Giant Reptiles

Fossil Snapshots of Biotic Response to Climatic Shifts

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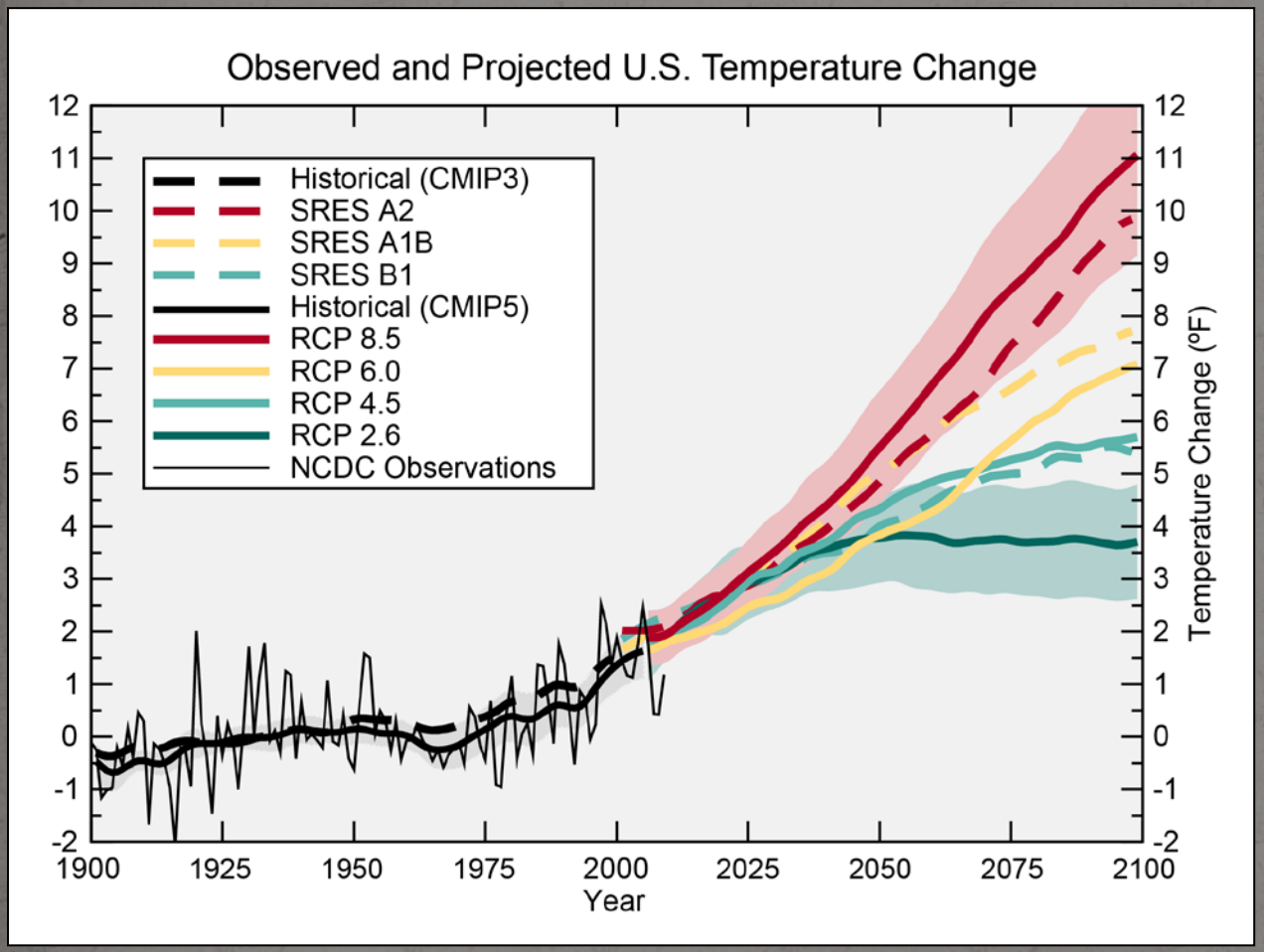
NATURAL HISTORY
IN ASSOCIATION WITH THE SMITHSONIAN INSTITUTION

Image modified from:
swordlord3d.deviantart.com/art/Titanoboa-The-Stomping-Land-01-458275652

Future Climate

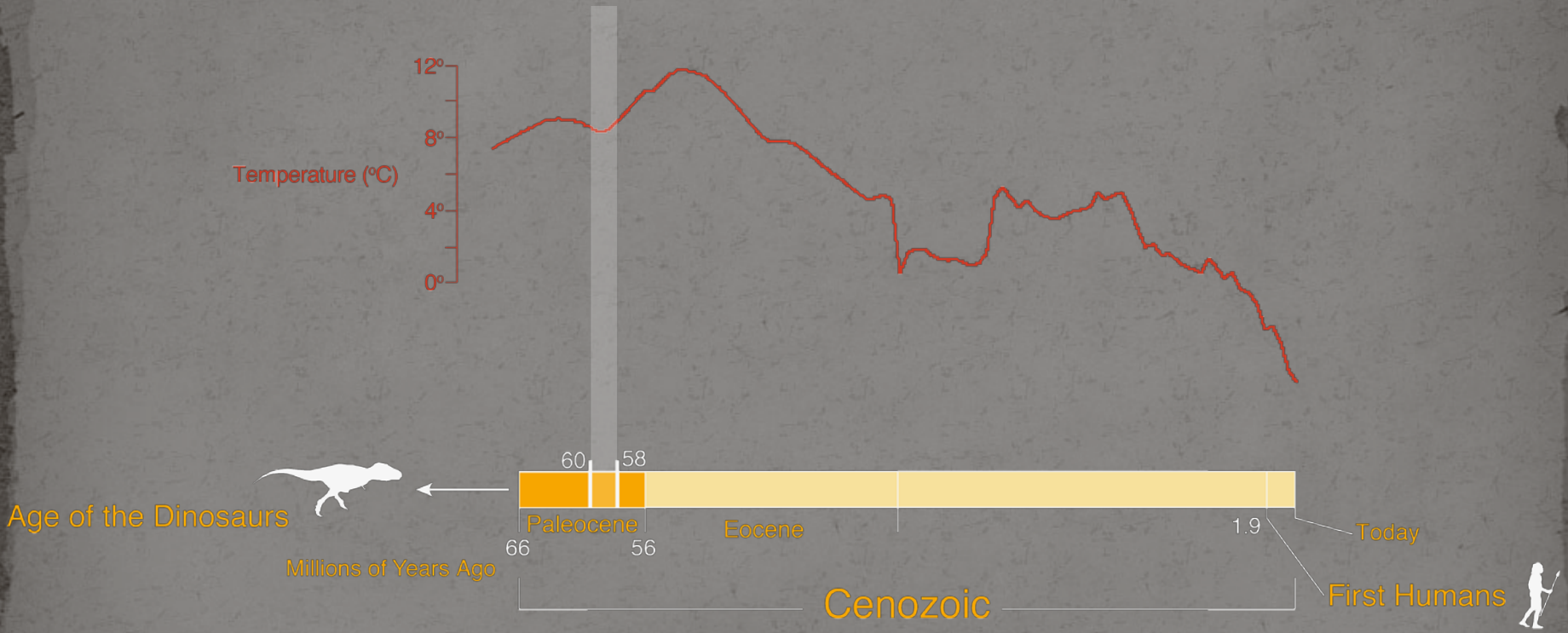


http://data.globalchange.gov/report/nca3/chapter/appendix-faqs/figure/observed-and-projected-us-temperature-change

- Most reasonable models: 7–11 degrees (F) warmer than today by 2100
- Must travel back in time to see what the planet was like when it was last that warm…

Look to the past

- Hot temperatures and getting hotter
- How do rising temperatures impact life?



Temp. from Zachos et al. 2001

Ectotherms & Climate

- Reptiles are ectothermic ('cold-blooded')
- Require energy from their environment
- More connected to changes in climate

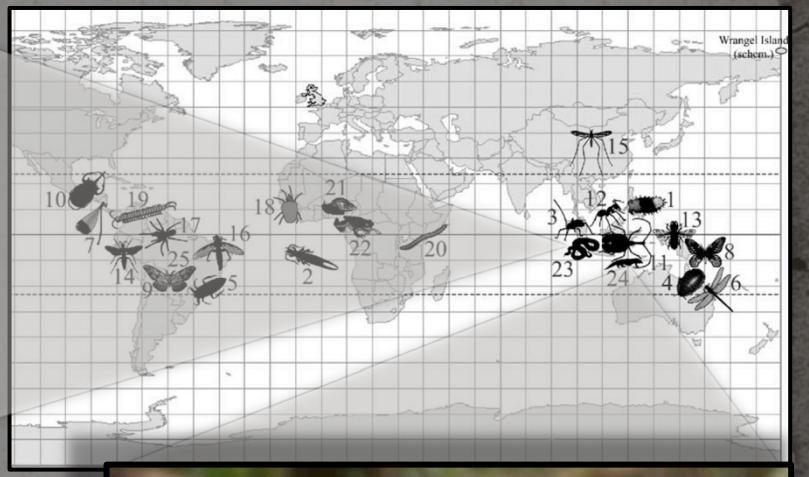
http://adurkin.weebly.com/bioheroics

wildretina.com

Ectotherms & Climate

- Land-living ectotherms can reach larger sizes in warm climates

Makarieva et al. 2005

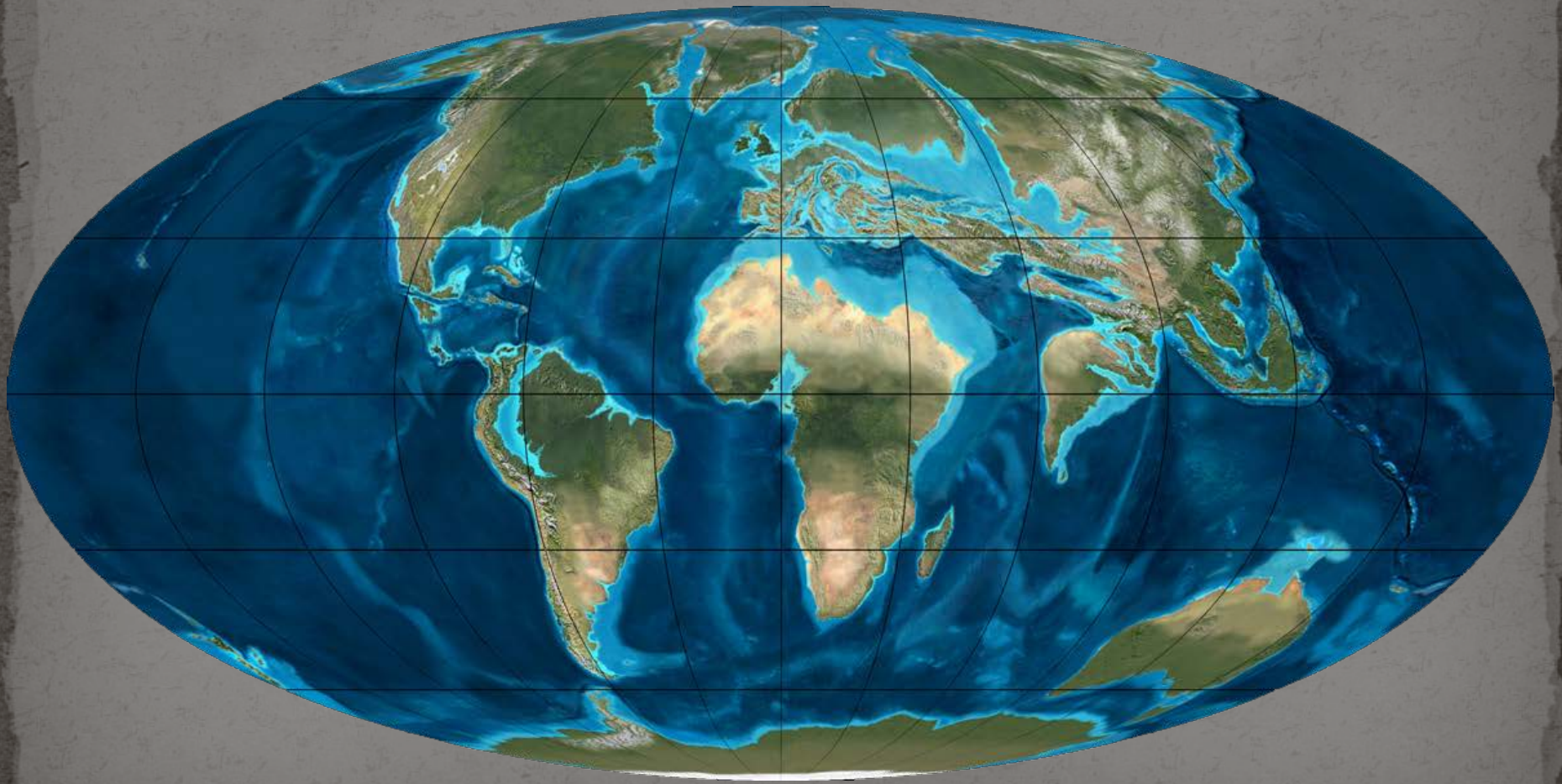


- Often reach higher diversity as well

natureandscience-alb.blogspot.de

The Paleogene World

- ‘Greenhouse’ environment, no year-round polar ice



Map by R. Blakey: http://jan.ucc.nau.edu/~rcb7/50moll.jpg

The Paleogene World

Palm Leaves
Wyoming, USA

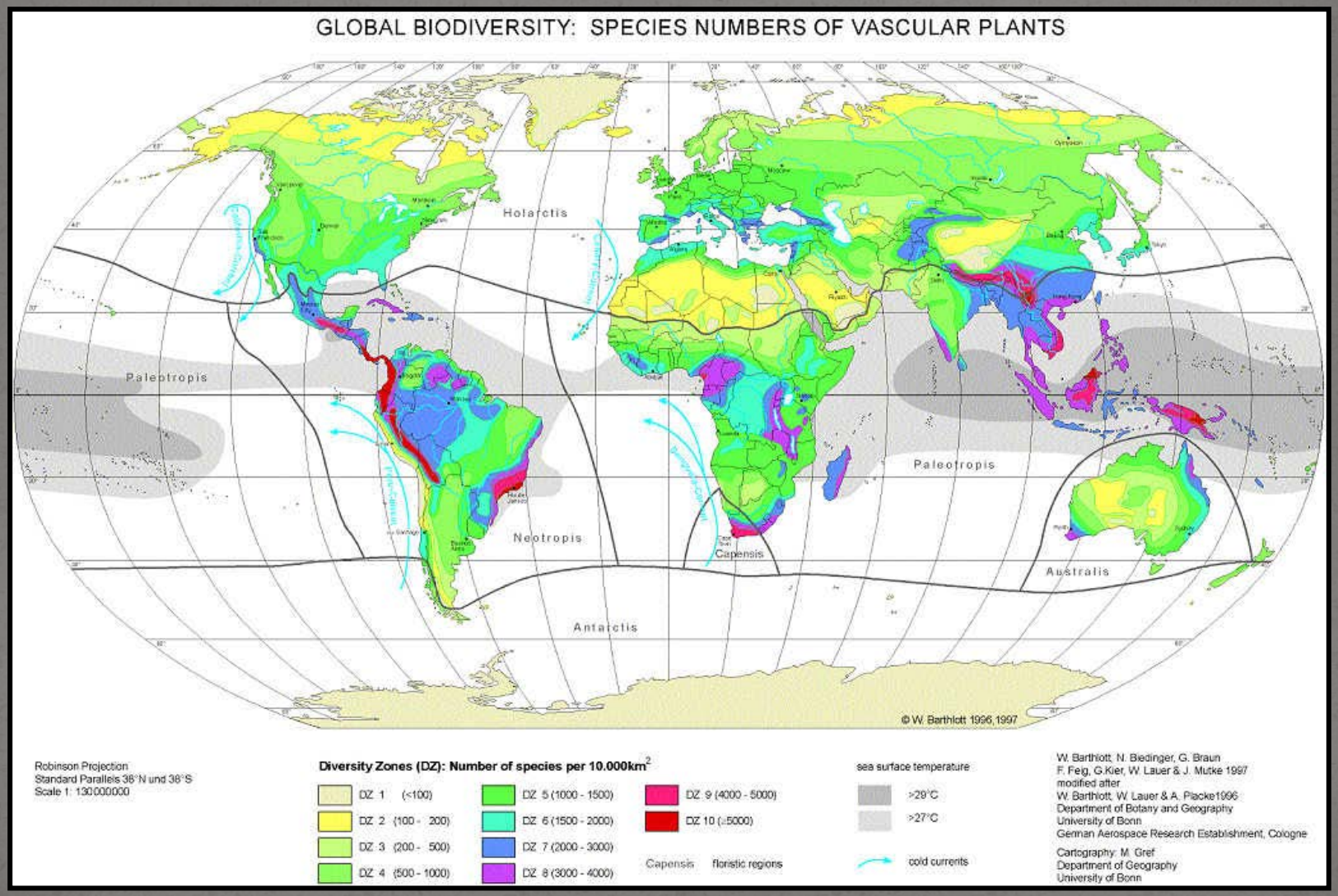
Alligator-relative
Northern
Canada

Crocodylian: Eberle et al. 2014

Palm: http://nature.nps.gov/

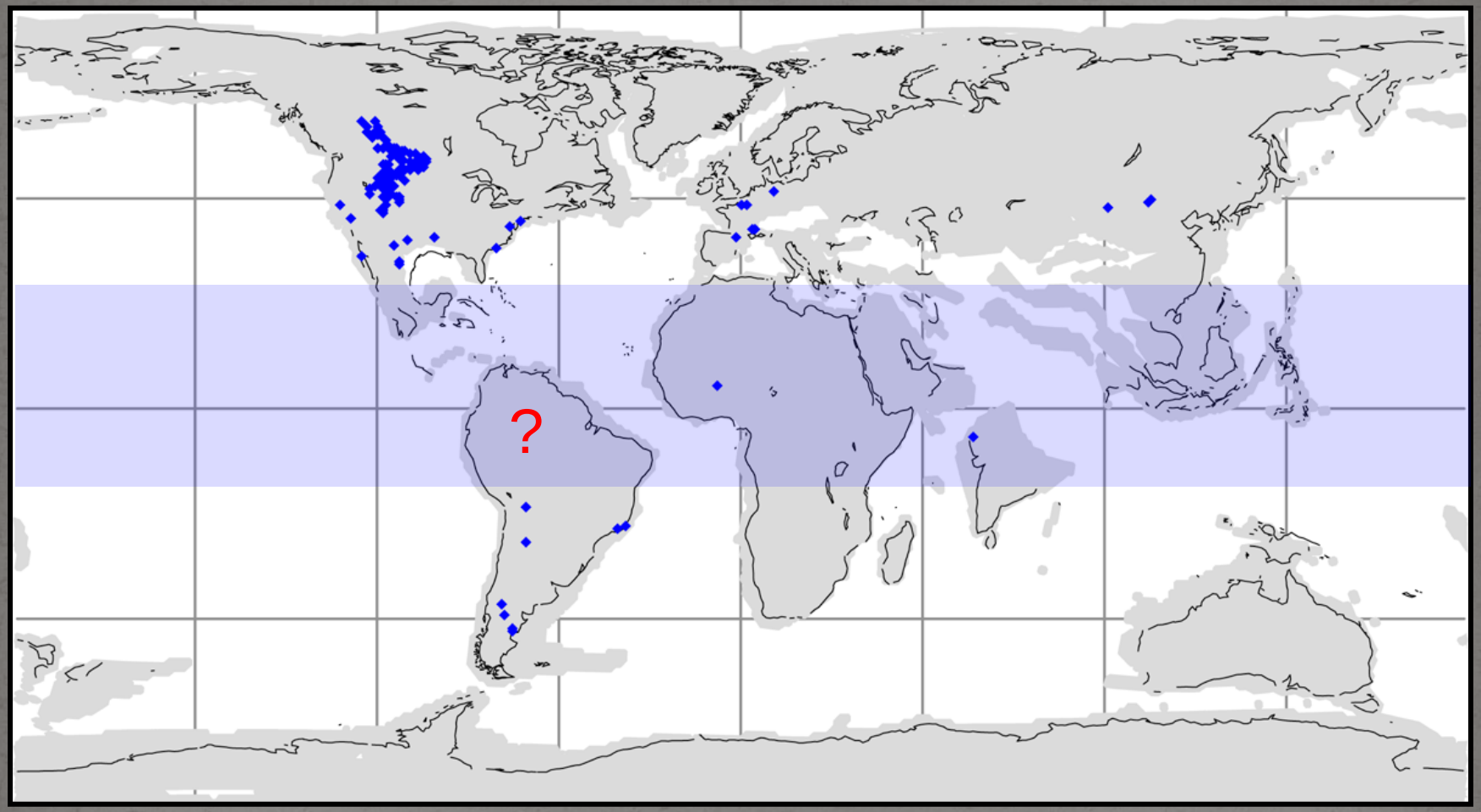
Map by R. Blakey: http://jan.ucc.nau.edu/~rcb7/50moll.jpg

Tropics hold most of Earth's biodiversity



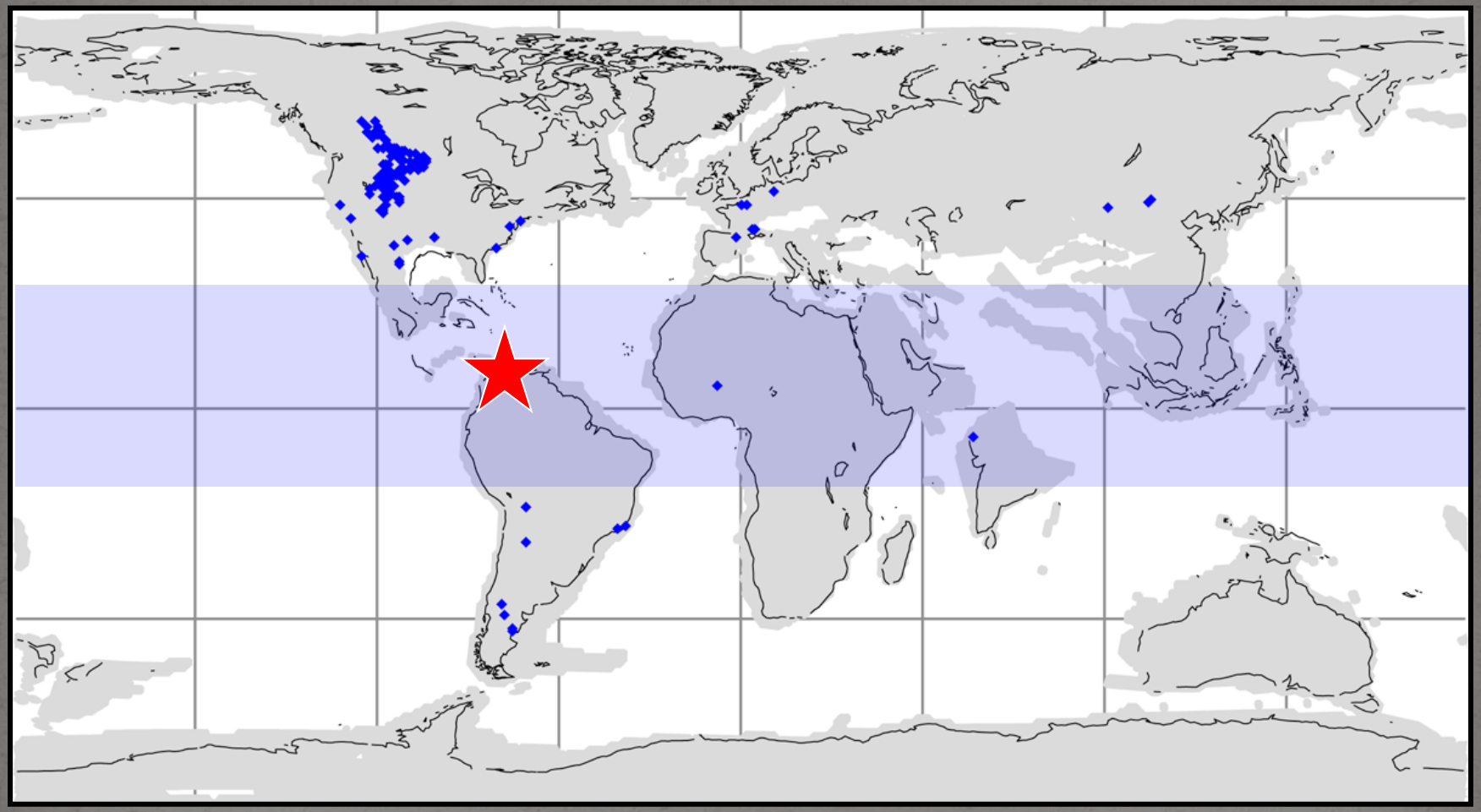
biohere.com/images/globbiod.JPG

Fossil Record in the Tropics



Paleobiology Database

Fossil Record in the Tropics



Paleobiology Database

Cerrejón Formation,
Northern Colombia

Cerrejón Coal Mine

- World's largest open pit coal mine
- 5° North latitude during Paleocene

Google Earth 2008

Turtle Diversity at Cerrejón

- At least 4 different species
- Related to modern side-necked turtles

Much More at Cerrejón

Crocodyliform Diversity at Cerrejón

Illustration by J. Bourque

Turtle Chomper

- Bite marks on turtle shells

animal-kid.com

The chomper?

- Vertebra of a **very** large, unidentified crocodyliform

And then there was something else…

Biggest Snakes Alive Today

- Anaconda

- Reticulated Python

Another Reptile at Cerrejón

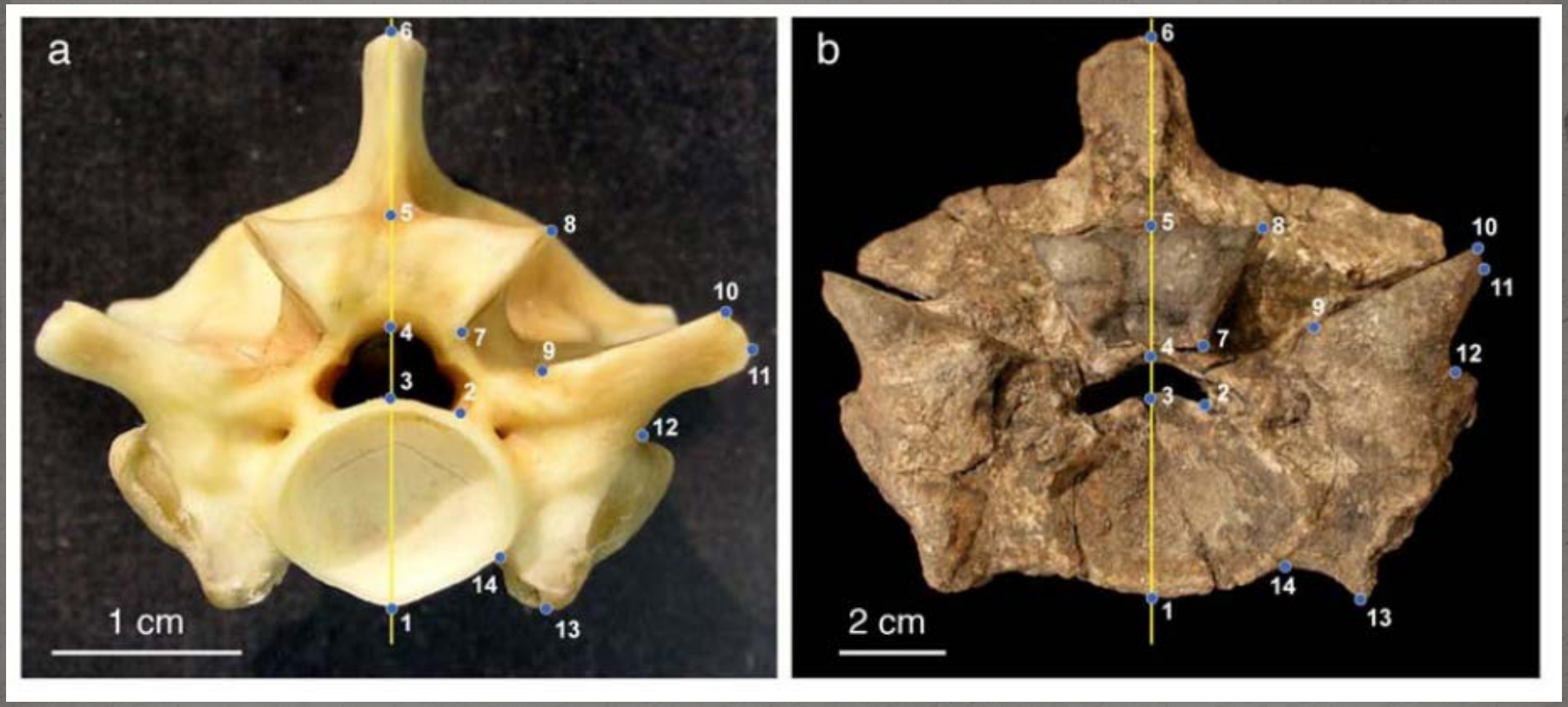
- Large vertebrae
- Around 140 individuals

Another Reptile at Cerrejón

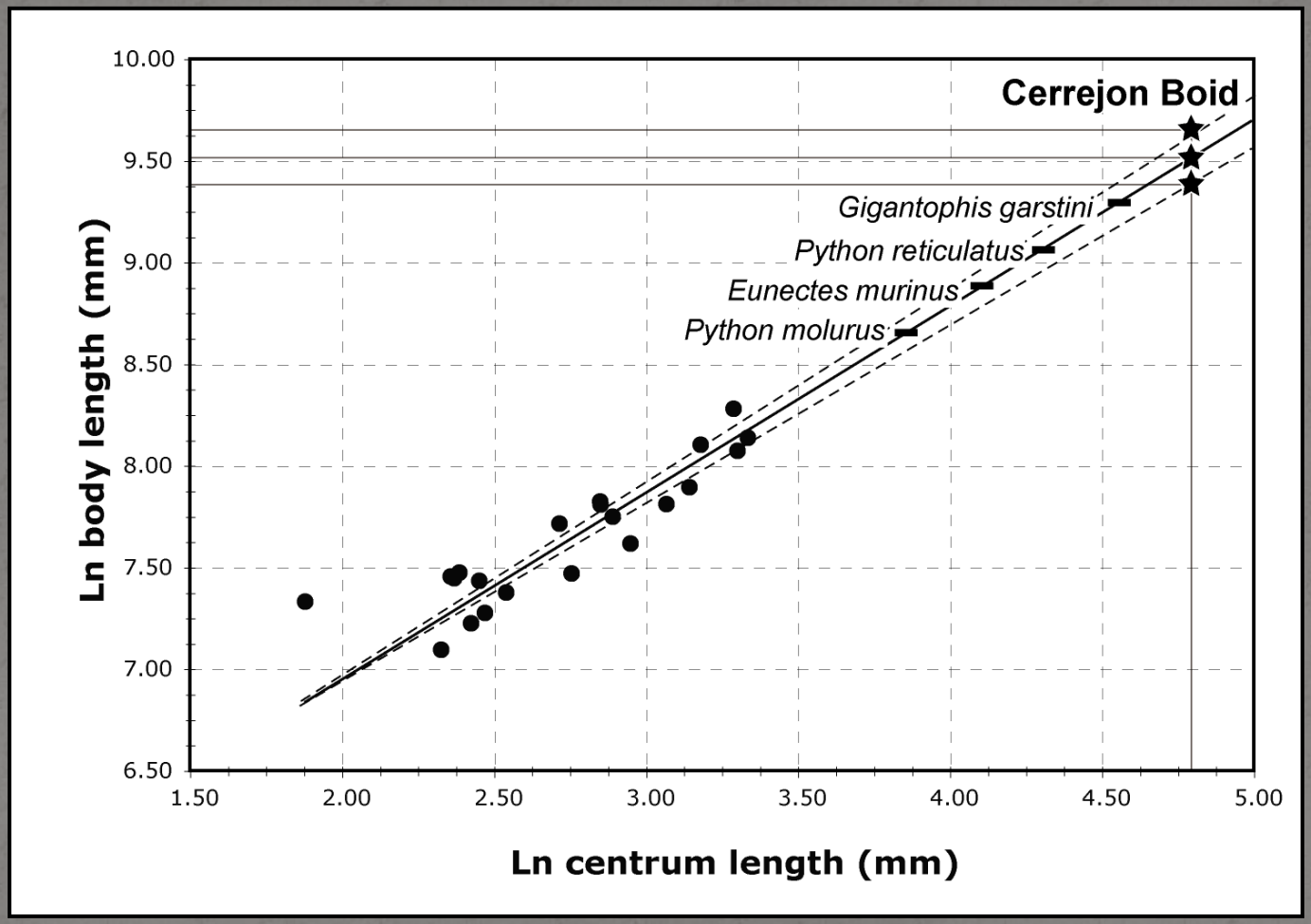
- Large vertebrae
- Around 140 individuals

How big was it?

- Need to know where in the body its from



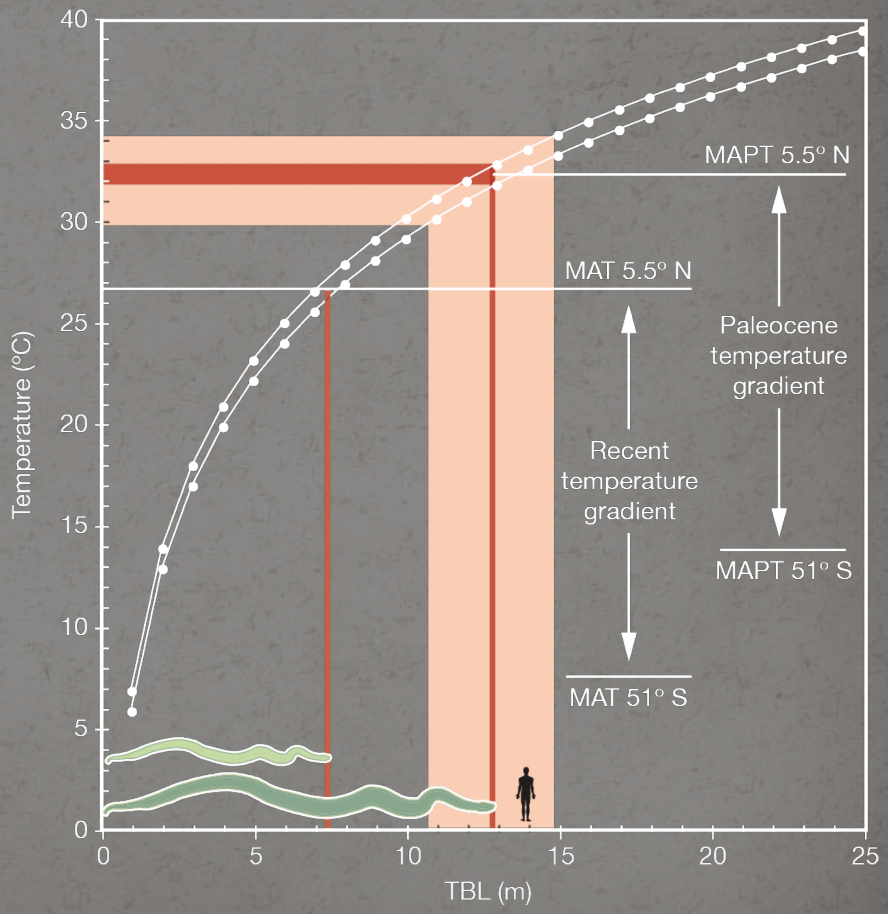
Size from vertebrae



Titanoboa = 45 ± 5 feet

How did it get so big?

- Would have required higher temperatures to metabolize
- Mathematical relationship between size and temperature



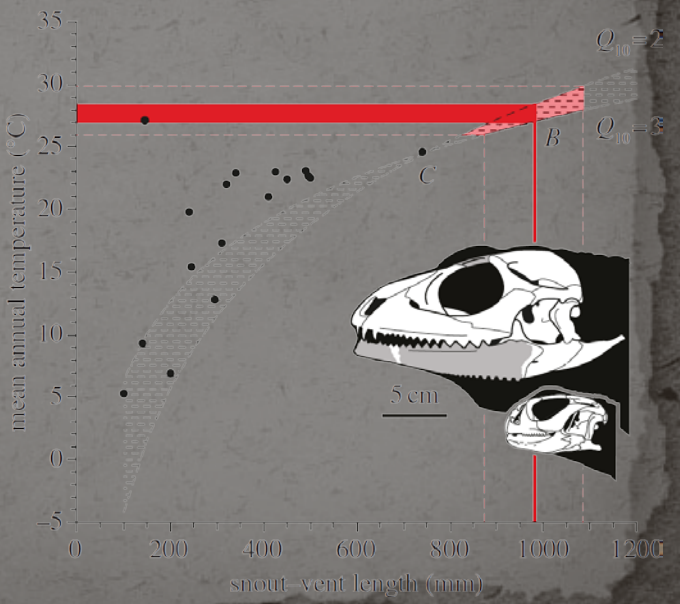
Head et al. 2009

Mathematical Relationship

- Physiology & temperature summarized by:

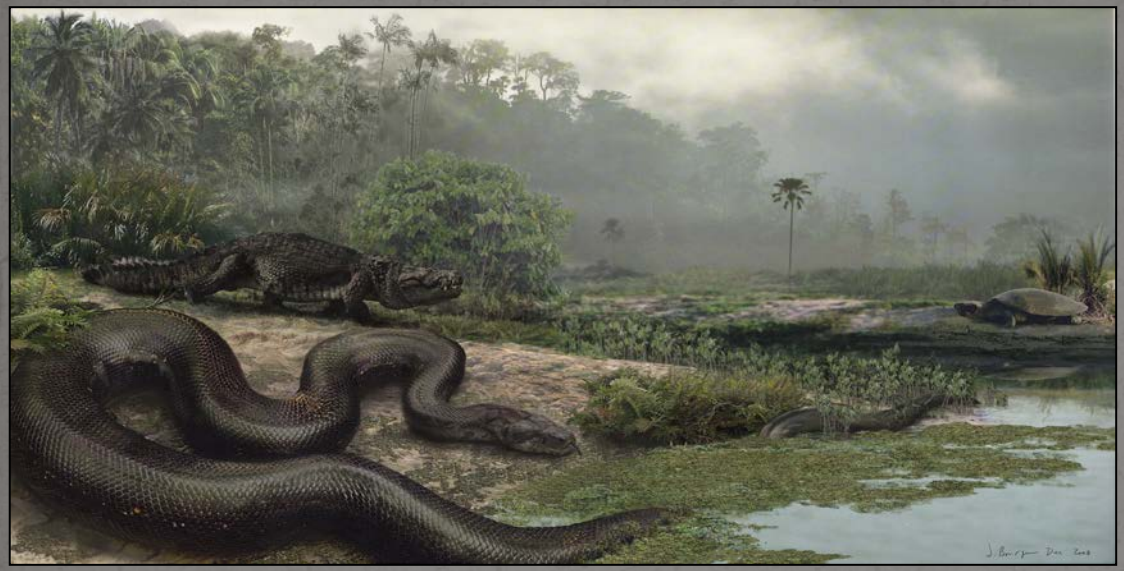
$$MAPT = MAT + 3\alpha 10^{o}C\left(\frac{log_{10}\frac{TBL_f}{TBL_m}}{log_{10}Q_{10}}\right)$$

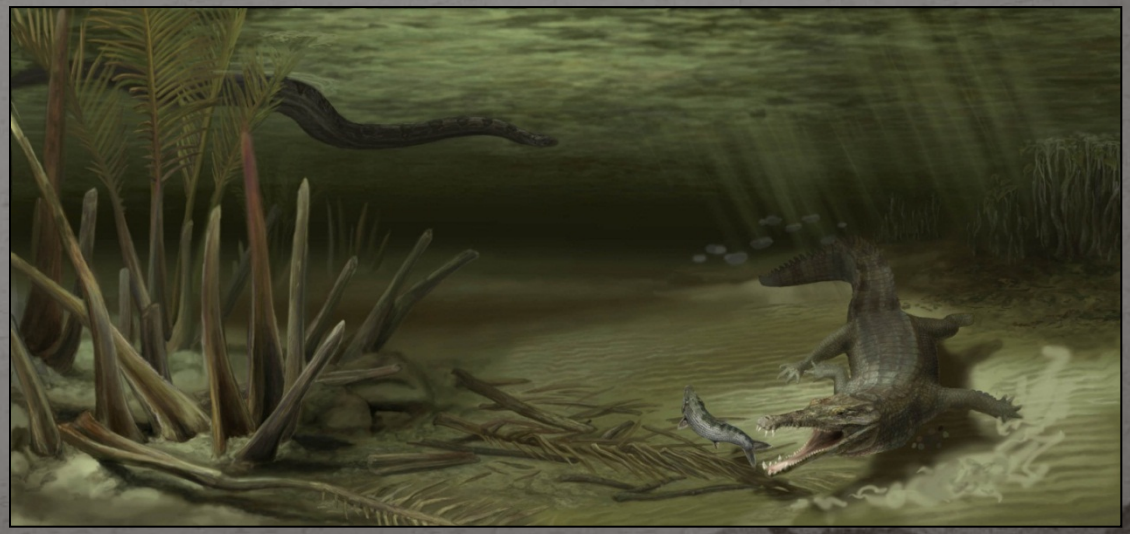
  - MAPT = Mean Annual PaleoTemperature
  - MAT = Mean Annual Temperature
  - TBL_m = Total Body Length (modern)
  - α = metabolic scaling exponent
  - Q_{10} = mass-specific metabolic rate
  - TBL_f = Total Body Length (fossil)



Head et al. (2013)

Greenhouse ecosystem with giant & diverse reptiles





Titanoboa as a learning tool

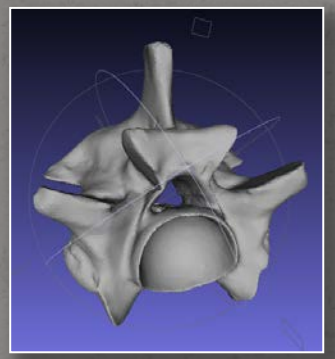
- Documentary
- Traveling Exhibit
- Promotions

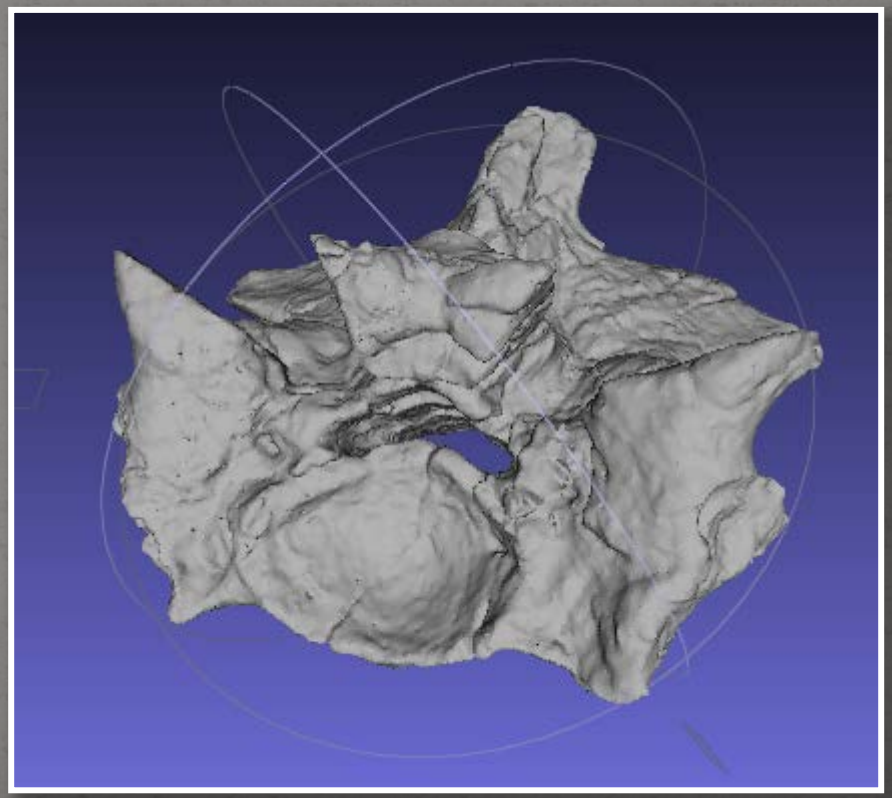
Smithsonian TV

play.google.com

A new look at old bones

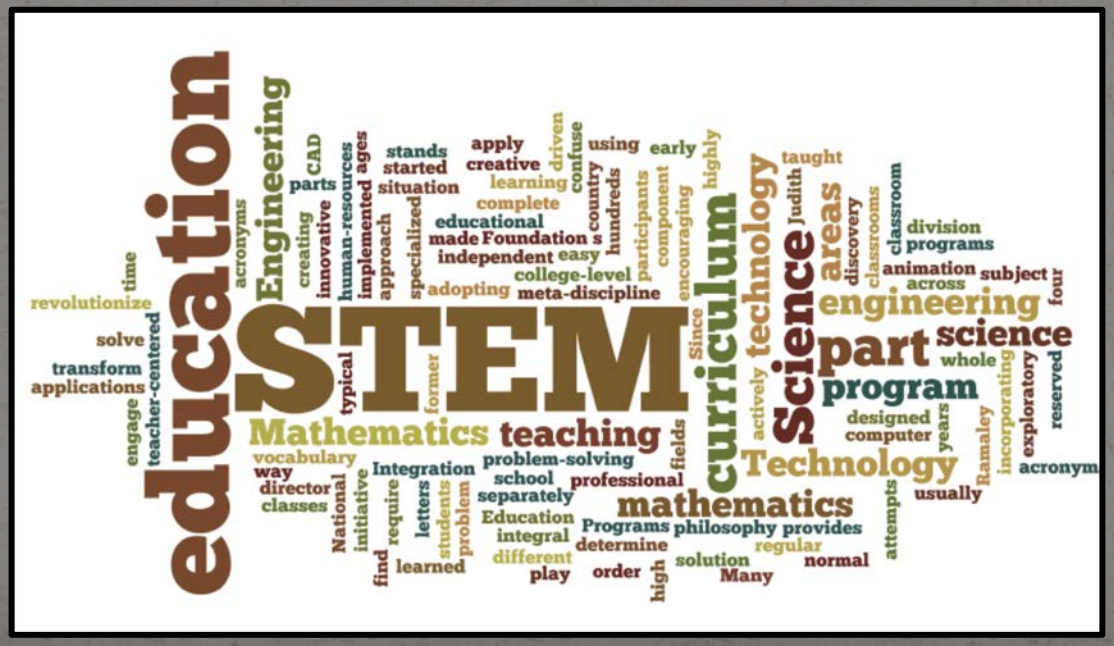
- 3D scans of *Titanoboa* vertebrae
- Data files available at morphosource.org (by request)





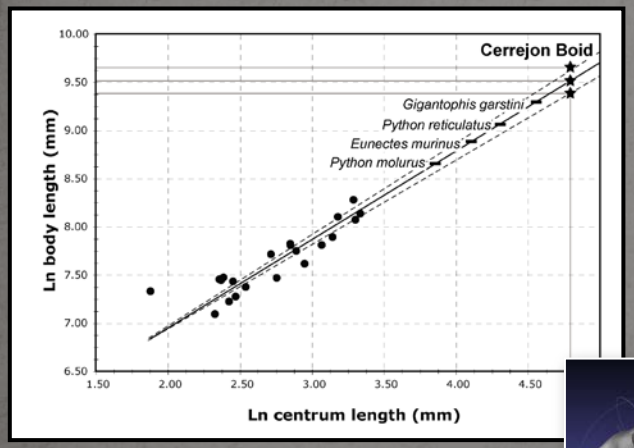
Potential for *Titanoboa* & Education

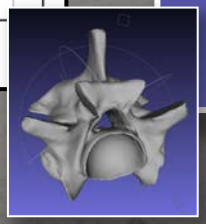
- Biological evolution in tandem with climate of a changing world
- Modern technological applications
- Inquiry-based mathematics

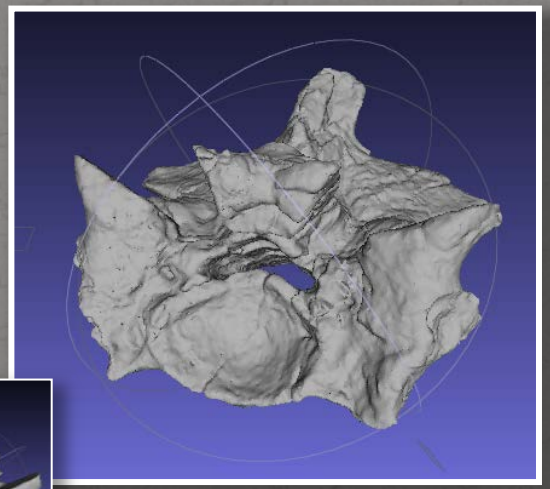


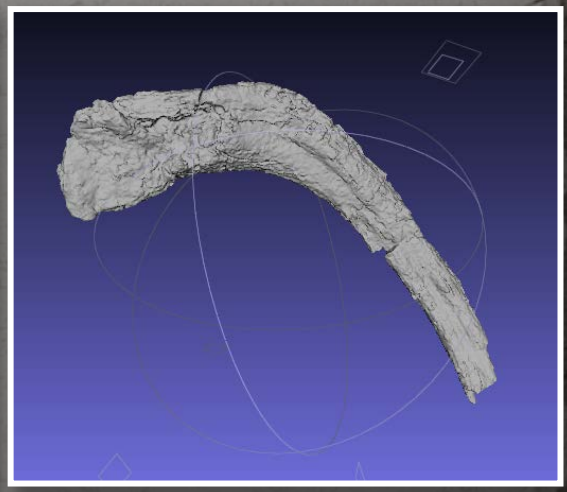
Material available for lessons

- 3D files for:
  - 3 *Titanoboa* vertebrae
  - 2 *Titanoboa* ribs
  - 1 Anaconda vertebra
- Data gathered from many modern relatives and all recovered specimens of *Titanoboa*



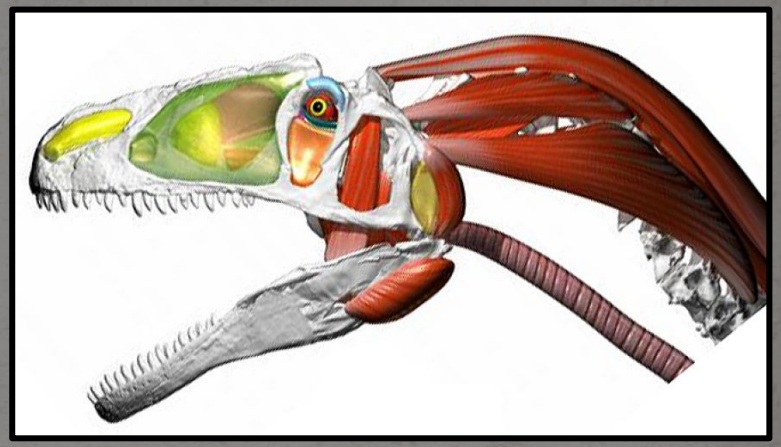






Future Directions & STEM

- 3D scanning to reconstruct skull from fragments
- Muscle modeling to determine strength
- Mechanical modeling for large snake motion



Funding Sources

- National Science Foundation
- Smithsonian Institute
- Florida Museum of Natural History

Thanks!!