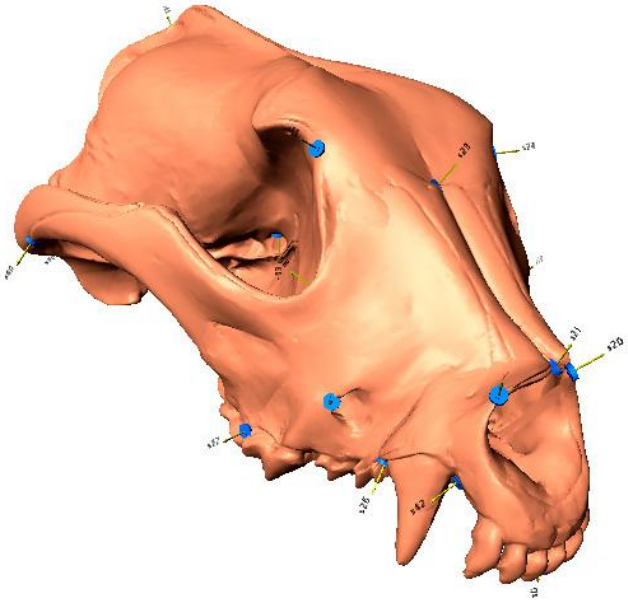
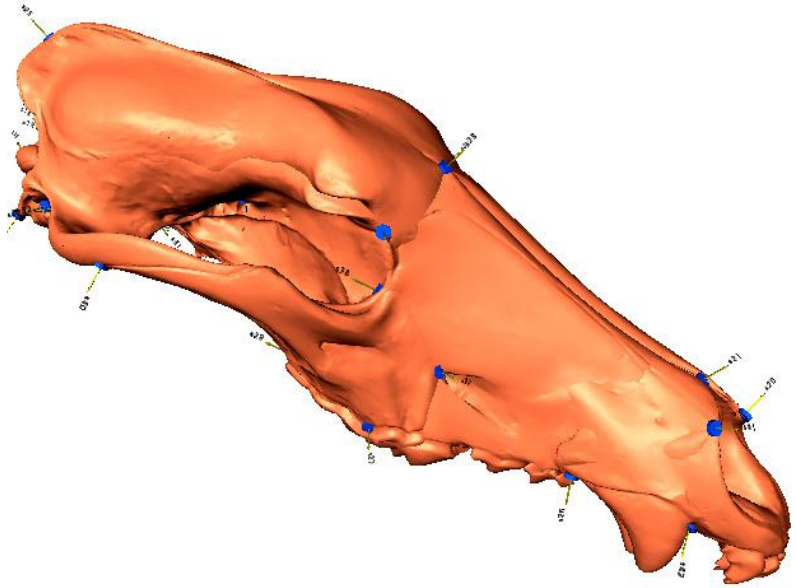
discovering a new rule in the evolution of mammals





UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

Andrea Cardini

UNIMORE & UWA

CFS

THE UNIVERSITY OF WESTERN AUSTRALIA

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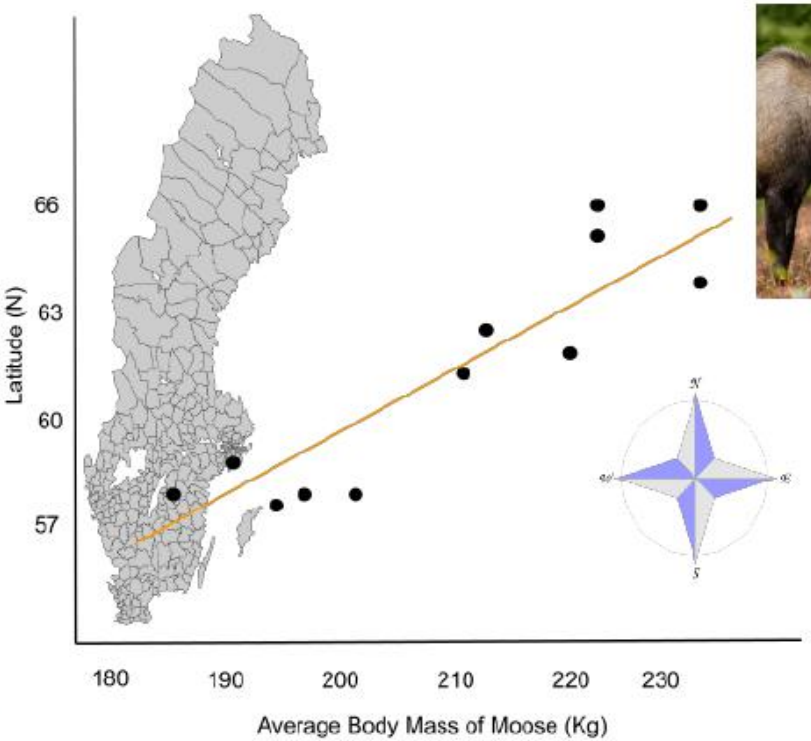
in mammalian morphological evolution

what's a rule?

trend in change among closely related species

e.g., Bergmann's rule



Bergmann's rule is an ecogeographical rule that states that within a broadly distributed taxonomic clade, populations and species of larger size are found in colder environments, and species of smaller size are found in warmer regions. Although originally formulated in terms of species within a genus, it has often been recast in terms of populations within a species. It is also often cast in terms of latitude.

(general trend; not a strict rule; plenty of exceptions)

'my' rule is about evolutionary allometry

size-related shape changes among species

pelycosaur femurs change during evolution

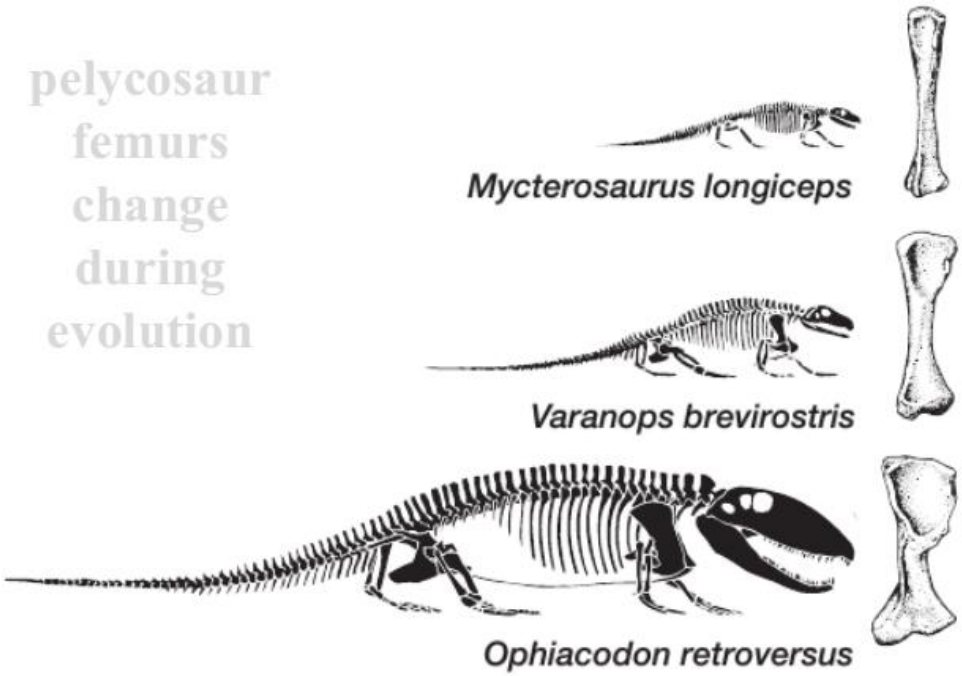
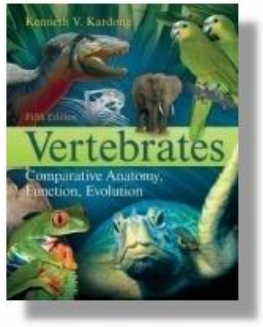
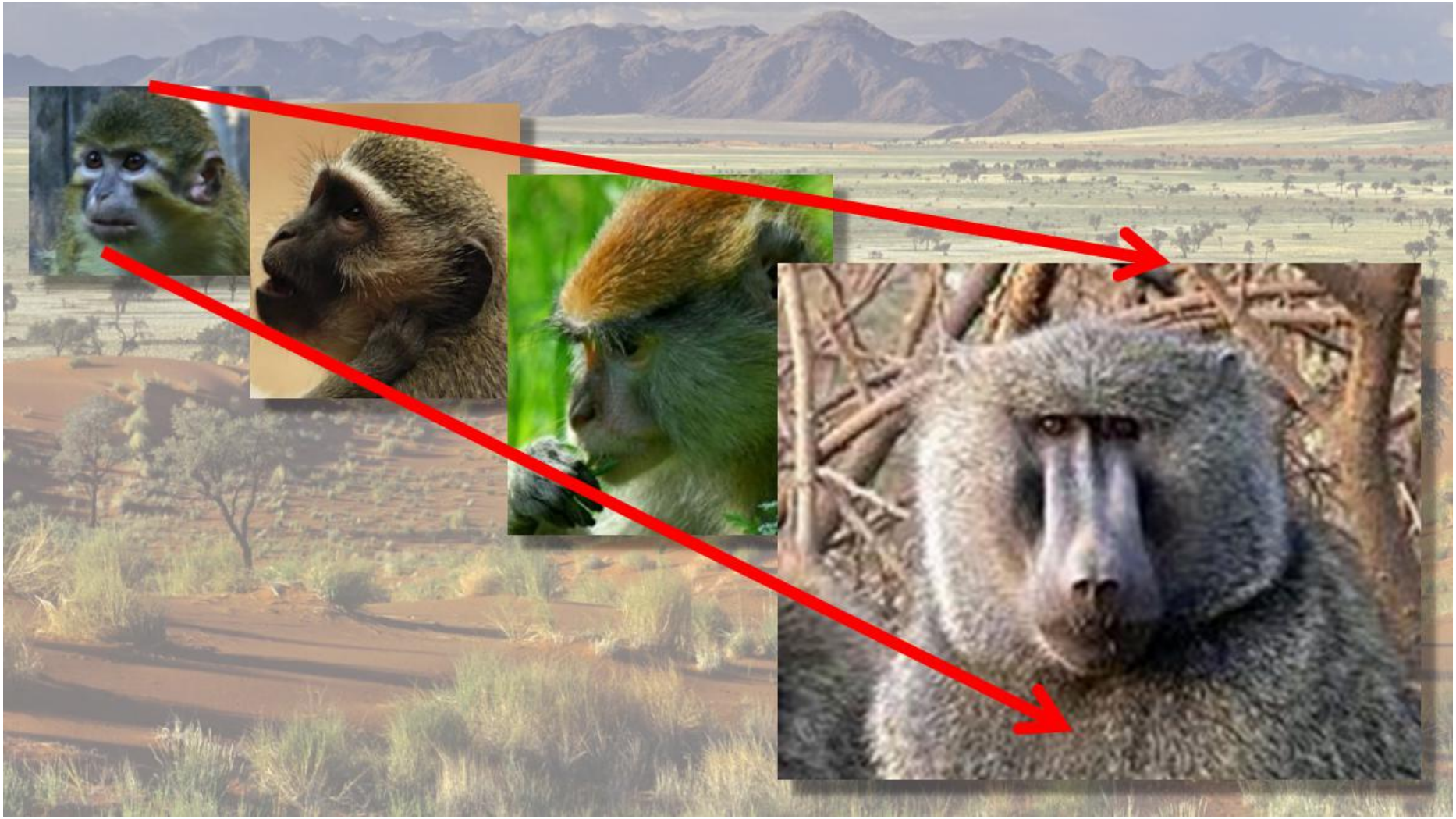


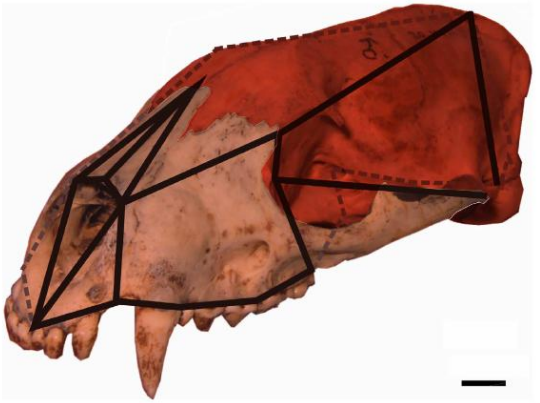
FIGURE 4.8 Body size and limb design in pelycosaurs. Relative sizes of three pelycosaur species are illustrated. The femurs of each, drawn to the same length, are shown to the right of each species. The larger pelycosaur carries a relatively larger mass, and its more robust femur reflects this supportive demand.



'my' rule is about **evolutionary allometry of crania** (averaged across adults within each species)



1st we showed it in 4 placental orders* (SYNTHESYS 2007)



nature COMMUNICATIONS

ARTICLE

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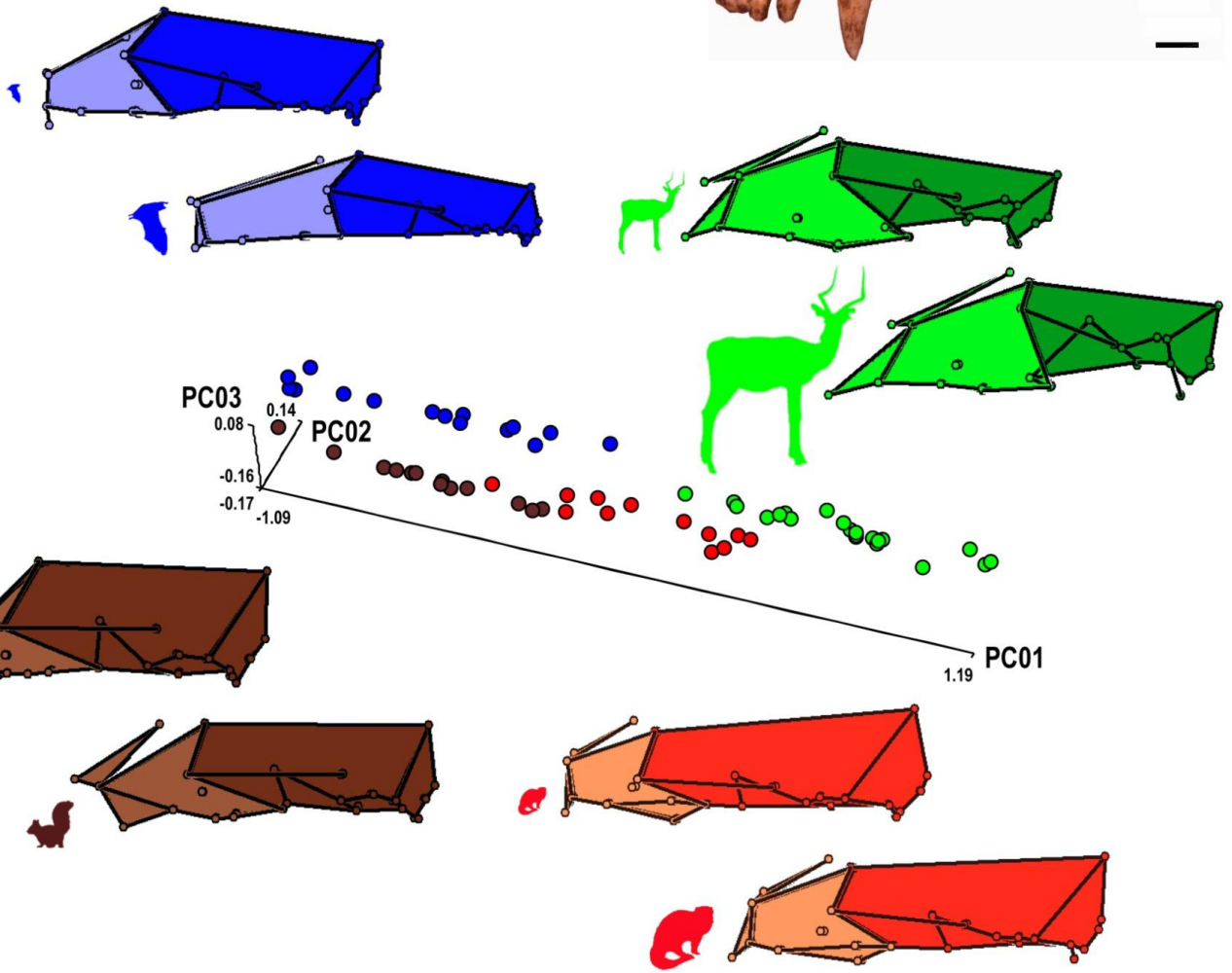
Larger mammals have longer faces because of size-related constraints on skull form

Andrea Cardini[1,2,3,4] & P. David Polly[5]

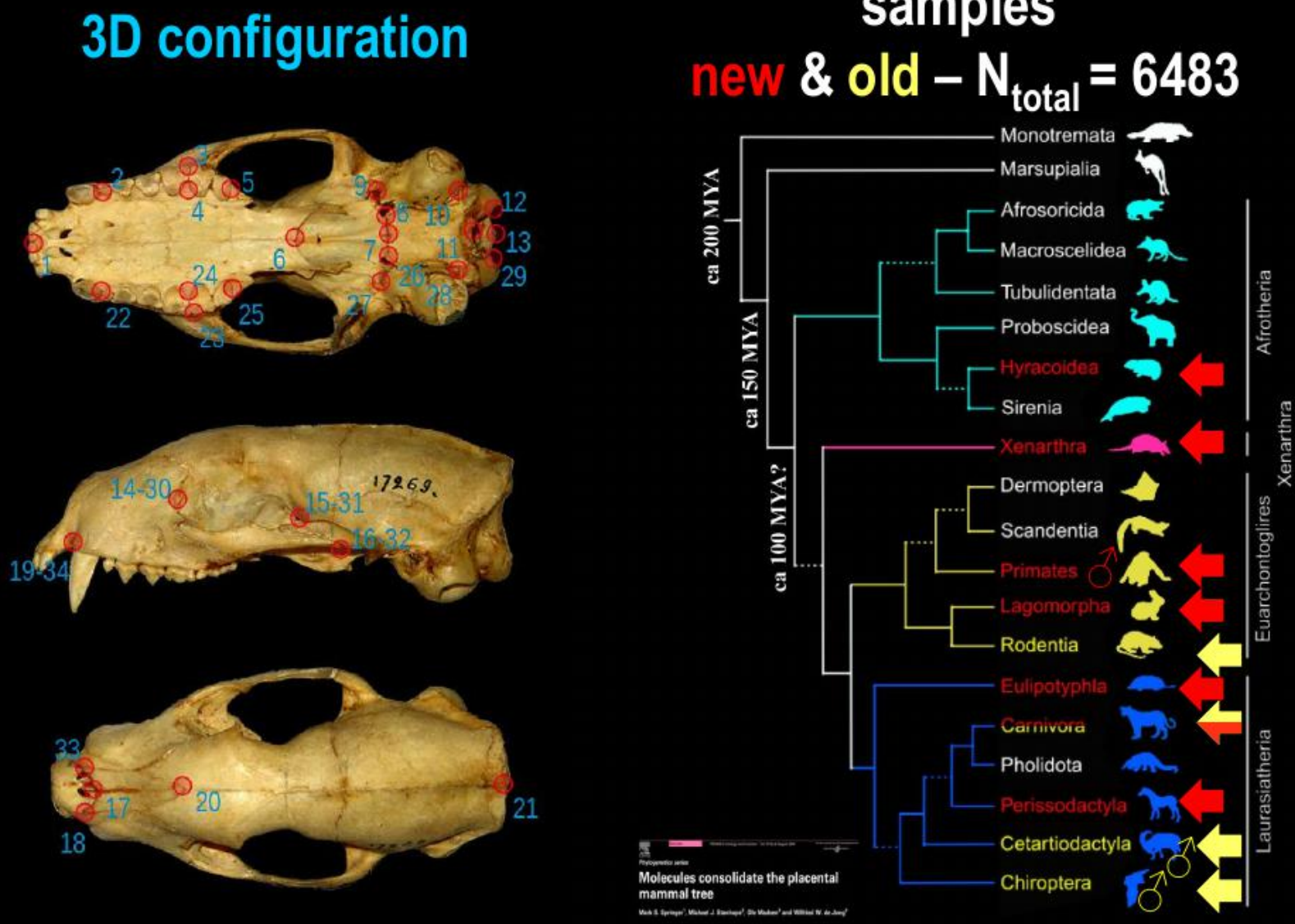
Facial length is one of the best known examples of heterochrony. Changes in the timing of facial growth have been invoked as a mechanism for the origin of our short human face from our long-faced extinct relatives. Such heterochronic changes arguably permit great evolutionary flexibility, allowing the mammalian face to be remodelled simply by modifying postnatal growth. Here we present new data that show that this mechanism is significantly constrained by adult size. Small mammals are more brachycephalic (short faced) than large ones, despite the putative independence between adult size and facial length. This pattern holds across four phenotypic lineages: antelopes, fruit bats, tree squirrels and mongooses. Despite the apparent flexibility of facial heterochrony, growth of the face is linked to absolute size and introduces what seems to be a loose but clade-wide mammalian constraint on head shape.



***ca subfam./tribe representative of an order**

now hoping to show it in several more

(SYNTHESYS 2015 + 2007 + Leverhulme 2004)



and it looks promising!

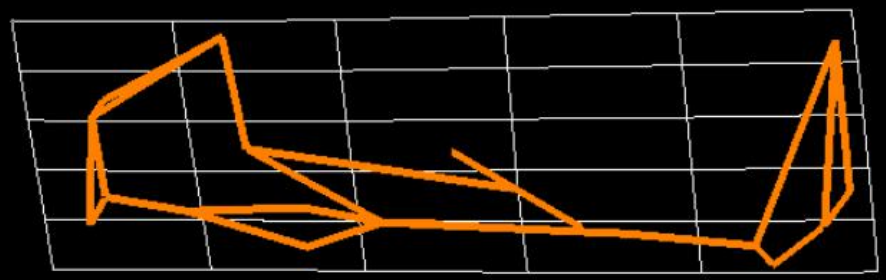
allometric analyses
RESULTS?

e.g.,

$N_{sp.}$ = 13

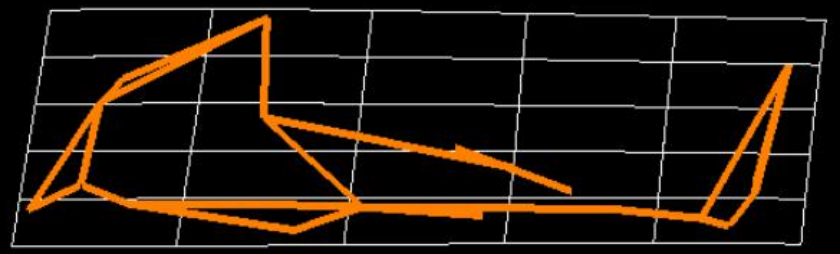
size max/min = 2.3

R2 (allom. var.) = 16%



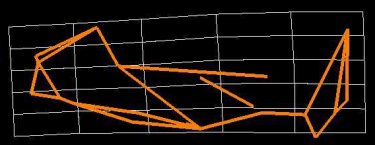
visualization ca. x4

(allometric predictions min-max
in side view – wireframe/TPS)



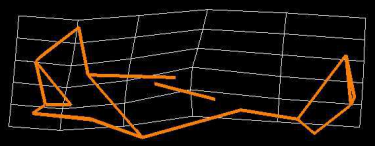
hyraxes

N_{sp}	max/min	R2
4	1.3	36%



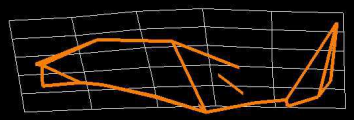
sloths? (NB above family level!)

5	1.5	87%



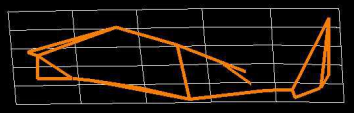
armadillos

N_{sp}	max/min	R2
16	5.3	24%



Dasypus (subfam. with min. allom.)

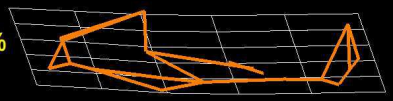
5	1.8	17%



x8

canids

N_{sp}	max/min	R2
31	2.7	22%

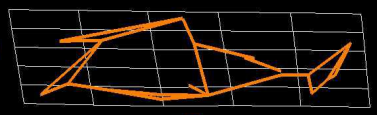


herpestids

13	2.3	16%

equids

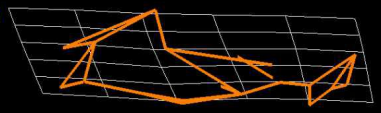
N_{sp}	max/min	R2
7	1.3	25%



x8

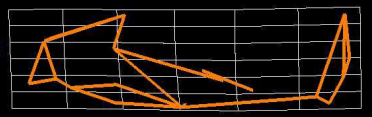
Antilopinae-Cephalophinae + Hippotragini + Reduncini + Alcelaphini + Peleini + Caprinae + Hippotragini + Reduncini + Alcelaphini + Peleini

22	2.6	17%



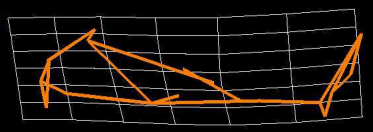
Erinaceinae

N_{sp}	max/min	R2
11	1.4	23%



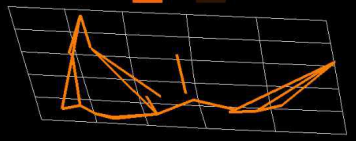
African Pteropodidae

15	2.9	32%



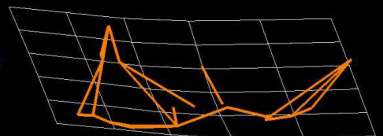
cercopithecini

N_{sp}	max/min	R2
21	1.9	64%



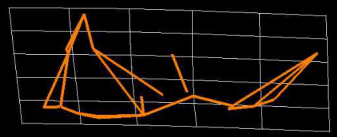
papionini

33	2.0	60%



African colobines

19	1.4	30%

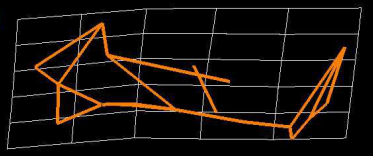


leporids

N_{sp}	max/min	R2
32	1.5	24%

Protoxerini squirrels

12	2.3	39%



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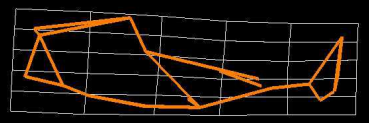

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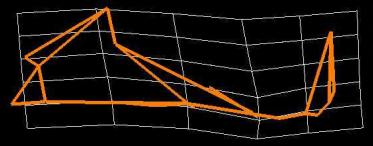

armadillos

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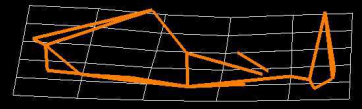

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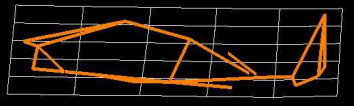
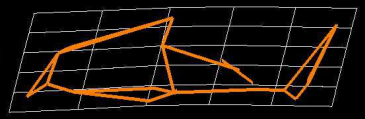


x8

canids

N_{sp}	max/min	R2
31	2.7	22%



herpestids

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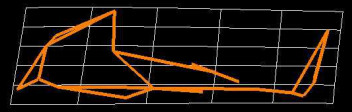
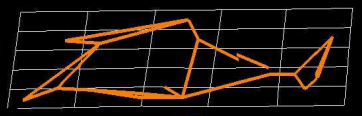


equids

N_{sp}	max/min	R2
7	1.3	25%



x8

Antilopinae-Cephalophinae + Hippotragini

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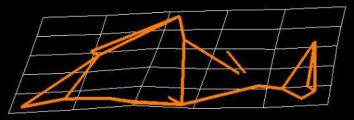

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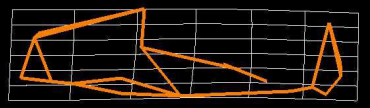

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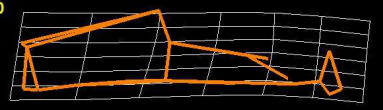

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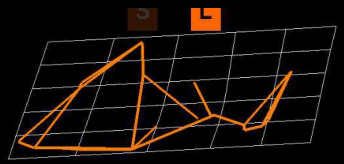

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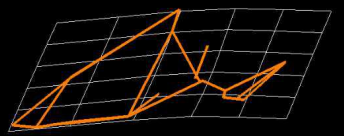

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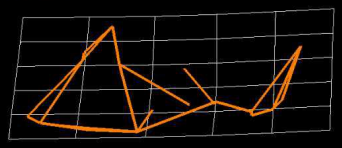

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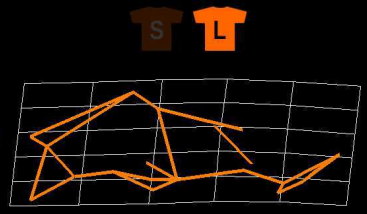

Protoxerini squirrels

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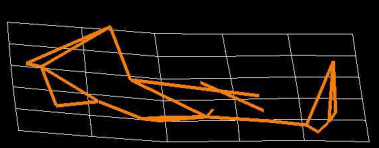


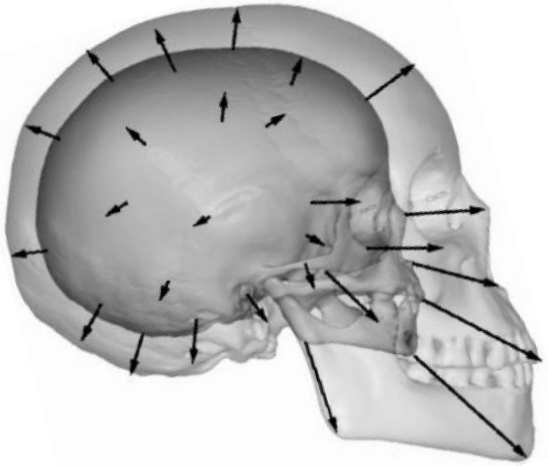
then, if it's a pervasive macroevolutionary trend ('rule'?), why is it so?

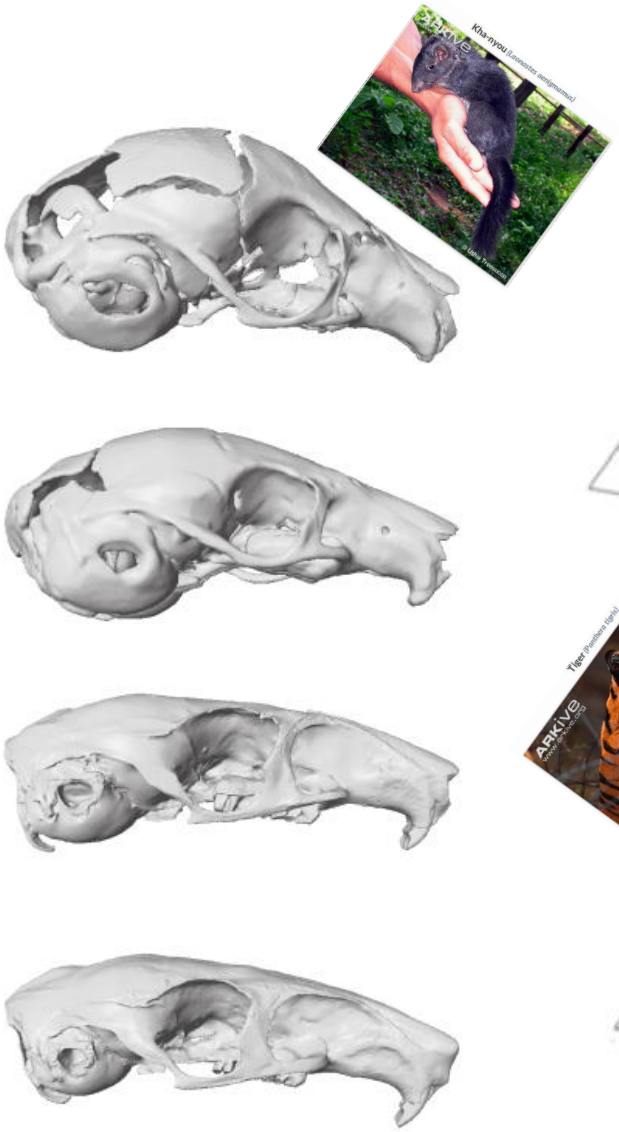
why??? don't ask me: I am a *patternologist*

'measuring the shape of hills behind the fog'

(modified from Bookstein)

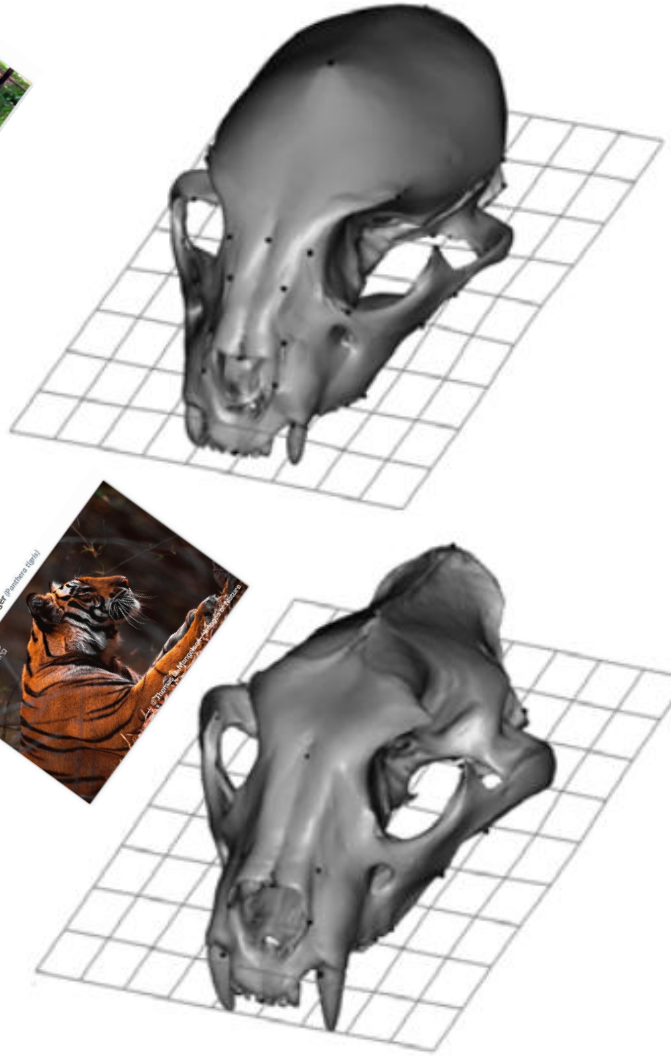
my 'favourite' guess: evodevo-constraints





Ontogeny of the cranial system in *Laonastes aenigmamus*

Anthony Herrel,[1] Anne-Claire Fabre,[2–4] Jean-Pierre Hugot,[5] Kham Keovichit,[6] Dominique Adriaens,[7] Loes Brabant,[8] Luc Van Hoorebeke[8] and Raphael Cornette[5,9]



Three-dimensional cranial ontogeny in pantherines (*Panthera leo*, *P. onca*, *P. pardus*, *P. tigris*; Carnivora:, Felidae)

VALENTINA SEGURA[1,2*], GUILLERMO H. CASSINI[1,3,4] and FRANCISCO J. PREVOSTI[1,5]

conclusions?

with low cost morphometrics and great museum collections, mammals may have another 'evo-rule'

thanks to Dan Franklin (UWA)

- Royal Botanic Gardens, Kew (RBGK)
- Naturalis Biodiversity Center (NBC)
- Royal Botanic Garden Edinburgh (RBGE)
- Museo Nacional de Ciencias Naturales (MNCN) & Real Jardín Botánico (RJB)
- Museum für Naturkunde (MfN)
- National Museum Prague
- Simbiotica
- Botanischer Garten und Botanisches Museum (BGBM)
- Hungarian Natural History Museum
- Naturhistoriska riksmuseet (NRM)
- Royal Museum of Central Africa (RMCA)
- Royal Belgian Institute of Natural Sciences (RBINS)
- State Museum of Natural History Stuttgart (SMNS)
- VU University Amsterdam
- University of Copenhagen
- Museum National d'Histoire Naturelle
- Natural History Museum Vienna (NHMW)
- Senckenberg Gesellschaft für Naturforschung (SGN)
- The Natural History Museum (NHM)
- Hellenic Centre for Marine Research

but without support from SYNTHESYS, this would not have happened

if I may, 2 suggestions for SYNTHESYS 4?

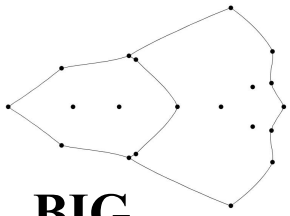
feedback from applicants (even if not funded)

'capitalize' on visits by experts

(maybe in coop. with local universities):

practical demos? lectures? workshops?

many thanks for inviting me! & 1000 thanks to: SYNTHESYS, all organizers & administrators, museum curators and staff, and all collaborators including recent ones on big cats and kangroos



BIG

SMALL