

Prehistoric Panama 20 Million Years Ago: Evidence from the Fossil Record

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Outline

1. Background & context: Panama as a gateway to the Americas
2. GABI (Great American Biotic Interchange)
3. Collecting Miocene fossils in Panama: A once-in-a-century opportunity
4. Panama 20 million years ago:
 - Cast of characters
 - Age and ancient ecology, etc.
5. Why should we care?

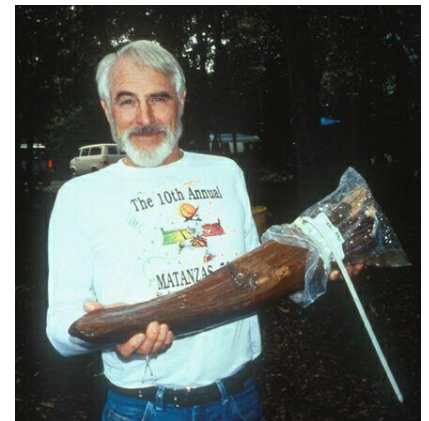
Background: Panama as a Gateway to the Americas



Marshall 1988
American Scientist
76:380-388

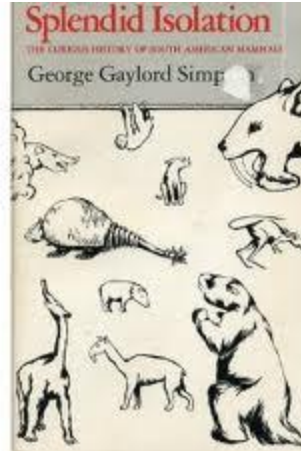
GABI (Great American Biotic Interchange)

- Has fascinated paleontologists and biologists since the mid 18th century
- Simple and classic story: during the Pleistocene (about 2 million years ago) the Isthmus formed, resulting in a land bridge
- This profoundly impacted life
 - On land
 - In the oceans

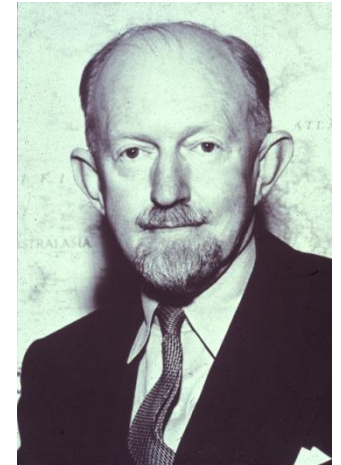


S. David Webb, FLMNH

Simpson—1980, Splendid Isolation



- Three faunal horizons “strata” in South America representing past 60 million
 - First Phase: Old timers alone
 - Second Phase: Aliens appear
 - Third phase: Interchange (GABI)



GABI—a more complex story that continues to evolve

- In contrast to Simpson's third phase (GABI), several distinct phases and pulses of land species dispersal before and after the formation of the Isthmus
- In contrast to the classic story of the floodgates opening during the Pleistocene, GABI started about 8 million years ago with multiple dispersal events

Late Miocene— 8 million years ago

- Ground sloths in Florida
- Racoons, coati, etc (procyonids) and mastodons to S. America
- With no Isthmus,
Dispersal route problematical



Pliocene: 4 to 5 million years ago

- Giant flightless bird *Titanis* dispersed into southern North America (TX, FL)
- Other groups, like edentates, northward into Mexico
- Assymetrical exchange

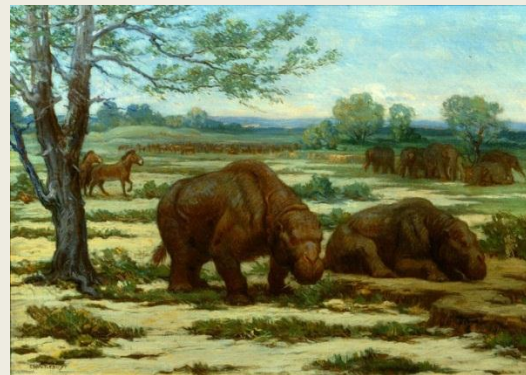


Since 2 to 3 million years ago

- Classic paleo-oceanographic evidence indicates full closure of Isthmus
- “Floodgates Open” on land
- But evidence suggests that within this time, complex dynamics of repeated dispersals and back “dispersals”



Panama, Azuero Peninsula, late Pleistocene (20,000 years ago—last Ice Age)



Why should we care?

- During the height of the GABI over the past 1-2 million years, base line diversity was swamped in terrestrial ecosystems
- A natural experiment in ecology and evolution: how are ecosystems perturbed by invasion?
 - Mixed faunas exceeding species carrying capacity
 - Asymmetrical competition and extinction

A new wrinkle

- STRI Panama Geology Project has published new geological evidence for a much earlier development of Isthmus (Miocene+)
- Earlier affects on shoaling of the seaway that connected the Pacific and Caribbean basins
- Significance for migration of animals still to be tested

Collecting Miocene fossils in Panama: A once-in-a-century opportunity



20 million years ago—
15 million years before GABI

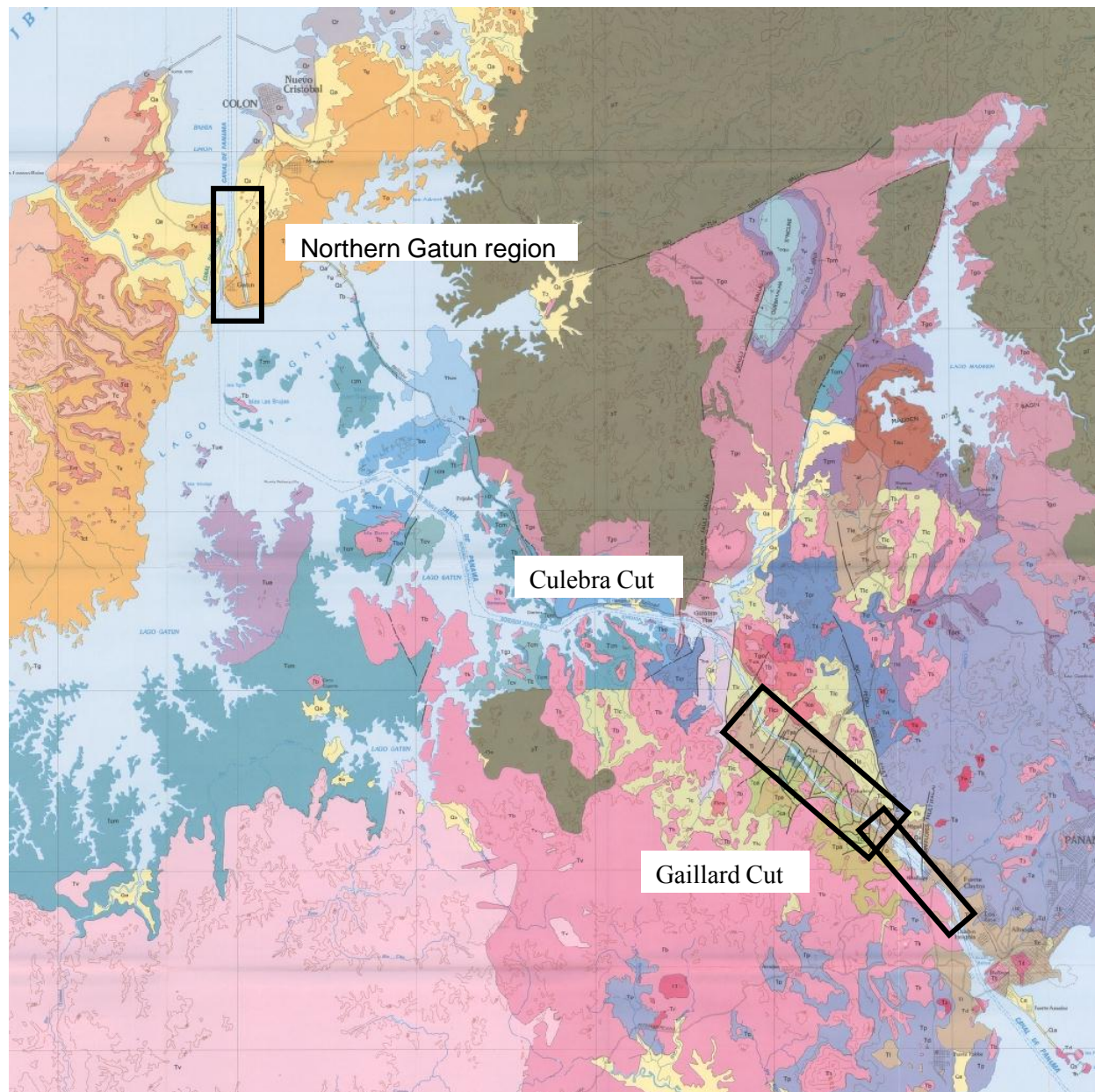
Why are these excavations so special for paleontology?

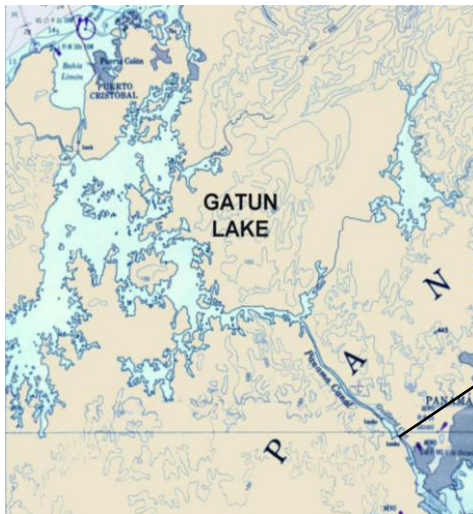


Nebraska badlands

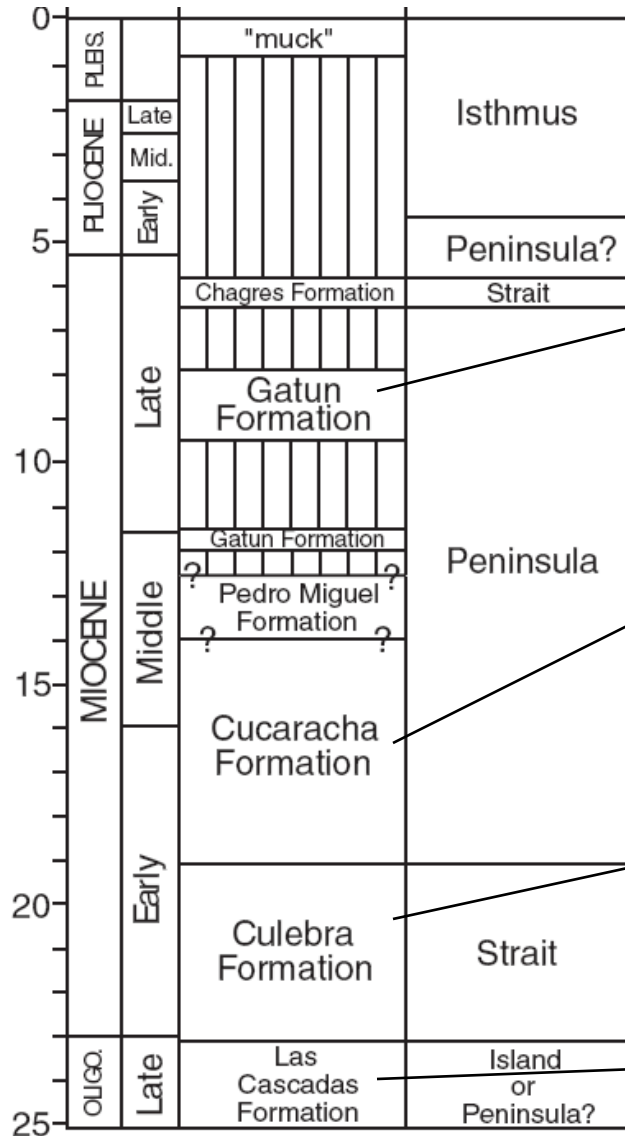


Tropical rainforest, BCI





Current stratigraphy & age



Fossil recovery mode—surface prospecting



Screenwashing for tiny fossils (microfauna)



Recent discovery: Spring break 2011



Order Chiroptera
Family Mormoopidae
ghost-faced bats, moustached bats,
and naked-backed bats

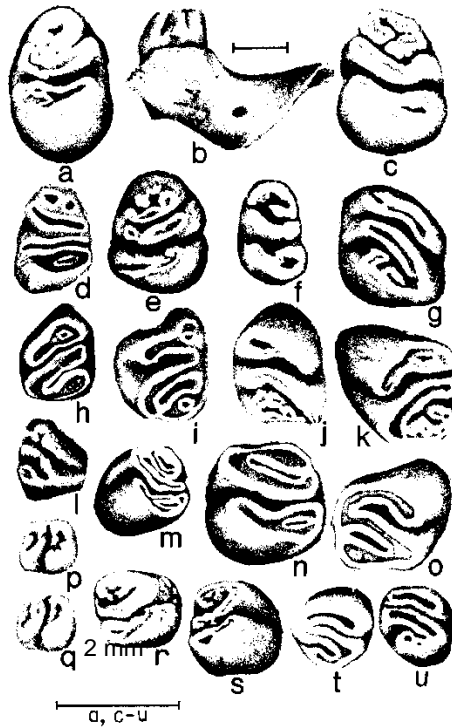
Ancient biodiversity in Panama

Cast of characters



Bats: Order Chiroptera

Rodents: Geomyoidea—Pocket Gophers



Panama rodent teeth

- *Texomys stewarti*
- Figs. d, h, l, m, r, s



Geomys--western

Flying squirrels



Family Sciuridae; Tribe Petauristini

Ground squirrels

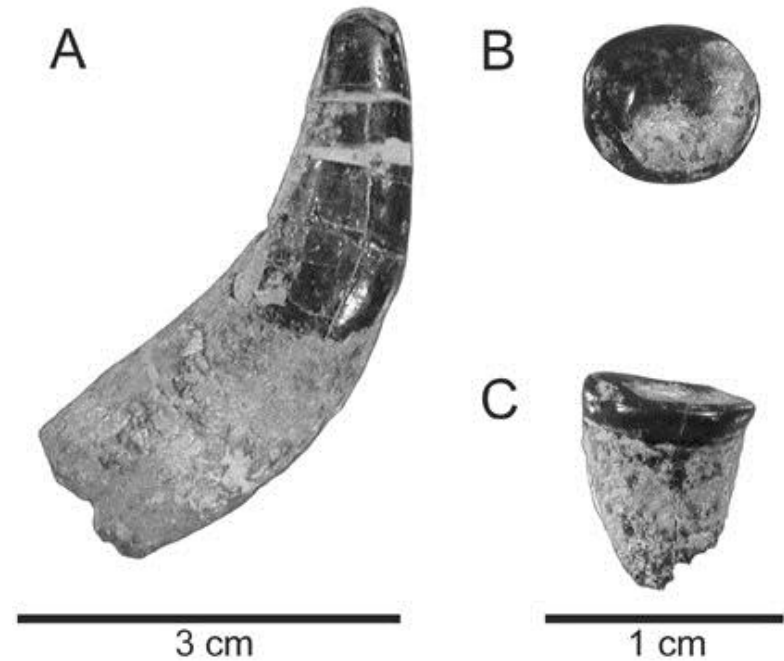
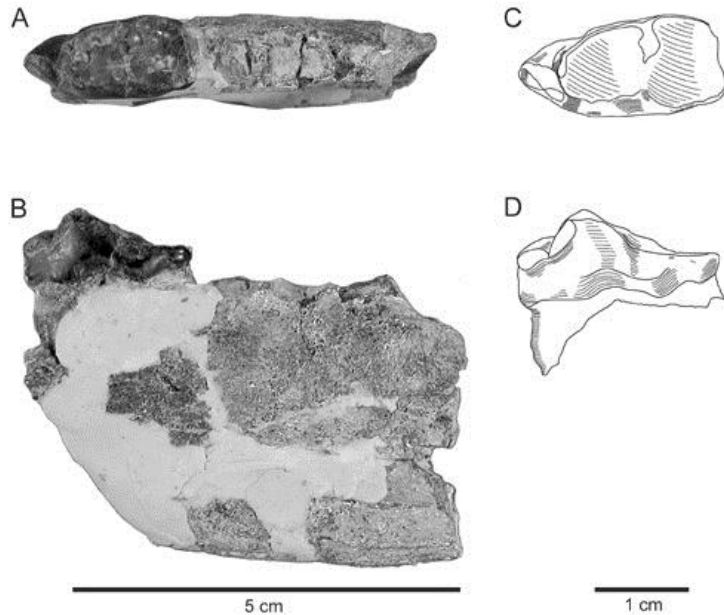


Family Scuridae

Raccoons, coatis (Procyonidae)

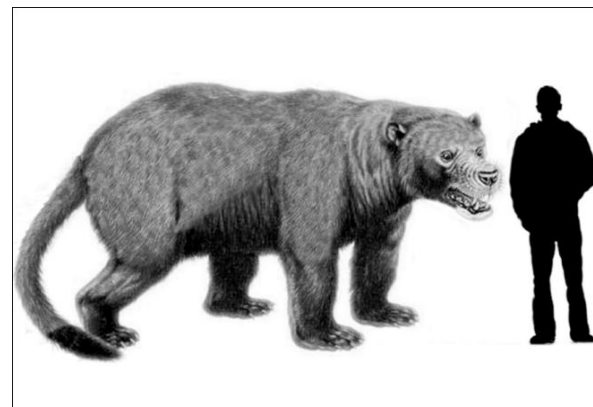


Dogs and wolves (Family Canidae)

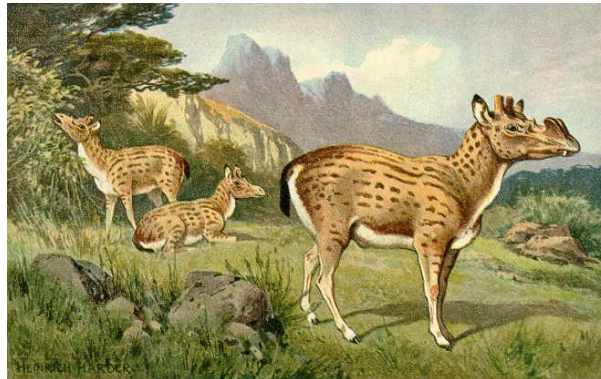
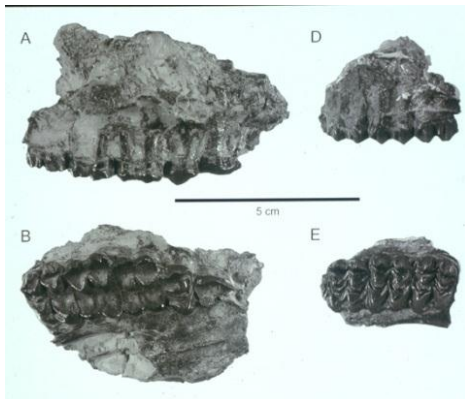


Tomarctus brevirostrus

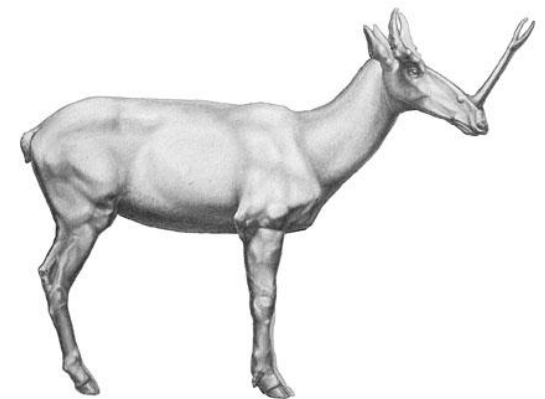
Bear Dog (Amphicyonidae)



Deer-like Artiodactyls (†protoceratids)

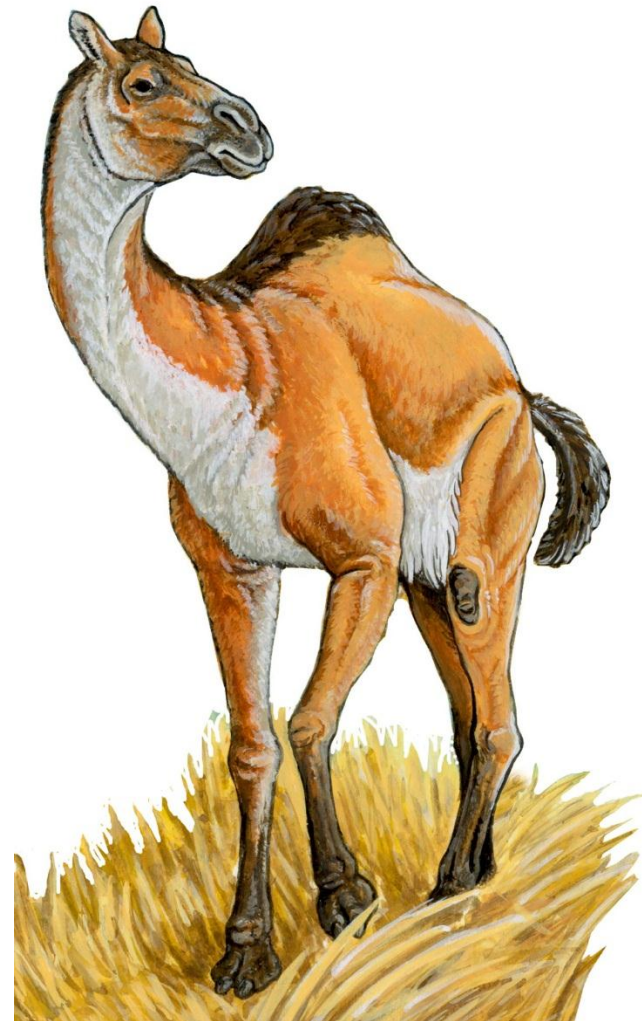


Paratoceras



Prosynthetoceras

Camels (Family Camelidae)

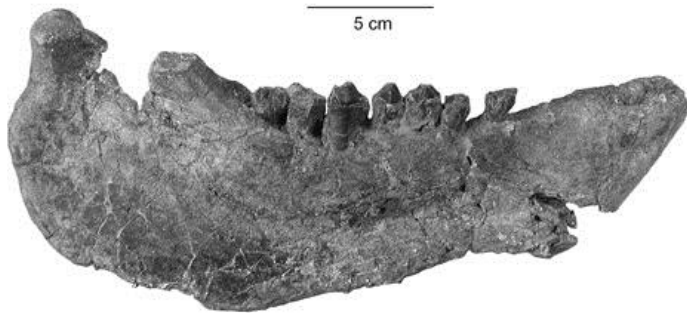


Oreodont

A



B



Merycochoerus



Peccary



"Cynorca" occidentale

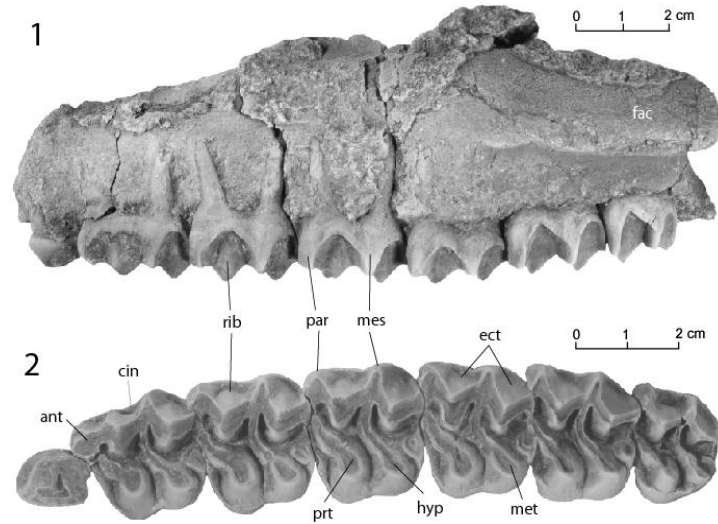
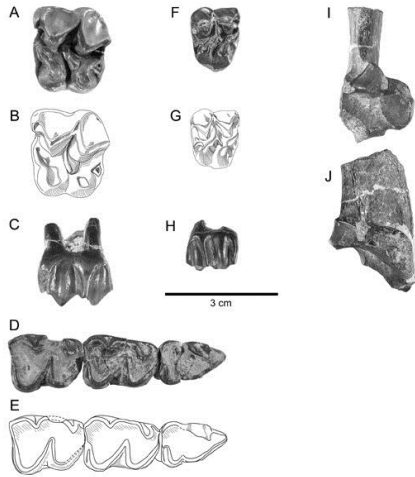


Modern Peccary Tayassuidae

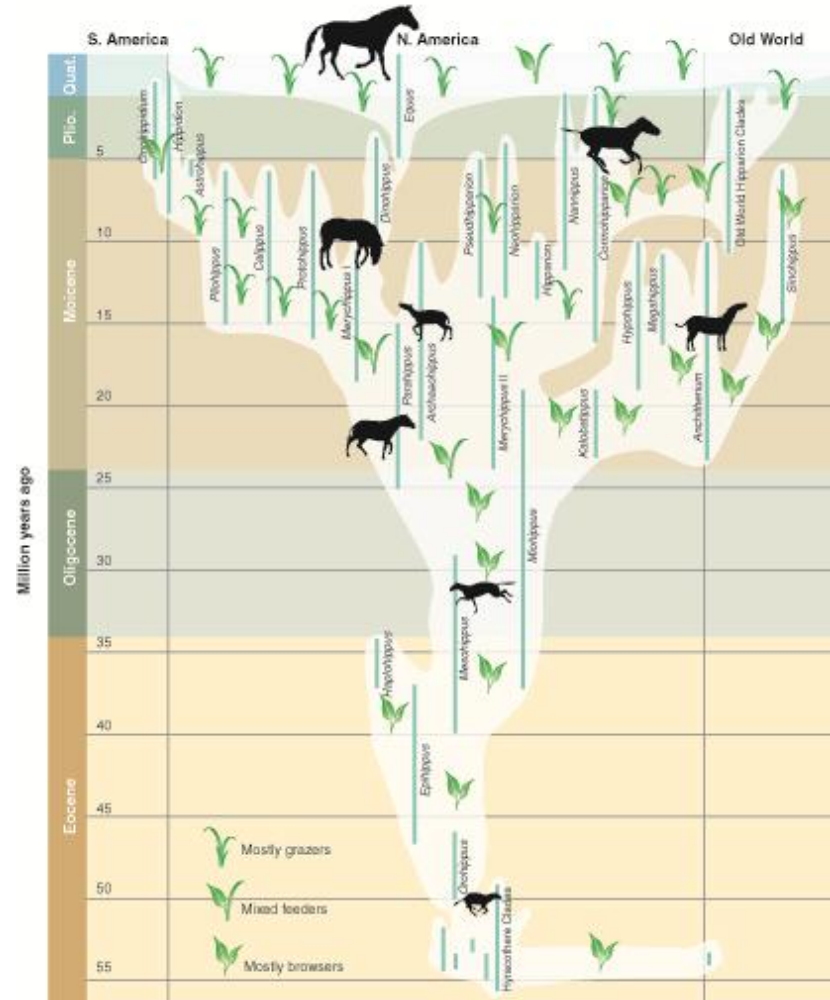
Giant pig-like anthracothere



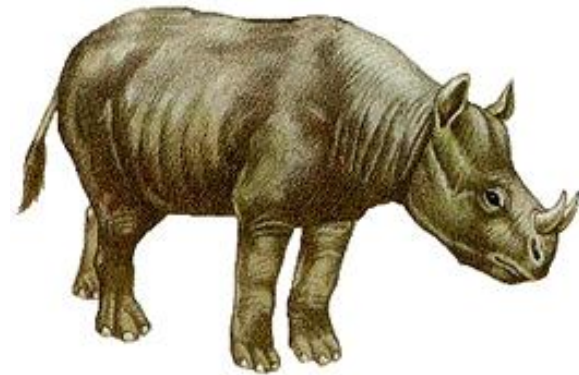
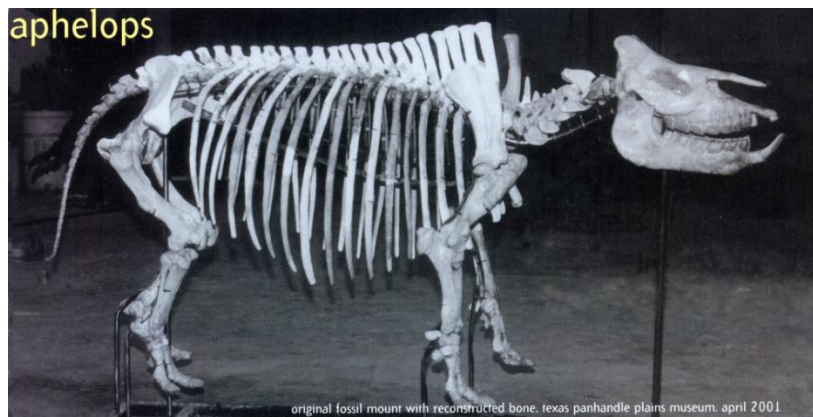
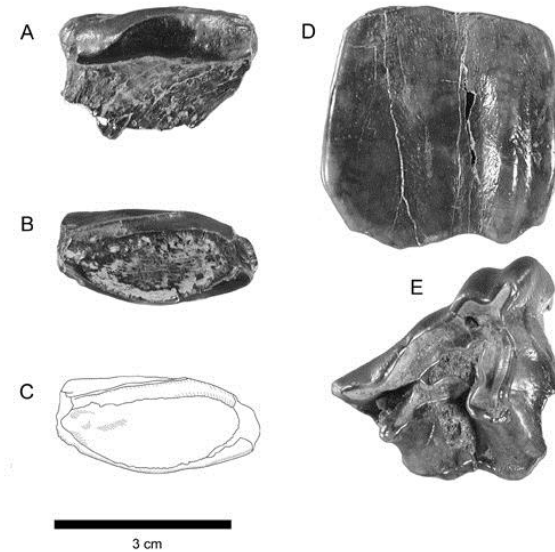
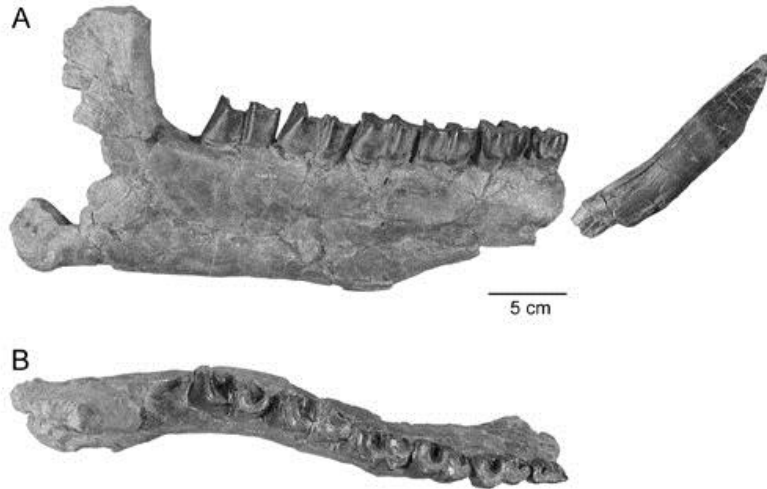
Horses (Family Equidae)



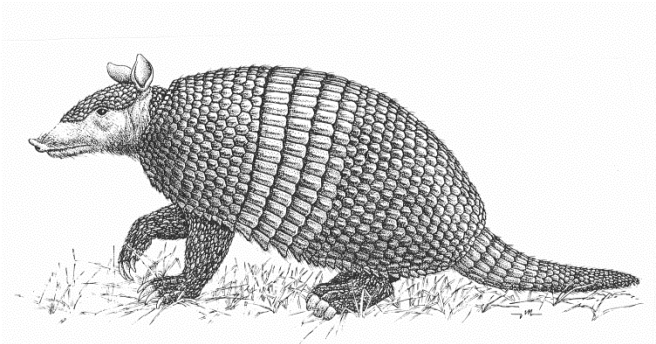
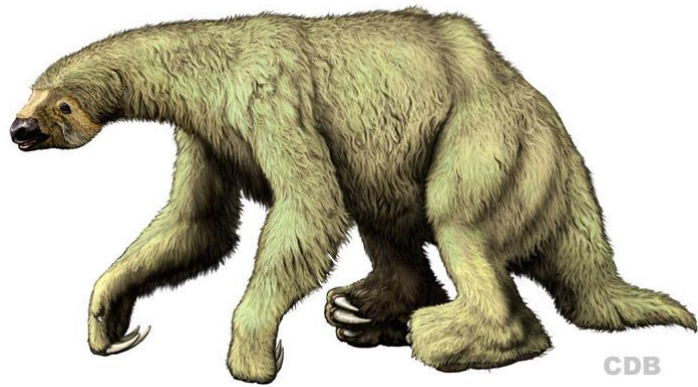
Important time in horse evolution



Rhinos (Family Rhinocerotidae)



Who's not been found in Panama yet during the Miocene-but lived in Colombia?



Why is it like this?



What were the land habitats like?

- Extinct mammal herbivore tooth morphology indicates mostly browse; no grasslands
- Carbon isotope analyses of these teeth indicate a range of C3 habitats from canopied forest to semi-open woodlands
- Fossil plants indicate tropical

Miocene Land Plants of Panama



Late Miocene analogs



Mascall, Oregon, 15 mya



Thomas Farm, Florida, 18 mya

Why should we care?

- Historical dimension
 - Macroevolution
 - Ecology
 - Biogeography
- Preservation/extinction and patterns of species diversity
- Stability/fragility of diverse ecosystems



“There is no present or future, only the
past, happening over and over again, now.

EUGENE O'NEILL, *A Moon for the Misbegotten*