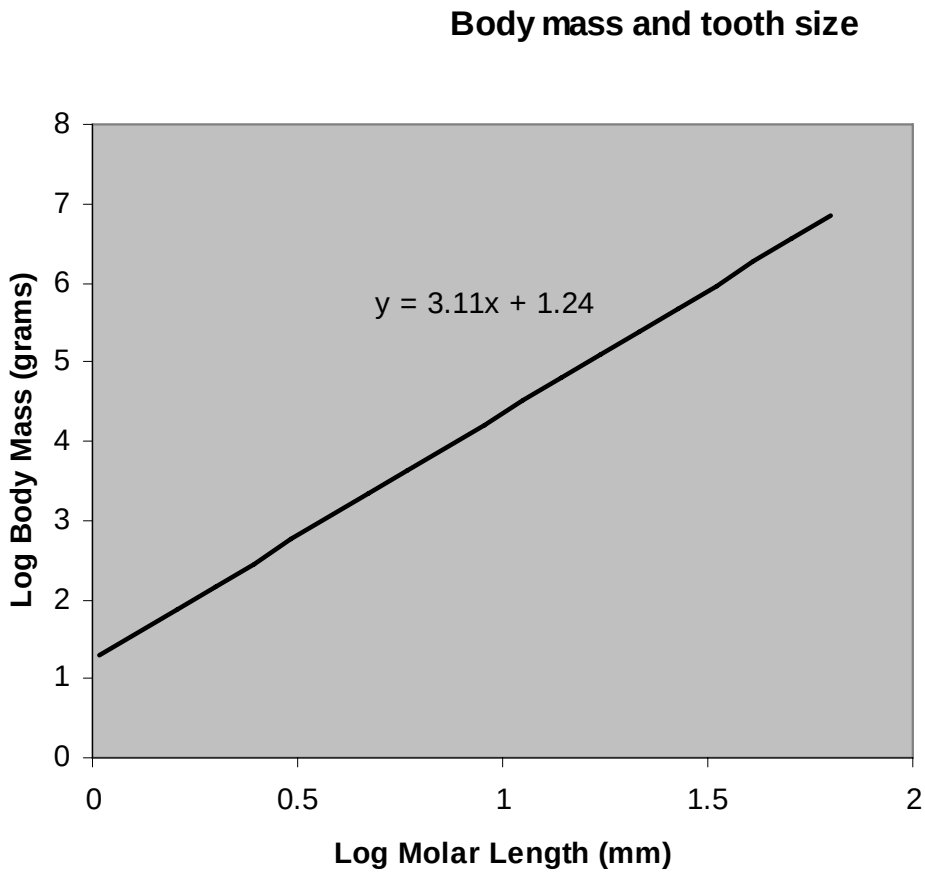
Scaling between length of first molar and body mass in mammals

Log body mass = 3.11 log molar length + 1.24



(equation from Damuth and MacFadden, 1990)

Dog
Carnivorous

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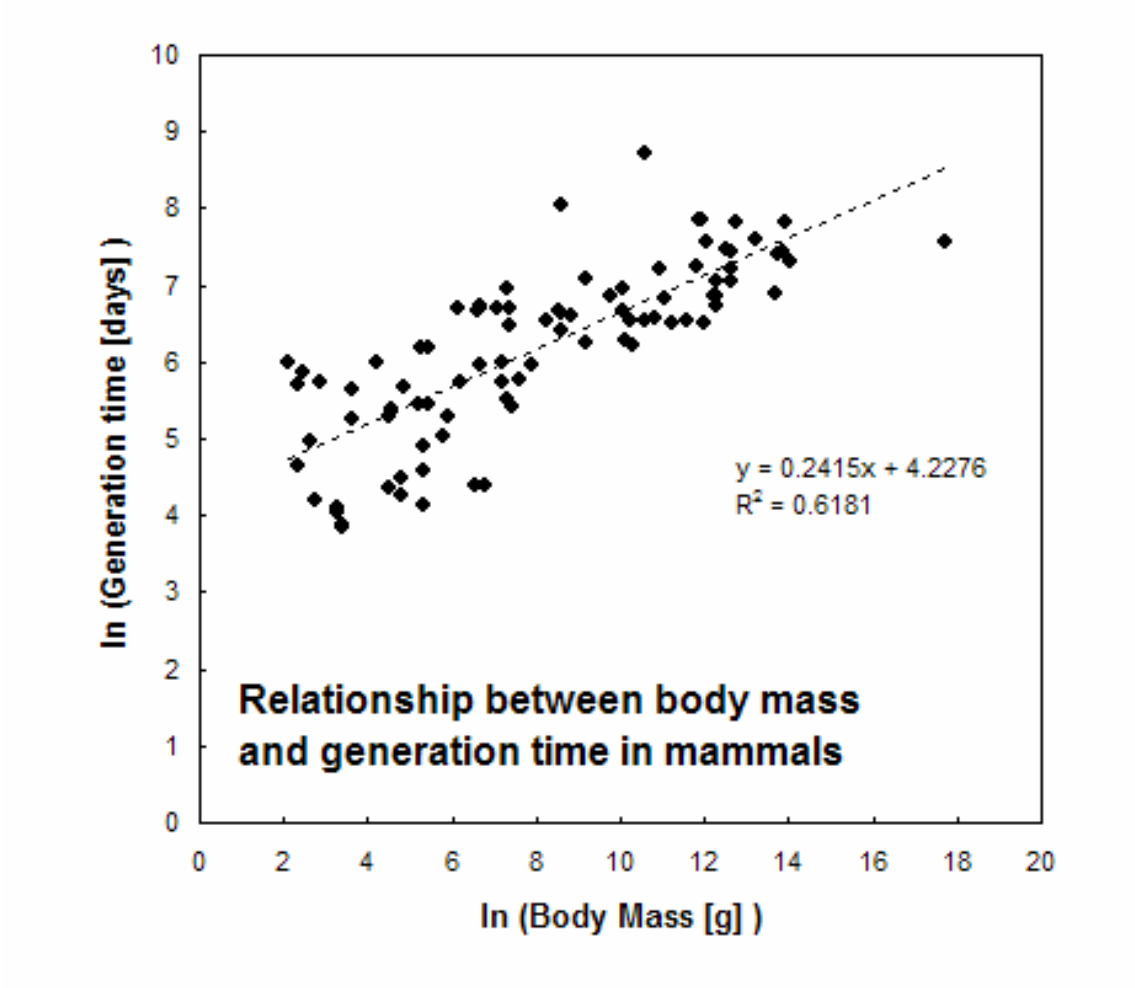
There is also a solid relationship between the body mass of a species and the length of a generation…



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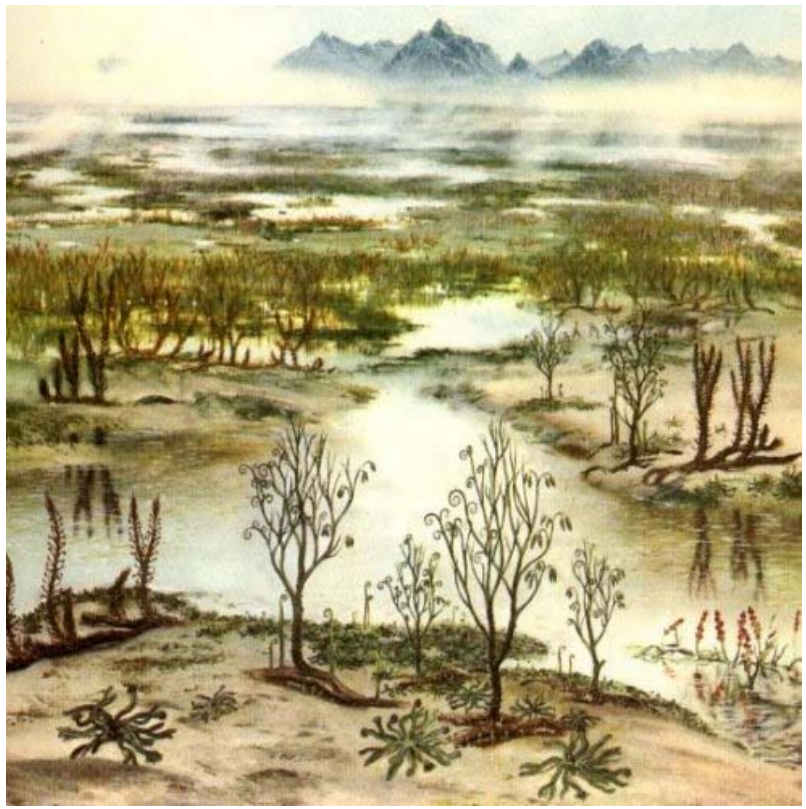
Paleoecology

The study of ecological relationships, including communities, in ancient times.



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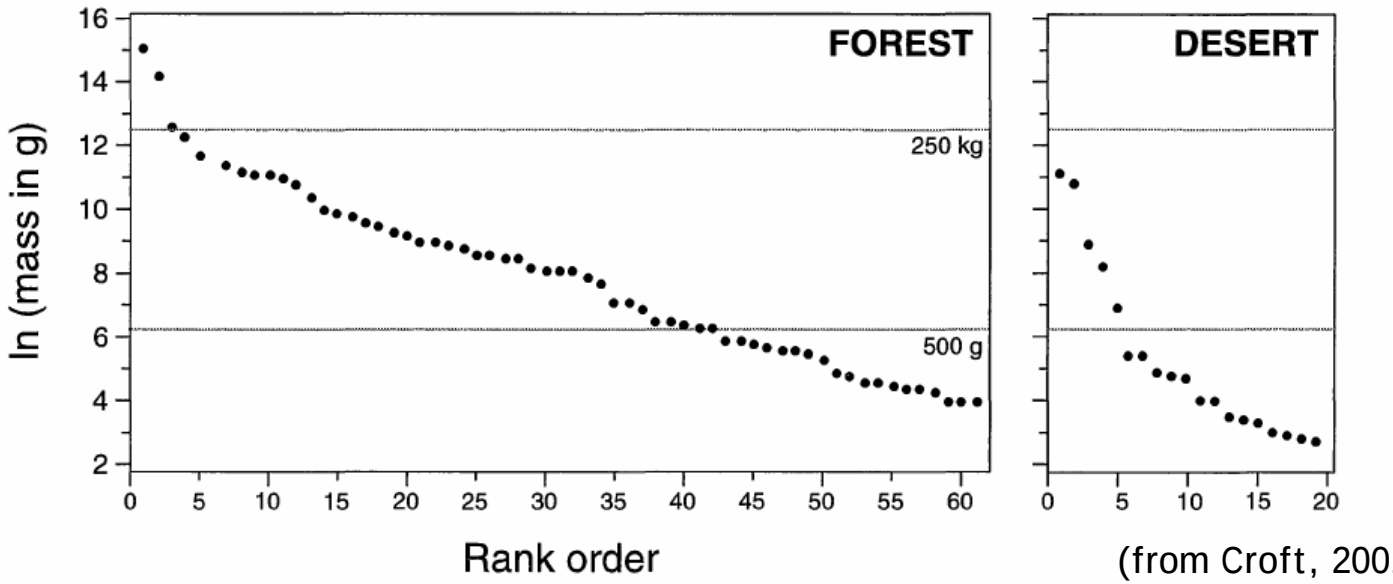
Cenograms

Inferring community habitat from distribution of species body masses.



(from Croft, 2001)

Distribution of body mass in the 62 species of a forest community

Distribution of body mass in the 20 species of a desert community

The type of community represented by a fossil assemblage can sometimes be identified by the body mass distribution of fossil species.