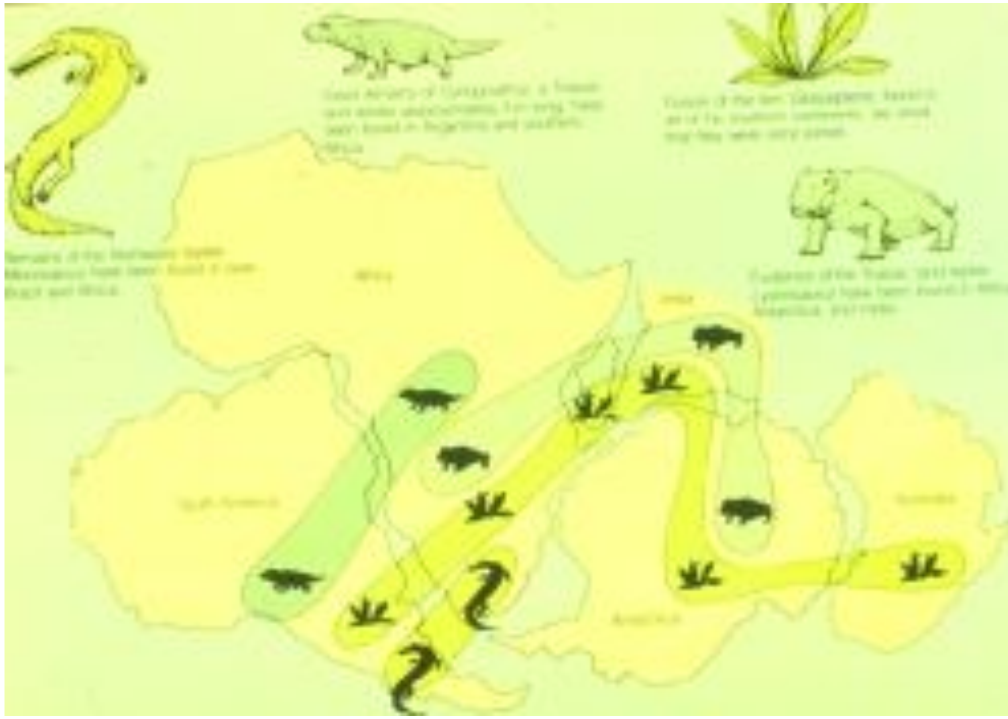
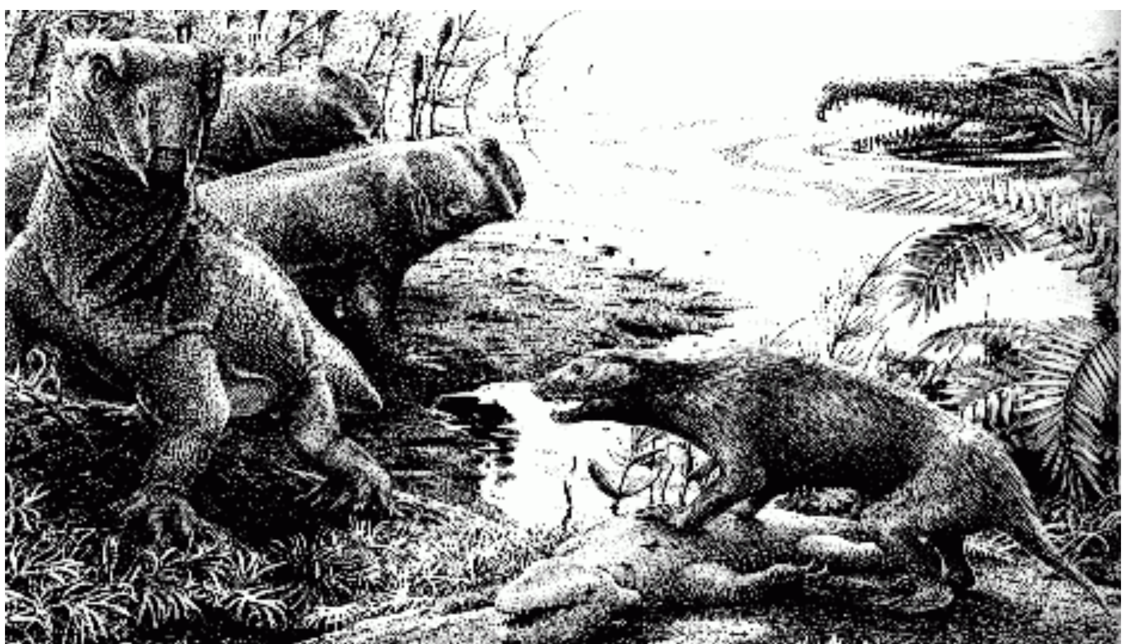
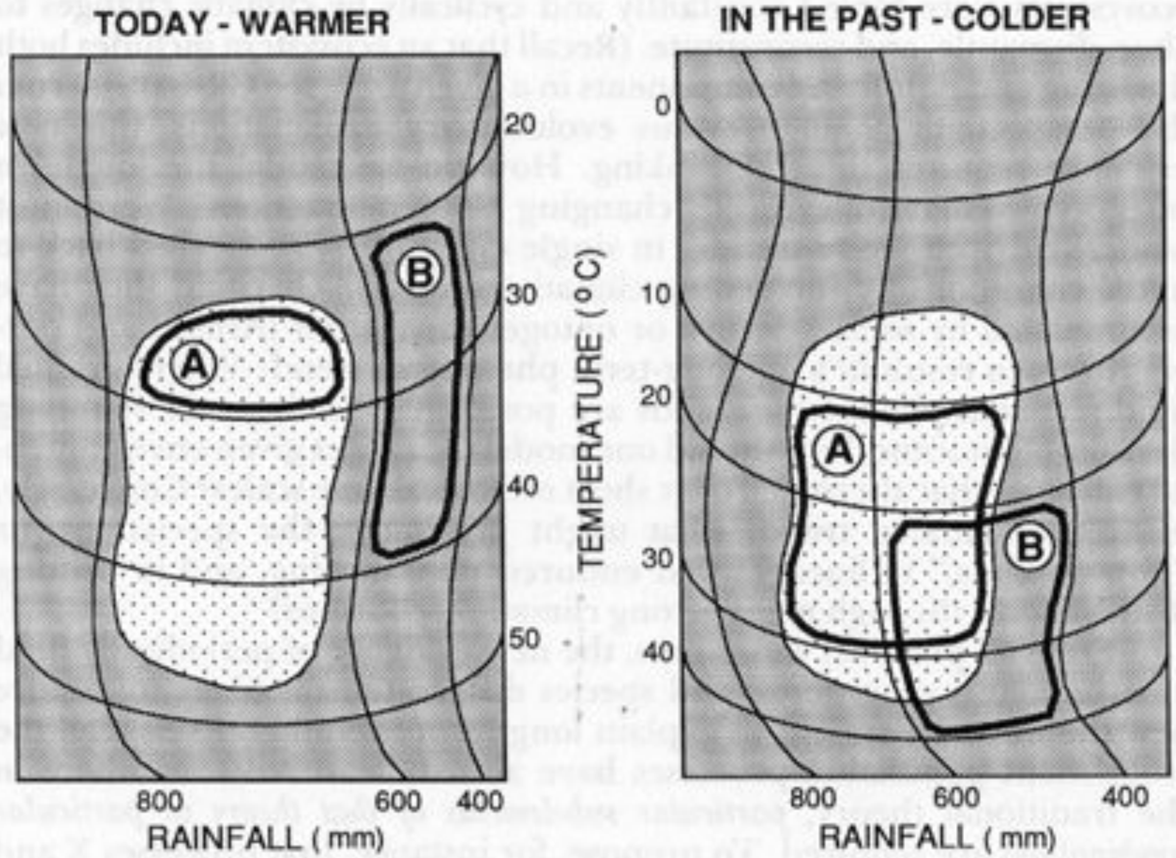
# Biogeografía de Paleovertebrados Chilenos

Alexander Vargas





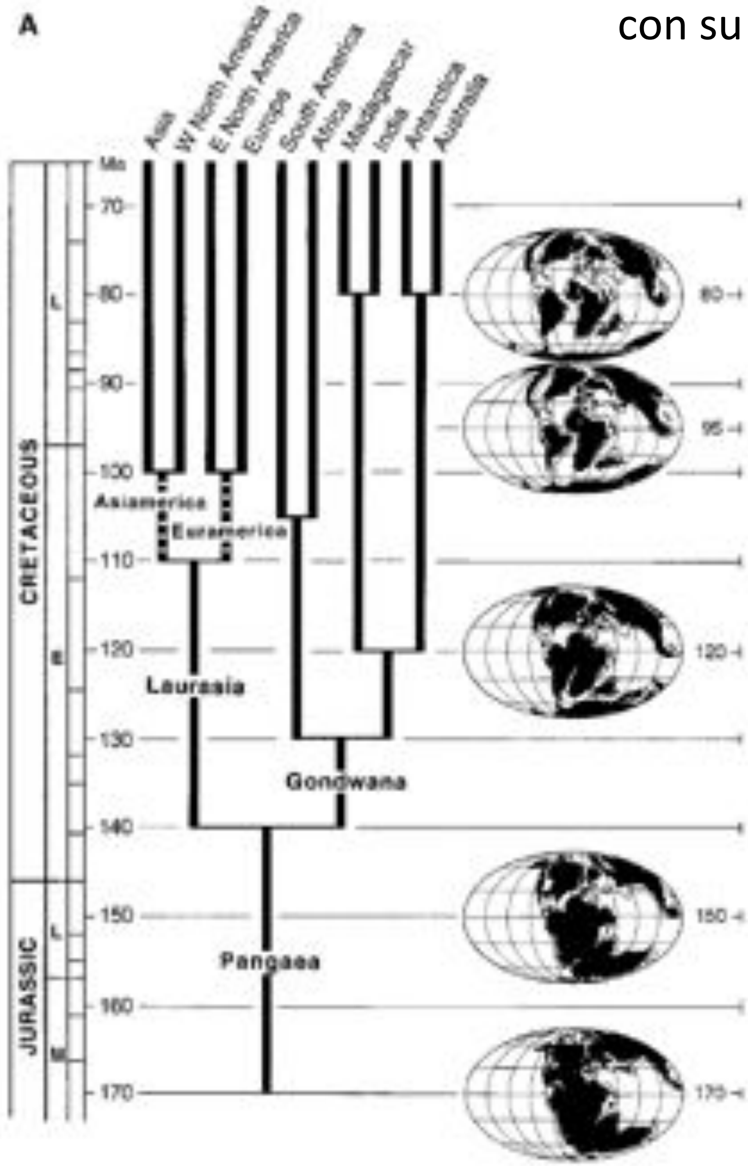


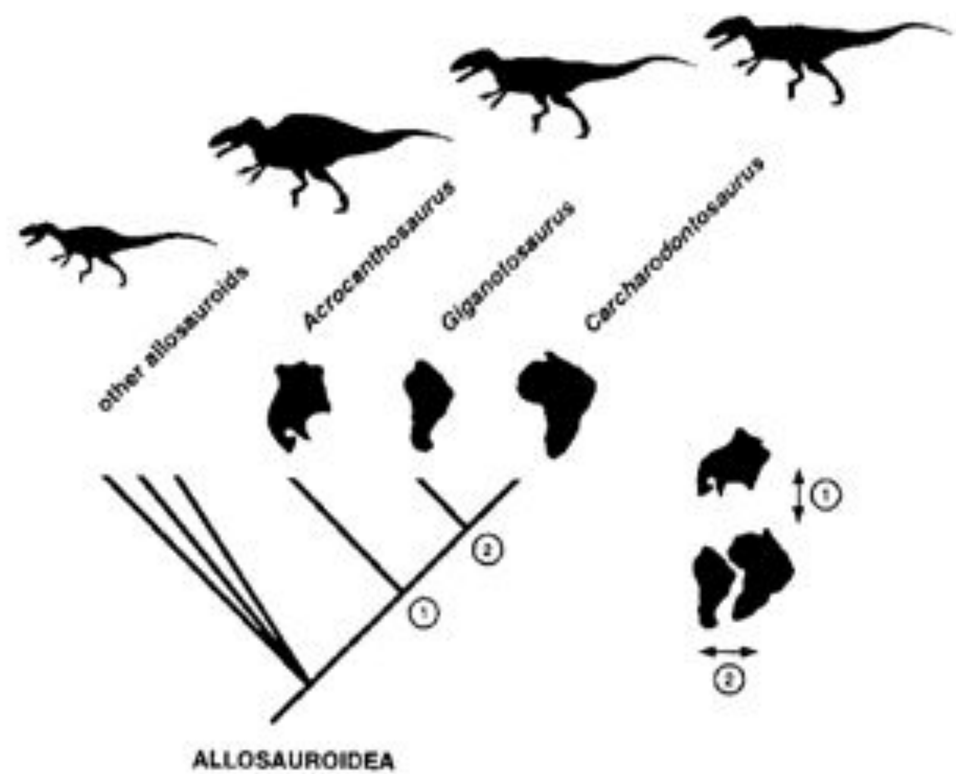

| HABITAT VARIABLES | TOLERANCE RANGE | |
|---|---|---|
| | SPECIES A | SPECIES B |
| TEMPERATURE | 10° - 30°C | 20° - 40°C |
| RAINFALL | 400 - 800 mm | 400 - 600 mm |
| SUBSTRATE | ONLY | AND |

Fig. 3. Hypothetical illustration of how 2 species, A and B, with overlapping tolerances for 3 habitat variables, can have disjunct distributions today, yet sympatric ones in the past.

Filogeografía.

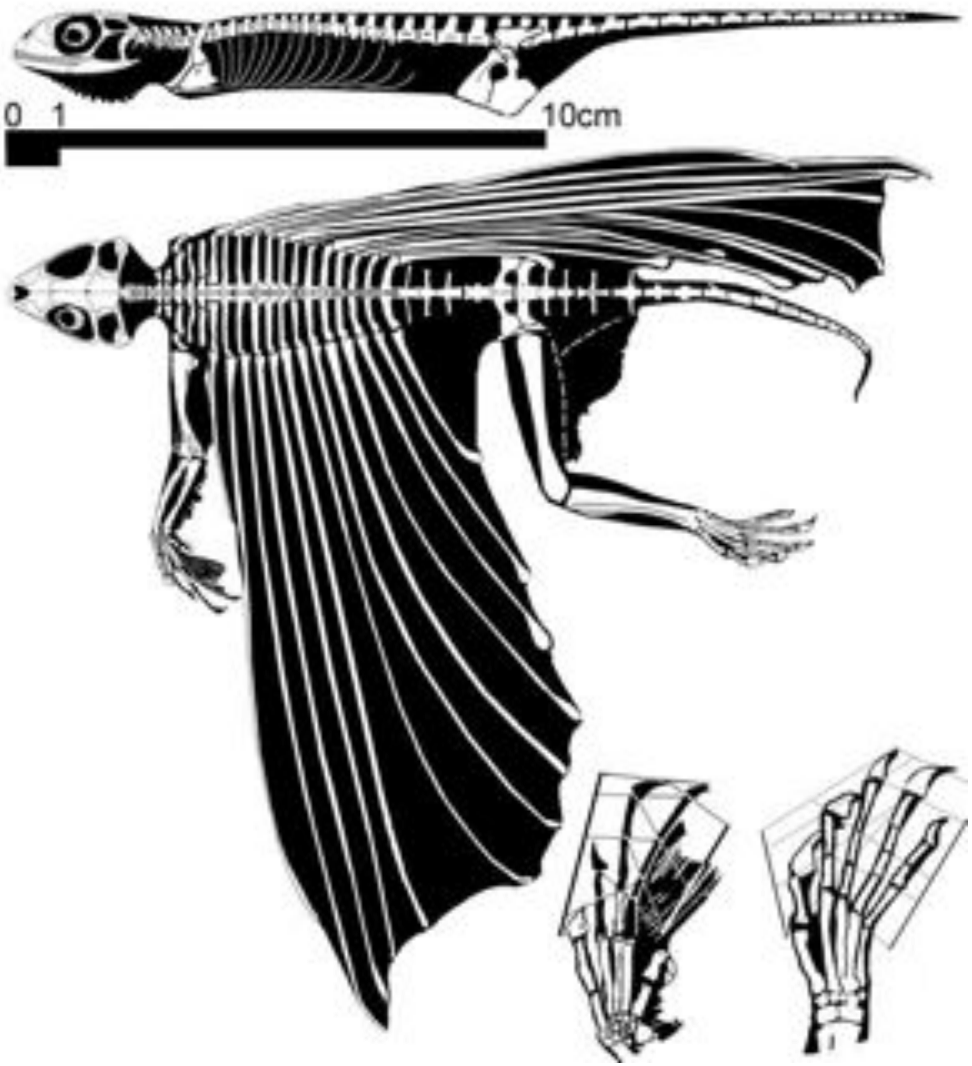
¿Quiénes comparten un ancestro en común más reciente? ¿Cómo se relaciona esta historia de los linajes con su distribución geográfica?




***La reconstrucción de las relaciones filogenéticas es parte indispensable para este análisis***

Richard Owen also distinguished homology from analogy (also known as **homoplasy), which he defined as a 'part or organ in one animal which has the same function as another part or organ in a different animal' (Owen, 1843: 374).**




**XENARTHRA**

Siempre se han reconocido como uno de los grupos más básicos de placentados (basales).

Cingulata

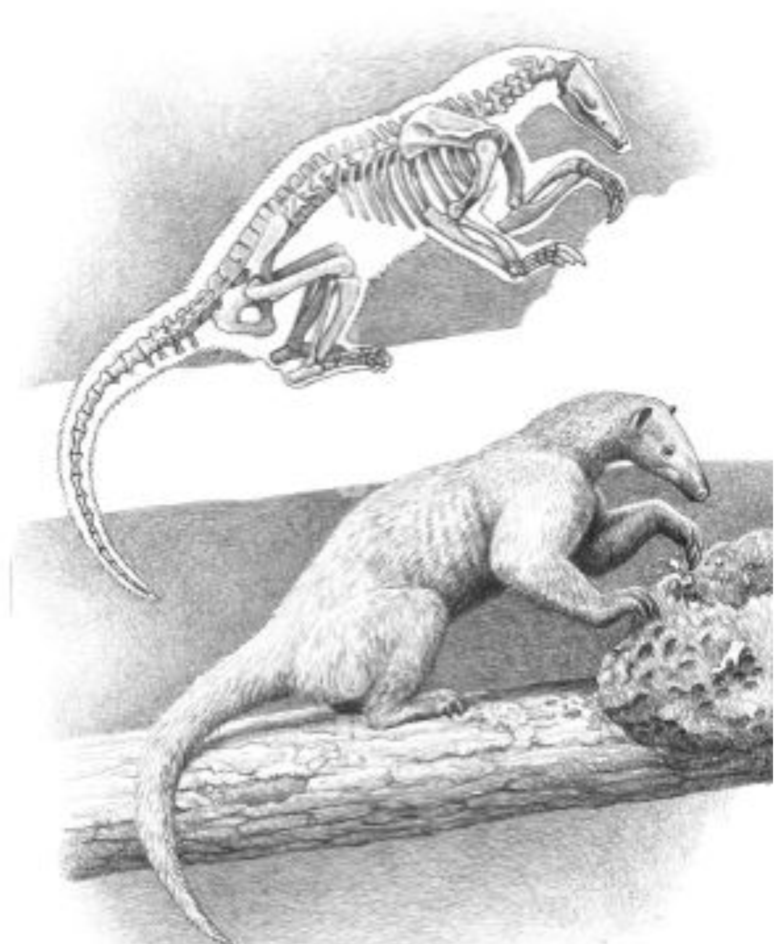
Vermilingua

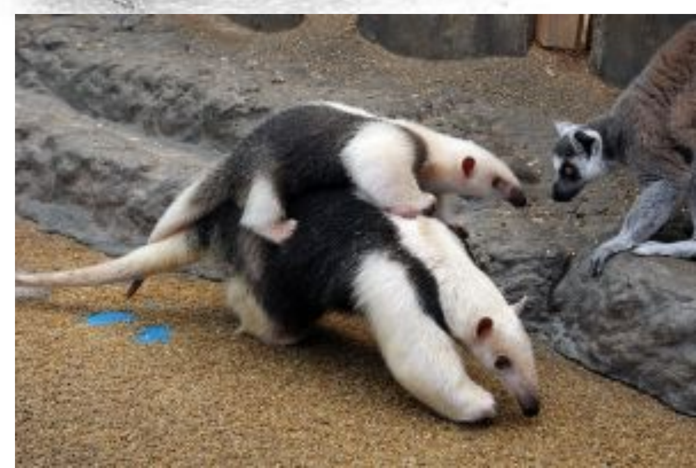
Fig. 3 Hypothetical life reconstruction of oldest Tinguirirican sloth *Pseudoglyptodon chilensis*

Pilosa

Fig. 305: The ant-eater *Eurotamandua joresi* belongs among the mammalian rarities at Messel. Head and body length, 50.5 cm; length of tail, 35.5 cm.

from Schaal and Ziegler, 1992

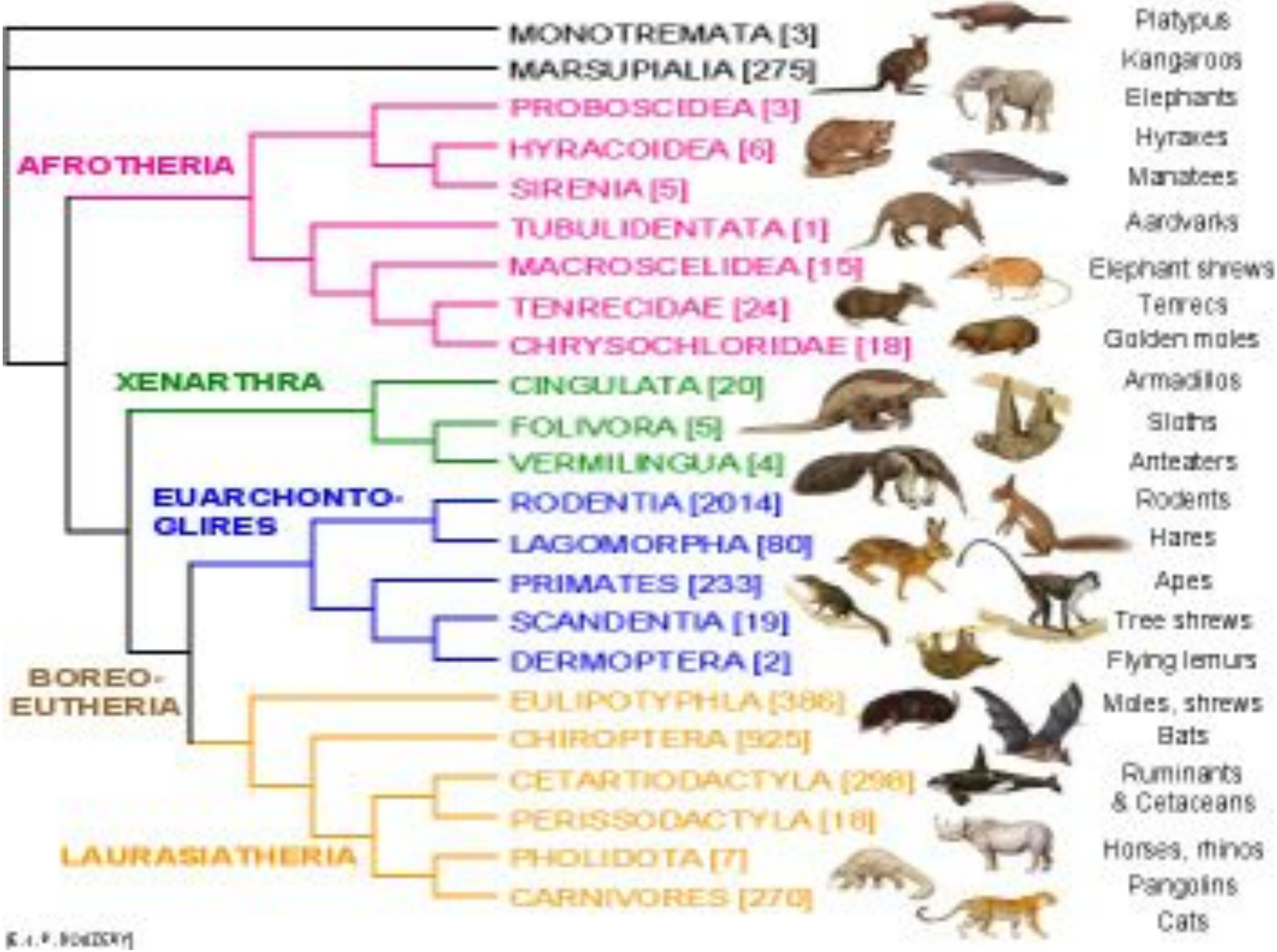




Misterio Biogeográfico: ¿Qué hace un Tamandua en el mioceno de europa?

America. All are characterized by the reduction or complete loss of the dentition. If teeth are retained, they lack enamel. Most edentates have highly developed claws, especially on the forelimbs, which in many genera are used for digging. In most modern edentates, this combination

Laurasiatheria: Pholidota

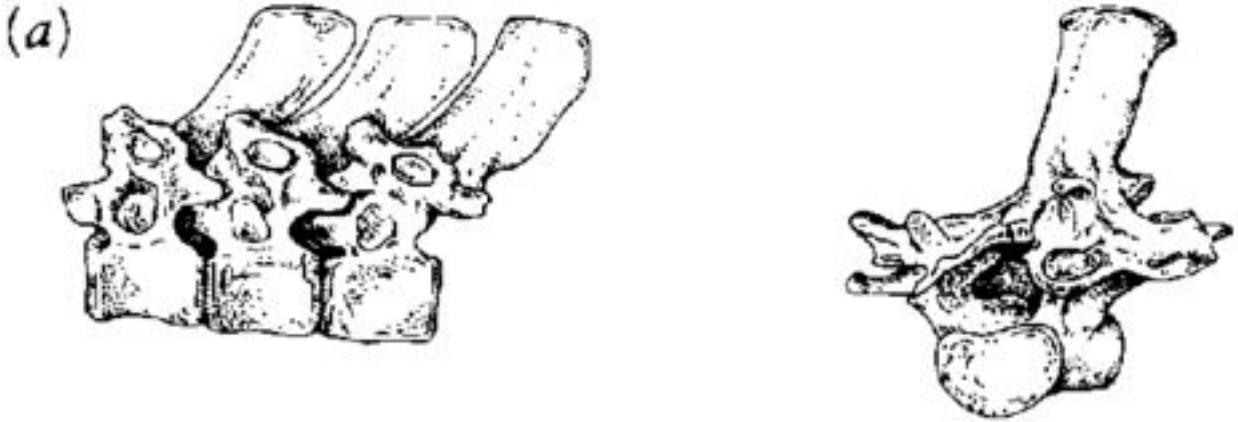


MONOTREMATA [3]
MARSUPIALIA [275]
AFROTHERIA
PROBOSCIDEA [3]
HYRACOIDEA [6]
SIRENIA [5]
TUBULIDENTATA [1]
MACROSCELIDEA [15]
TENRECIDAE [24]
CHRYSOCHLORIDAE [18]
XENARTHRA
CINGULATA [20]
FOLIVORA [5]
VERMILINGUA [4]
EUARCHONTO-
GLIRES
RODENTIA [2014]
LAGOMORPHA [80]
PRIMATES [233]
SCANDENTIA [19]
DERMOPTERA [2]
BOREO-
EUTHERIA
EULIPOTYPHLA [386]
CHIROPTERA [925]
CETARTIODACTYLA [298]
PERISSODACTYLA [18]
LAURASIATHERIA
PHOLIDOTA [7]
CARNIVORES [270]
Platypus
Kangaroos
Elephants
Hyraxes
Manatees
Aardvarks
Elephant shrews
Tenrecs
Golden moles
Armadillos
Sloths
Anteaters
Rodents
Hares
Apes
Tree shrews
Flying lemurs
Moles, shrews
Bats
Ruminants
& Cetaceans
Horses, rhinos
Pangolins
Cats





Vicki Tyley 2009




Pascual, 1968). The term xenarthra refers to the "strange" or accessory articulations between the vertebrae (Figure 21-85*a*). Their elaboration may be associated with the initial specialization of the postcranial skeleton for digging and may have enabled divergent groups such as the armadillos and glyptodonts to support a heavy carapace and the ground sloths to support their massive body in a near vertical posture. All members have an accessory area of attachment for the pelvic girdle between the ischium and the transverse processes of the caudal vertebrae (Figure 21-85*b*). In most genera, the scapula bears a second spine that is parallel but posterior to the first. In the sloths, the acromion extends anteriorly to fuse with the coracoid area.

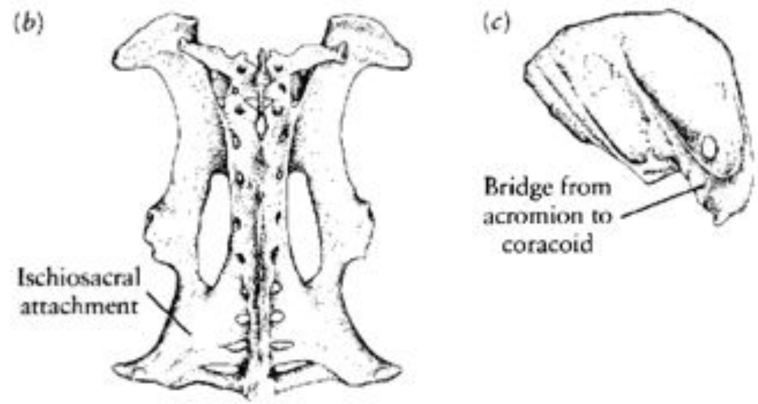



**Figure 21-85.** (*a*) Vertebrae of the South American anteater *Myrmecophaga* showing extra articulating surfaces. *From Gregory, 1951 and 1957.* (*b*) Pelvic girdle of an armadillo showing accessory articulation between the ischia and the caudal vertebrae. (*c*) Scapula of the ground sloth *Nothrotherium. From Stock, 1925. With permission of Carnegie Institution of Washington.*


ナノドン
don antelios

PALAENODONTA

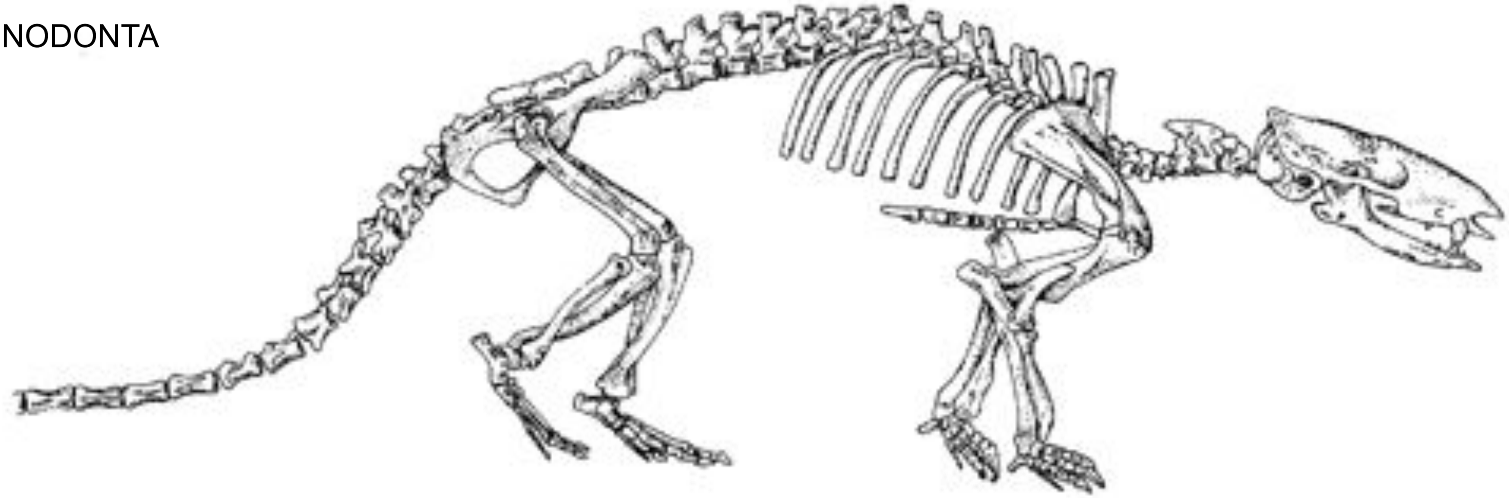


**Figure 21-92.** SKELETON OF THE EOCENE PALAEANODONT *METACHEIROMYS*. The original was 2 meters long. *From Simpson, 1931.*

early Tertiary North American Palaeanodonta. The best-known member of this group is the Eocene genus *Metacheiromys* (Figure 21-92). It resembles the xenarthrans in the loss of enamel and the reduction of the number of cheek teeth. The limbs are primitive but characterized by tuberosities which suggests that they were used in digging. Simpson pointed out a number of features that he believed showed incipient development toward the xenarthrous condition, including extra areas of vertebral articulation, a thickening of the posterior margin of the scapular spine, and the structure of the pelvis. None of these reach the stage of development of the earliest-known South American xenarthran, and Emry (1970) contended that they do not indicate close relationships.

In any case, *Metacheiromys* is too late and too specialized in the loss of all but two of the cheek teeth to be considered directly ancestral. The most primitive member of the Metacheiromyidae is *Propalaeanodon* from the Upper Paleocene (Rose, 1979) (Figure 21-93*a*). It consists of a lower jaw with seven teeth and a possibly associated humerus that suggests a digging habit. The enamel is already all but lost and the crowns of the teeth have no cusps, in common with the early South American armadillos. The ramus of the jaw is also relatively slender.

Palaeanodonts were a moderately successful radiation of small, robust, fossorial mammals known mainly from early Paleocene (Torrejonian) through latest Eocene (Chadronian) rocks of the Rocky Mountain region. In recent years, a few specimens have been found in lower Eocene sediments of China and lower Oligocene beds of Europe (Heissig, 1982; Tong and Wang, 1997; Storch and Rummel, 1999). Most representatives show dental reduction and modifications of the jaws and palate believed to be associated with myrmecophagy, or at least a diet of small invertebrates.

# PALAEONODONTIA

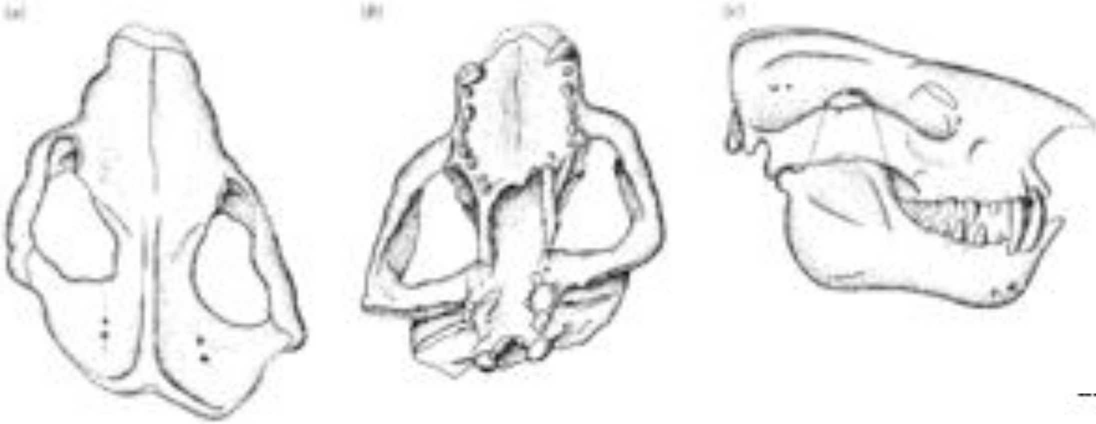


Figure 21-95. SKULL OF ERNANODON FROM THE LATE PALEOCENE OF CHINA. (a) Dorsal, (b) palatal, and (c) lateral views, ×3. From Radinsky and Ting, 1984.

The Epoicotheriidae is a second family of palaeanodonts that also appears in the Upper Paleocene. The Eocene and Oligocene members are highly specialized as subterranean burrowers, showing a degree of specialization of the skull, vertebrae, and limbs that is comparable to that of the African golden mole and some burrowing rodents (Figure 21-94) (Rose and Emry, 1983). The den-

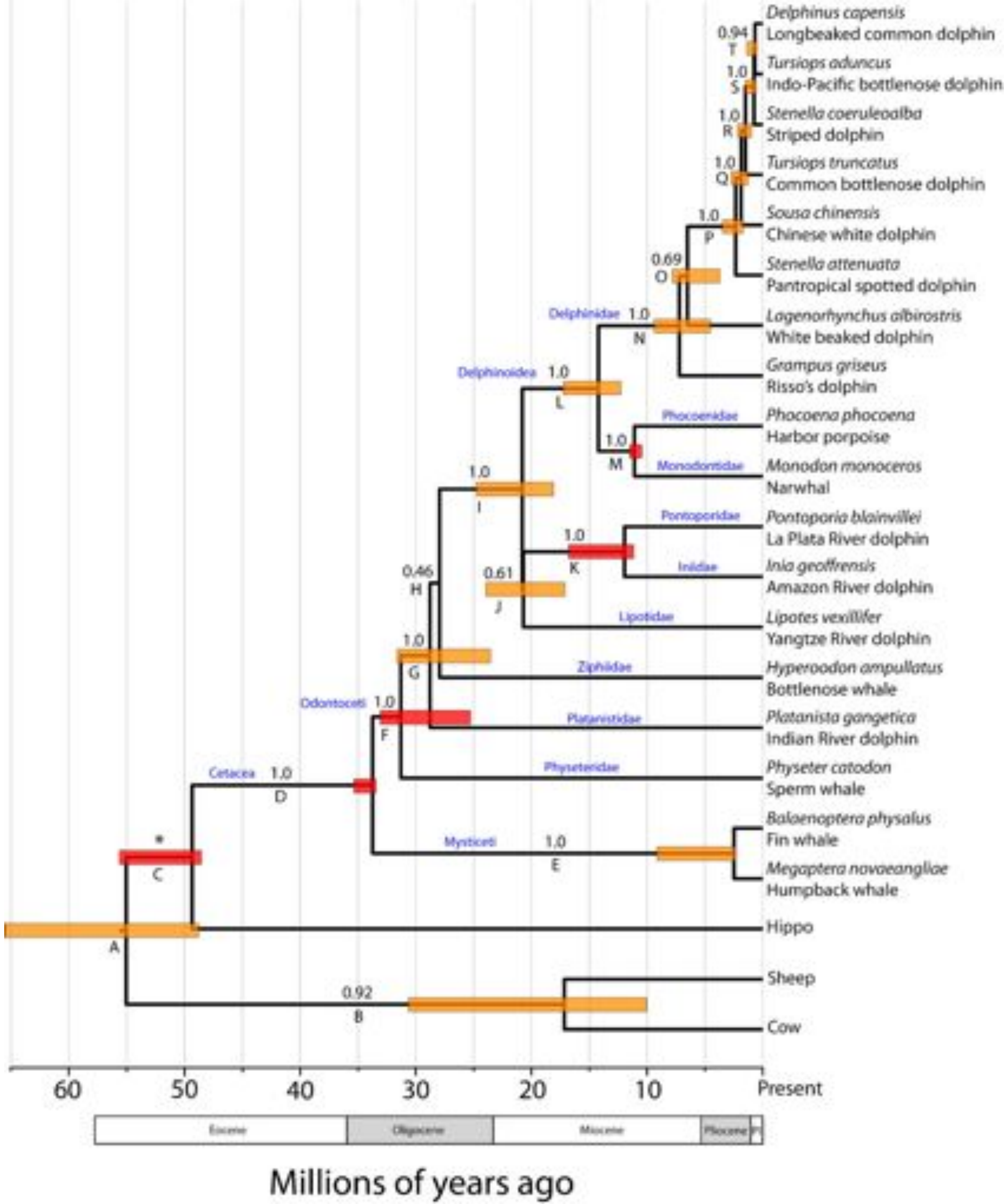
large canine. It seems possible that the otherwise isolated Upper Paleocene genus from China *Ernanodon* (Radinsky and Ting, 1984) may be related to the epoicotheres (Figure 21-95). The skull superficially resembles that of some sloths in the presence of both upper and lower caniniform teeth, but the lower tooth bites in front of the canine in both *Ernanodon* and the epoicothere, as in most mammals, whereas it bites behind the upper tooth in the sloth.


Pontoporia (de la plata)

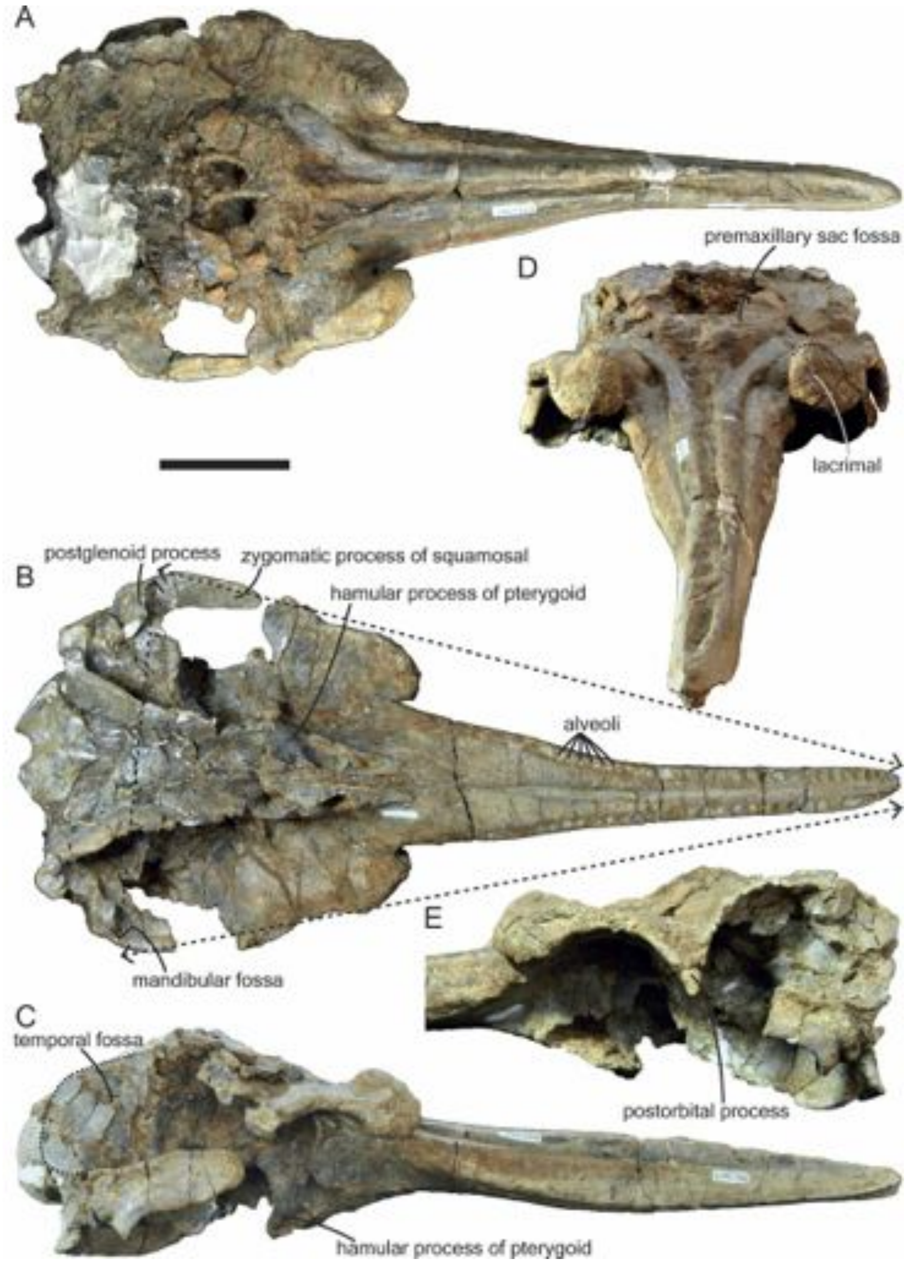

Platanista (Ganges)


Lipotes (Yangtze)


Inia (amazonas)



Delphinus capensis
Longbeaked common dolphin
Tursiops aduncus
Indo-Pacific bottlenose dolphin
Stenella coeruleoalba
Striped dolphin
Tursiops truncatus
Common bottlenose dolphin
Sousa chinensis
Chinese white dolphin
Stenella attenuata
Pantropical spotted dolphin
Lagenorhynchus albirostris
White beaked dolphin
Grampus griseus
Risso's dolphin
Phocoena phocoena
Harbor porpoise
Monodon monoceros
Narwhal
Pontoporia blainvillei
La Plata River dolphin
Inia geoffrensis
Amazon River dolphin
Lipotes vexillifer
Yangtze River dolphin
Hyperoodon ampullatus
Bottlenose whale
Platanista gangetica
Indian River dolphin
Physeter catodon
Sperm whale
Balaenoptera physalus
Fin whale
Megaptera novaeangliae
Humpback whale
Hippo
Sheep
Cow
0.94 T
1.0 S
1.0 R
1.0 Q
1.0 P
0.69 O
Delphinidae 1.0 N
Delphinoidea 1.0 L
Phocoenidae
1.0 M
Monodontidae
1.0 I
Pontoporiidae
1.0 K
Iniidae
0.46 H
0.61 J
Lipotidae
1.0 G
Ziphiidae
Odontoceti 1.0 F
Platanistidae
Physeteridae
Cetacea 1.0 D
*
C
Mysticeti 1.0 E
A
0.92 B
60
50
40
30
20
10
Present
Eocene
Oligocene
Miocene
Pliocene
Millions of years ago




Los Iniidae más antiguos están representados por una gran diversidad de géneros en ambientes *marinos* de la costa *pacífico* (Perú y Chile)

**#3: Connectivity of aquatic fauna 5-12 mya, including the “paranaense interior sea”**

Fosssil of currently “amazonian” and “atlantic” groups are found in marine environments in Chile

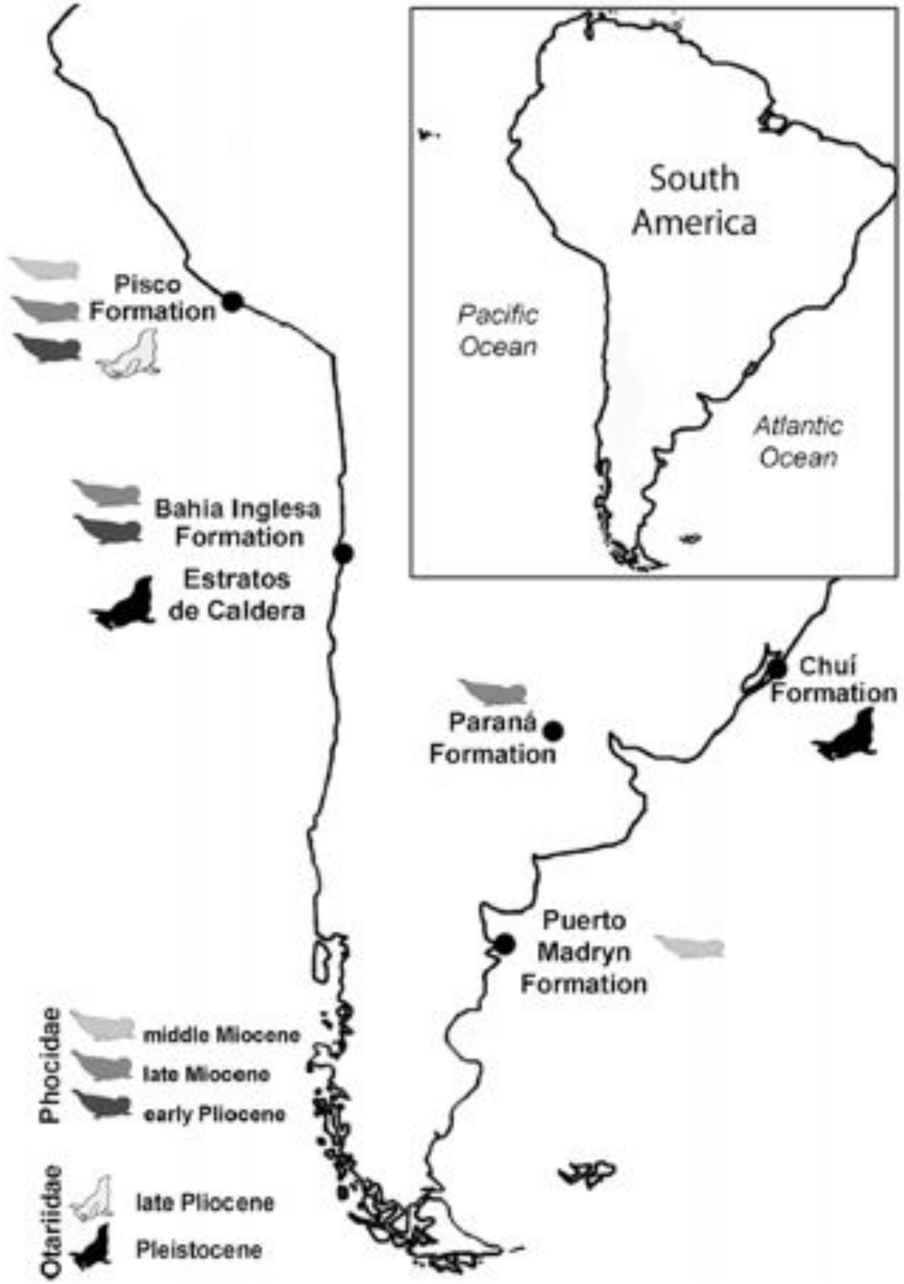



FIGURE 5. Map showing the occurrences of fossil pinnipeds in South America.

**ANTHROPOIDEA: Platyrrhini y Catarrhini**

The earliest remains that have been assigned to the Anthropoidea are teeth and jaw fragments from the late Eocene of Burma, which are assigned to the genera *Amphipithecus* and *Pondaungia* (Ba Maw, Ciochon, and Savage, 1979) (Figure 20-38). Unfortunately, they are too incomplete to establish their specific affinities or to characterize the primitive nature of this group. Unquestioned members of the catarrhine radiation are common in North Africa at the beginning of the Oligocene, and a single genus marks the first appearance of the Platyrrhini in South America in the middle to late Oligocene. The early anthropoids are clearly distinguished from all prosimians by a relatively larger and more convoluted brain with reduced olfactory lobes. The rostrum is shortened and the amount of olfactory epithelium is reduced. The orbits are more forwardly directed and are separated from the temporal fossa by a postorbital septum. The mandibular rami and frontal bones are typically fused at the midline.

## PLATYRRHINI

The Platyrrhini are restricted to South and Central America throughout their history. The earliest known fossil is *Branisella*, a member of the modern family Cebidae from the middle to late Oligocene of Bolivia. This genus and all South American monkeys retain a dental formula of

$$\frac{2 \quad 1 \quad 3 \quad 3}{2 \quad 1 \quad 3 \quad 3}$$

whereas most adequately known Catarrhini have lost one of the premolars. The Ceboidea can also be distinguished by the derived character of a greatly inflated auditory bulla and the flattened face and widespread nostrils that give the group its name. Sixteen living genera and eight that are known only as fossil represent this group during the Cenozoic (Rose and Fleagle, 1981).

Hoffstetter (1980) suggested that the Platyrrhini may be most closely related to the family Parapithecidae, among the Old World Anthropoidea. This family is represented by the genera *Parapithecus* and *Apidium* from the Oligocene of Egypt, which are primitive in retaining three premolars. They may represent remnants of the stem group of all anthropoids but are generally considered to be more closely related to the later Catarrhini.

Nariz plana, fosas nasales lateralmente orientadas

Dado que el orden de los Primates no apareció hasta el final del periodo Cretácico (unos 60 millones de años atrás) en América del Norte, cuando Sudamérica llevaba ya aislada del resto de continentes cerca de 40 millones de años (y lo seguiría estando casi 57 millones más), el origen último de este grupo de primates ha sido muy debatido en el pasado. El primer mono del Nuevo Mundo conocido es *Branisella boliviana*, del Oligoceno de Bolivia, de características primitivas pero claramente platirrino. Las dos posibles vías propuestas para la llegada de los antepasados de *Branisella* a América del Sur es por un lado, el cruce de formas primitivas desde Norteamérica a través del Caribe, o bien desde África, a través de un menos extenso Océano Atlántico. En ambos casos se tuvo que cruzar por fuerza una extensión de mar respetable, lo cual debió hacerse navegando sobre balsas naturales de ramas y árboles caídos accidentalmente durante las tormentas tropicales. Dado que en Norteamérica sólo hubo formas primitivas como adapiformes y plesiadapiformes, similares a los actuales lémures, que se extinguieron a finales del Oligoceno, la teoría con más fuerza es la de un poblamiento de origen africano que se produjo a finales del Eoceno o comienzos del Oligoceno, más o menos en la misma época en que los ancestros de los roedores sudamericanos (chinchillas, maras, capibaras, cuyes, etc.) llegaron también desde África, quizás incluso en un mismo proceso migratorio único.

Chilecebus carrascoensis (20 m.a.)

Platyrrhini más antiguos 26 m.a.

## Rodentia
## Hystricomorpha

- Mandíbula histricognatha
- Proceso coronoide más reducido que en los sciurognathos
- Cerca de la base del último molar poseen una prominencia proyectando hacia posterior


Naked mole rat (Phiomorpha)


Gundi (Ctenodactylomorfo)


Porcupine (Hystricidae)

Hystricomorpha
- → Ctenodactylomorphi
- → Hystricognathi
  - → Baluchimynae †
  - → Hystricidae (Old world porcupines)
  - → Phiomorpha
  - → Caviomorpha

**Hystricomorpha**

Hystricognathi

Caviomorpha

Capybara
(*Hydrochoerus hidrochaeris*)

Pacarana
(*Dinomys branickii*)

Chinchilla
(*Chinchilla lanigera*)

Guinea Pig
(*Cavia porcellus*)

Agutí brasileño
(*Dasyprocta leporina*)

Degu
(*Octodon degus*)

# 2011

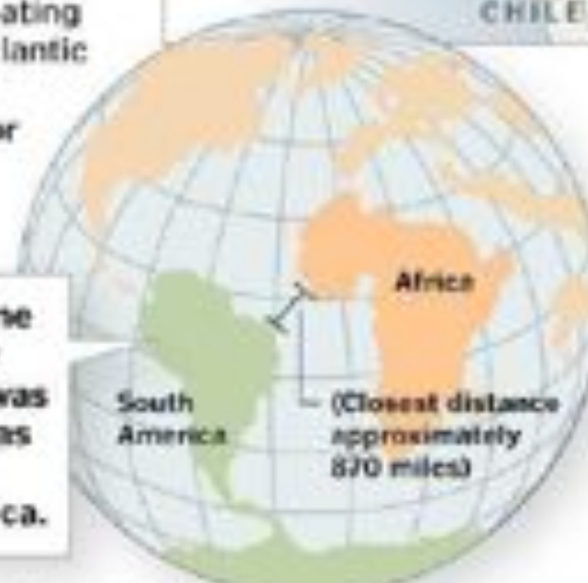
Fragmento de mandíbula del *Canaanimys maquiensis*, un diminuto roedor encontrado en la Amazonía peruana datado en **41 millones de años.**

Foto: Laurent Marivaux

## Early rodent fossil found in Peru

A team of researchers including Darin Croft of CWRU has discovered the fossil remains (teeth) of the first rodents in South America, which lived 41 million years ago in a region called Contamana. At the time, South America was an island continent, not connected to North America by a land bridge as it would be later. These earliest rodents likely arrived from Africa, floating across the southern Atlantic Ocean on a naturally occuring raft of trees or other vegetation.

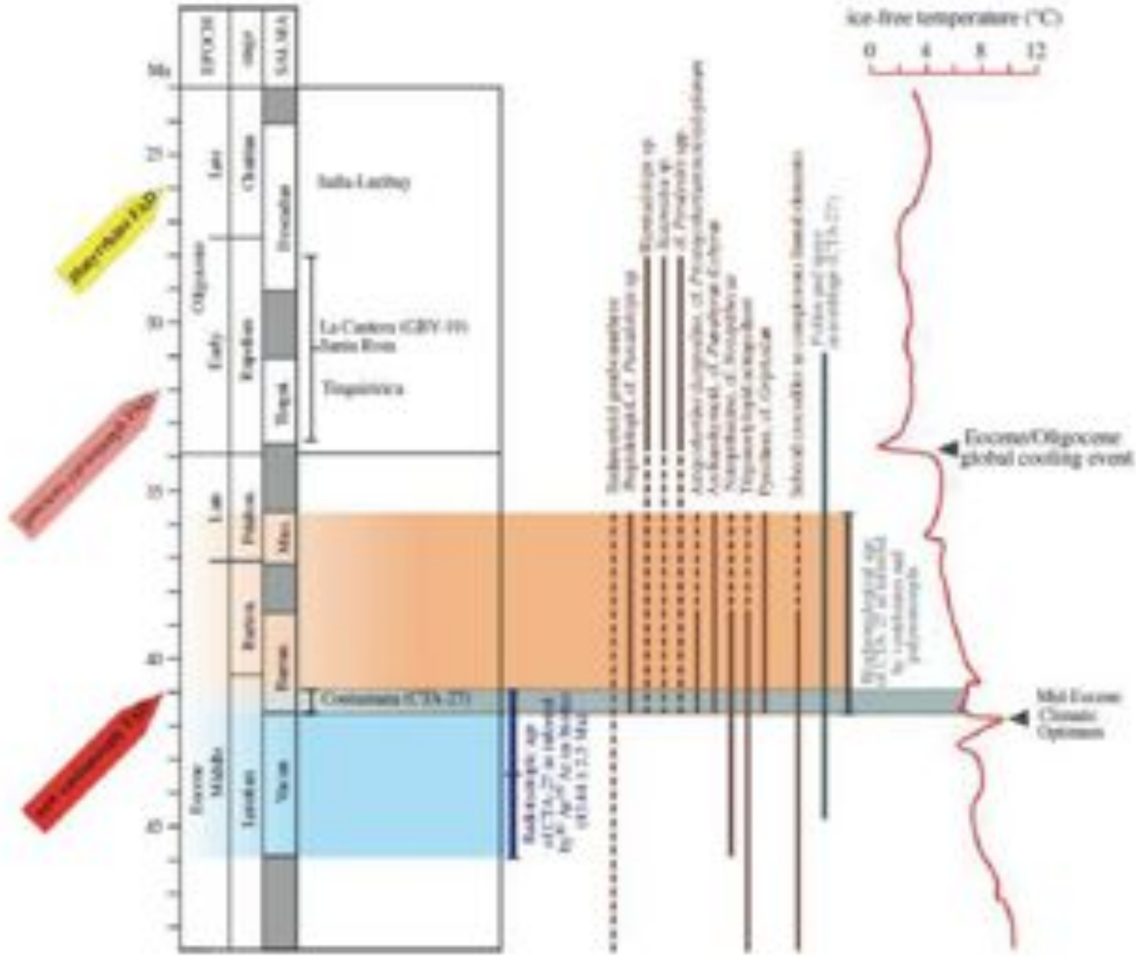

**During the Eocene Era, present-day South America was an island that was much closer to what is now Africa.**




SOURCES: Case Western Reserve University; ESRI

JOHN MANGELS AND KEN MARSHALL | THE PLAIN DEALER

# IMPLICANCIAS BIOGEOGRÁFICAS




Primates y roedores caviomorfos no habrían llegado en el mismo evento de radiación!!

## UNGULADOS

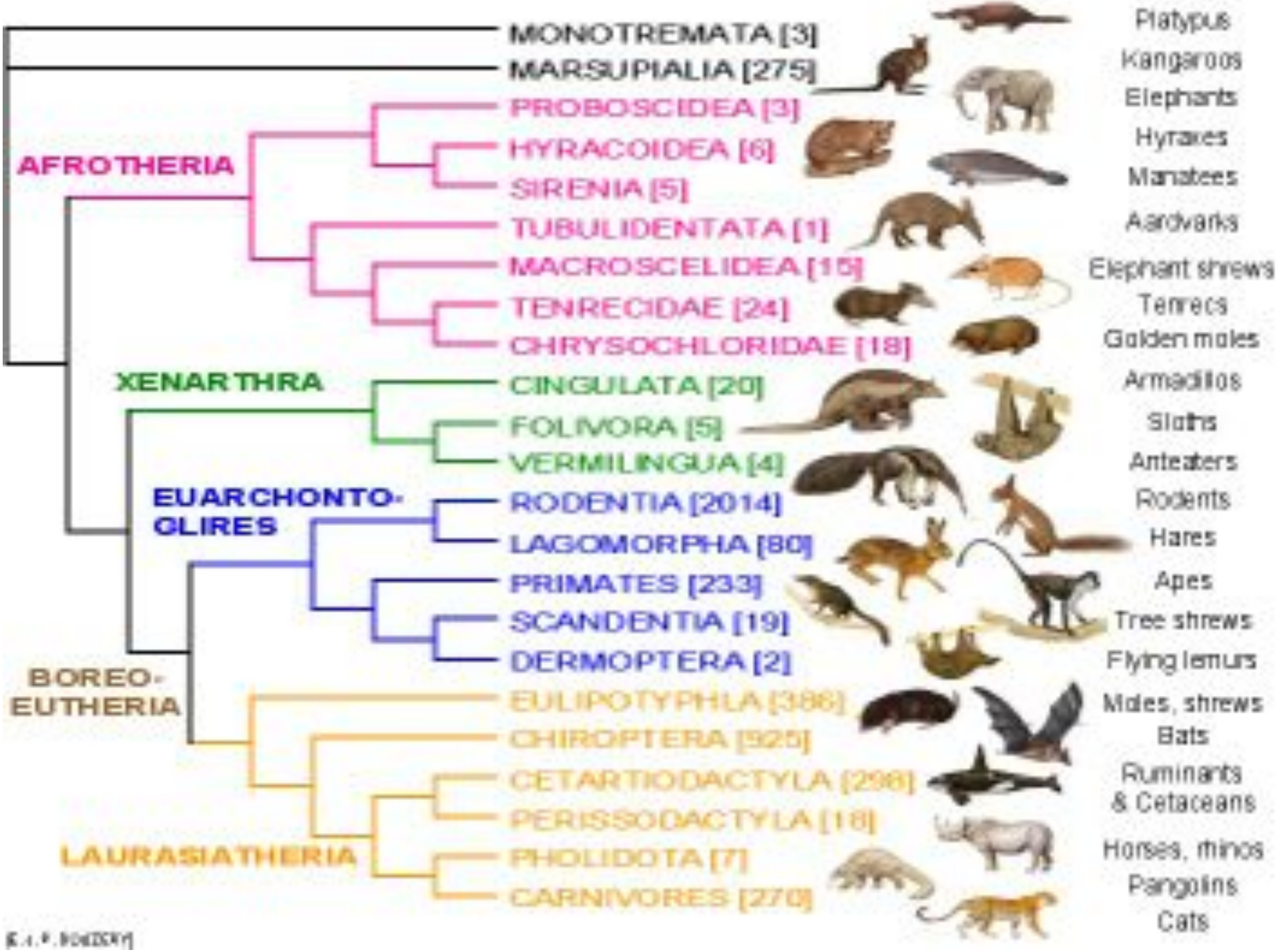












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Platypus
Kangaroos
Elephants
Hyraxes
Manatees
Aardvarks
Elephant shrews
Tenrecs
Golden moles
Armadillos
Sloths
Anteaters
Rodents
Hares
Apes
Tree shrews
Flying lemurs
Moles, shrews
Bats
Ruminants
& Cetaceans
Horses, rhinos
Pangolins
Cats

**AFROTHERIA:**

**Clado molecular con significado biogeográfico**

Africa was never as completely isolated as Australia or South America, but in the early Tertiary there was certainly much more continuous movement of mammals between North America and Eurasia than between either of these continents and Africa (Maglio, 1978).

A limited number of lineages appear to have entered Africa in the early Tertiary; these included prosimian primates, creodont carnivores, and possibly several lineages of early condylarths. Orders typical of the northern continents such as artiodactyls, perissodactyls, insectivores, and the Carnivora were almost certainly later immigrants that were highly differentiated before they entered Africa.

Other groups appear to have differentiated in Africa. The elephants and their close relatives within the order Proboscidea are the best known and are most specifically associated with Africa. The hyraxes or conies differentiated there, as did the short-lived, rhinoceroslike embrithopods. Although early fossils are not known, the aardvarks have been confined to Africa for most of their history. Fossils of early sirenians are common in northern Africa, which suggests that their origin may be associated with the margins of that continent.

Tenrecoidea

Hyracoidea

Sirenia

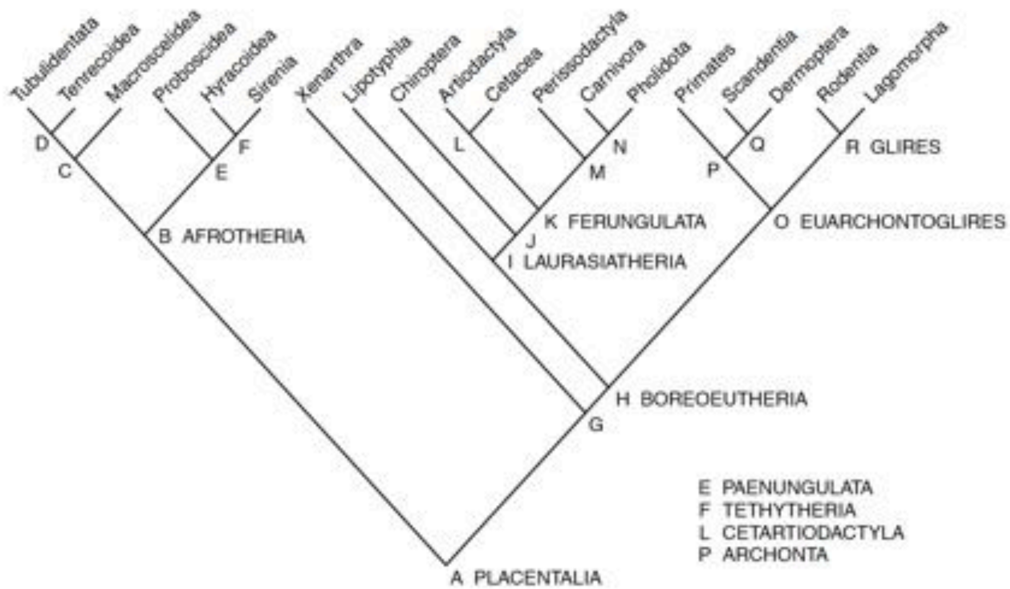
Tubulidentata

Macroscelidia

Proboscidea

**LAURASIATHERIA**
**Clado molecular con significado biogeográfico**

Muchos grupos fuertemente respaldados por la biología molecular han generado una especie de "alivio" en la filogenia de los mamíferos, donde las afinidades de los principales grupos han sido tradicionalmente controvertidas.Sin embargo, tampoco ha sido posible identificar synapomorfías claras para nuevos clados como Boreoeutheria, Euarchontoglires, Laurasiatheria, Feurugulata, Afrotheria, Atlantogenata., Por lo tanto, no es de extrañar que sea difícil ubicar muchas formas fósiles de placentarios basales en algunos de estos grupos.

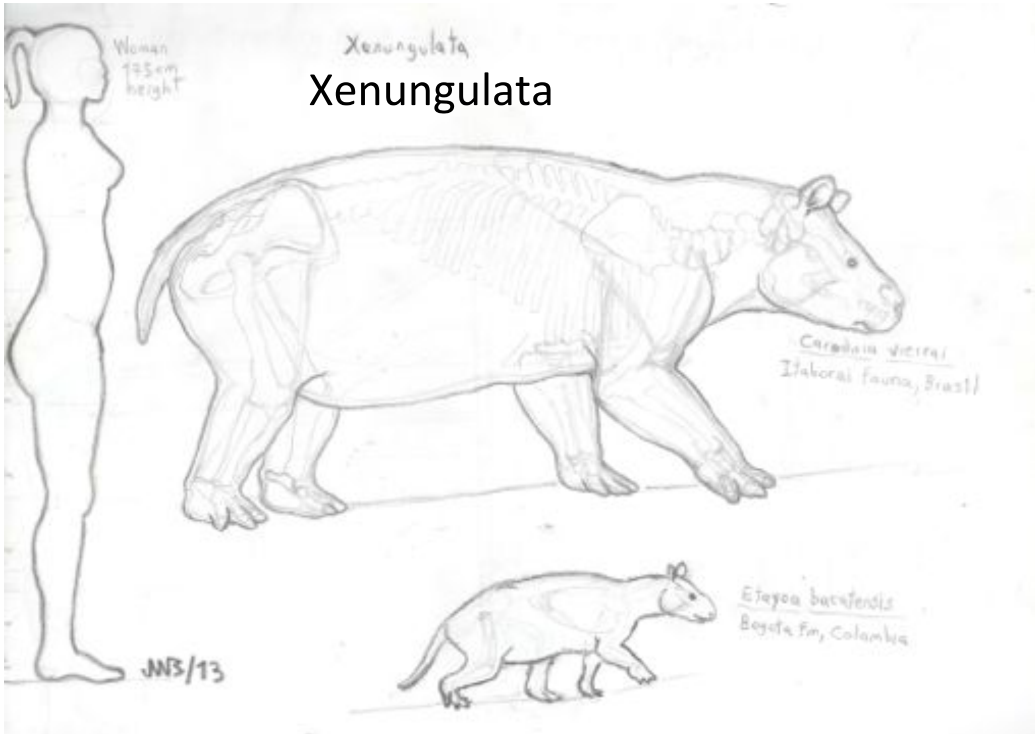



Cladograms showing the postulated relationships of the placental mammals. The outlines of the tree are founded on recent molecular analyses, and morphological synapomorphies are taken from Novacek *et al.* (1988) and other sources. Synapomorphies for all nodes have yet to be discovered: **A PLACENTALIA**, chorioallantoic placenta, prolonged gestation in uterus, median vagina, epipubic bones and pouch absent, shell membrane absent, narrow stylar shelves on upper molars, optic foramen widely separated from sphenorbital fissure; **B AFROTHERIA**, no synapomorphies identified (except perhaps the 'trunk'); **C**, no synapomorphies identified; **D**, no synapomorphies identified; **E**, **PAENUNGULATA**, amastoidy (mastoid process concealed by expansion and overlap of squamosal), jugal extends posteriorly as a prominent ventral crest to anterolateral border of the glenoid fossa, carpals dorsoventrally compressed and serially arranged; **F TETHYTHERIA**, bilophodont cheek teeth with tendency to form additional lobe on posterior part of cingulum, forward displacement of orbits, infraorbital canal very short, zygomatic process of squamosal robust and extends dorsally and laterally, premaxilla with strong posterior process extending around reduced nasals and nearly contacting frontals; **G**, no synapomorphies identified; **H BOREOEUTHERIA**, no synapomorphies identified; **I LAURASIATHERIA**, no synapomorphies identified; **J**, no synapomorphies identified; **K FERUNGULATA**, no synapomorphies identified; **L CETARTIODACTYLA**, trochlea (groove) on navicular bone in ankle, narrow calcaneum and elongate heel process; **M**, no synapomorphies identified; **N**, no synapomorphies identified; **O EUARCHONTOGLIRES**, no synapomorphies identified; **P ARCHONTA**, sustentacular facet of astragalus in distinct medial contact with distal astragalar facets, pendulous penis suspended by reduced sheath between genital pouch and abdomen; **Q**, no synapomorphies identified; **R GLIRES**, posterior process of premaxilla long and contacts frontal, maxilla does not contact frontal, premaxilla and maxilla equally exposed in palate, glenoid fossa (jaw joint) set well dorsally of basicranium, upper and lower first incisor teeth absent, ever-growing incisors.

Por ejemplo, los mamíferos Cimolesta, vistos en la lectura anterior, podrían ser un grupo externo a los placentarios corona, o podrían ser Boreoeutherios o Laurasiatherios basales.

**Ungulados sudamericanos (Completamente extinguidos!)**

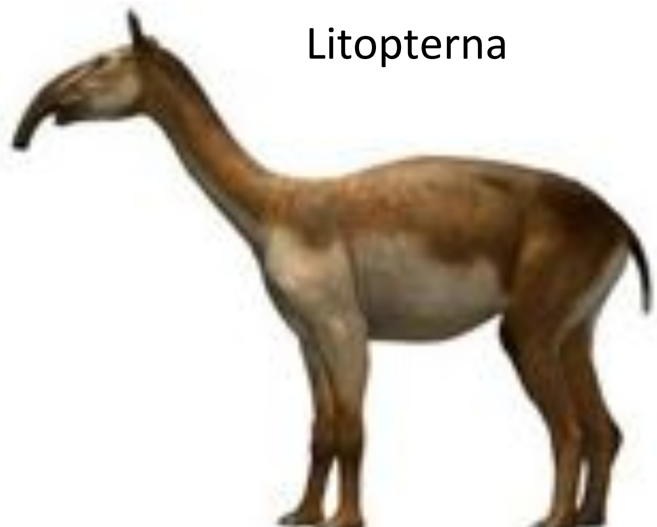
Xenungulata




Notoungulata

Astrapotheria

Litopterna



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Original Investigation

# Afrotherian affinities for endemic South American "ungulates"

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## ABSTRACT

The phylogenetic relationships of endemic South American ungulates are a highly debated topic. Among them, the most well-known clades are the Notoungulata and the Astrapotheria. Three unambiguous hard-tissue features characteristic of afrotherian mammals potentially indicate a relationship with the two South American clades: delayed cheek-tooth replacement, more than 19 thoracolumbar vertebrae, and the presence of a well defined astragalar cotylar fossa. New data based on many fossil specimens preserving deciduous dentition and a morphometric assessment of those specimens, together with a revision of available postcranial anatomy in relevant fossils are used to examine the distribution of the three characters in placental phylogeny.

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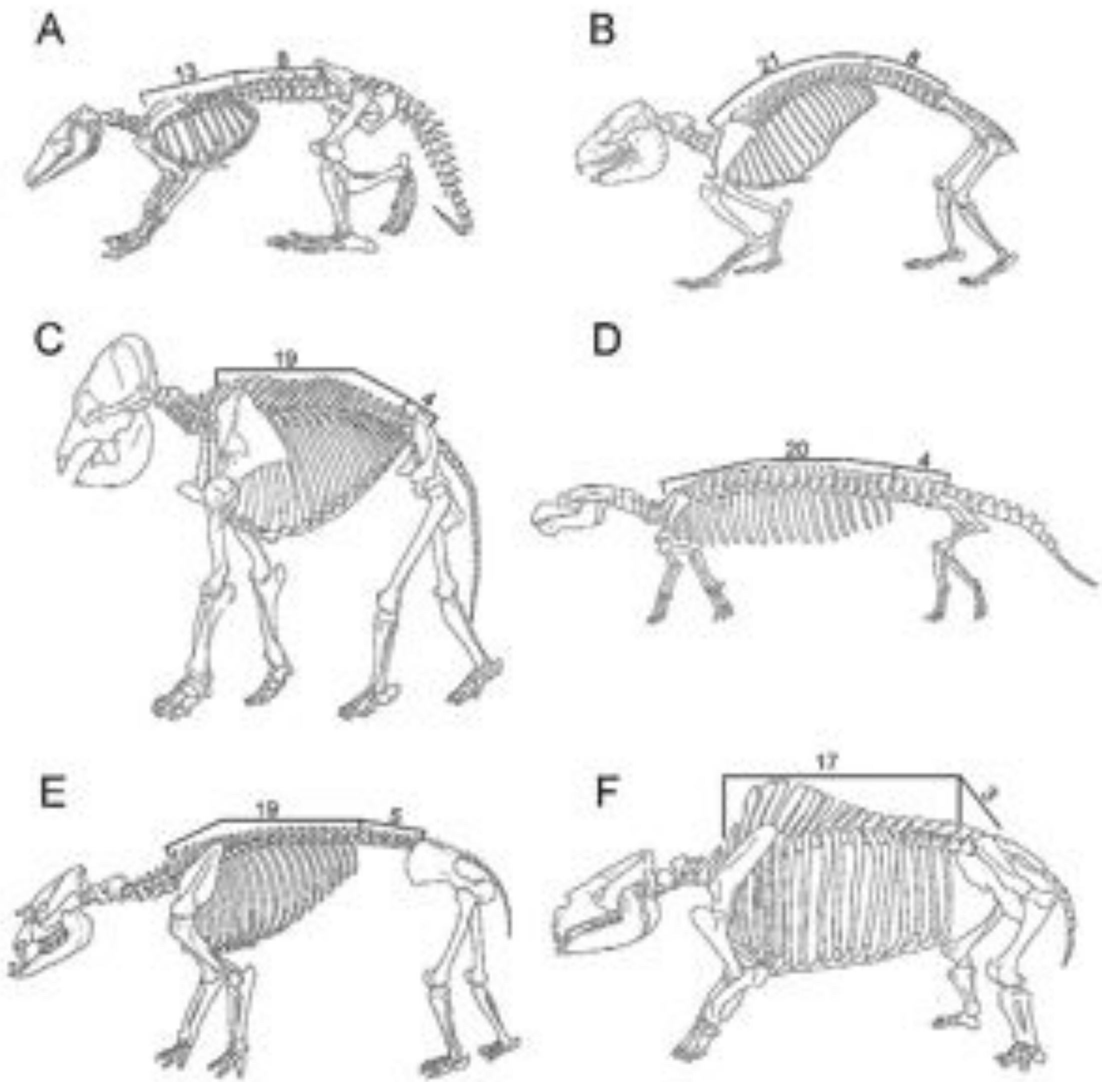



**Fig. 3.** Skeletal reconstructions of selected Afrotherian mammals showing TLV. A, *Orycteropus afer* (Tubulidentata) (MACN-Ma 13.99); B, *Procavia capensis* (Hyracoidea) (MACN-Ma 22.36); C, *Elephas maximus* (Proboscidea) (MACN-Ma 43.49); D, *Pezosiren portelli* (Sirenia) (modified from Domning, 2001); E, *Astrapotherium magnum* (Astrapotheria) (modified from Riggs, 1932); F, *Toxodon platensis* (Notoungulata) (MLP 12.II.26). Not to scale.

Los Microbiotheridae son un orden de marsupiales representado sólo por dos géneros: *Dromiciops*, el monito de monte o Chumaihuén Chileno, y *Microbiotherium*, del Oligoceno superior y Mioceno inferior de Australia. Se caracterizan por tener una gran bulla timpánica.  Es el único Australodelphia que no vive en australia

### Microbiotheriidae

The Microbiotheriidae is known from only two genera, *Dromiciops*, a small, mouselike form in the living fauna, and *Microbiotherium* from the Upper Oligocene and Lower Miocene. The dental formula is primitive

$$\frac{5\ 1\ 3\ 4}{4\ 1\ 3\ 4}$$

but the stylar shelves on the upper molars are small and the posterior molars are reduced. Microbiotheres are distinguished from all other marsupials by the enormous inflation of the auditory bulla. The posterior two-thirds is formed by a new ossification, the entotympanic, and the anterior one-third by the alisphenoid (Figure 19-13).

**The auditory bulla (pl. auditory bullae) is a hollow bony structure on the ventral, posterior portion of the skull of placental mammals that encloses parts of the middle and inner ear. In most species, it is formed by the tympanic part of the temporal bone.**

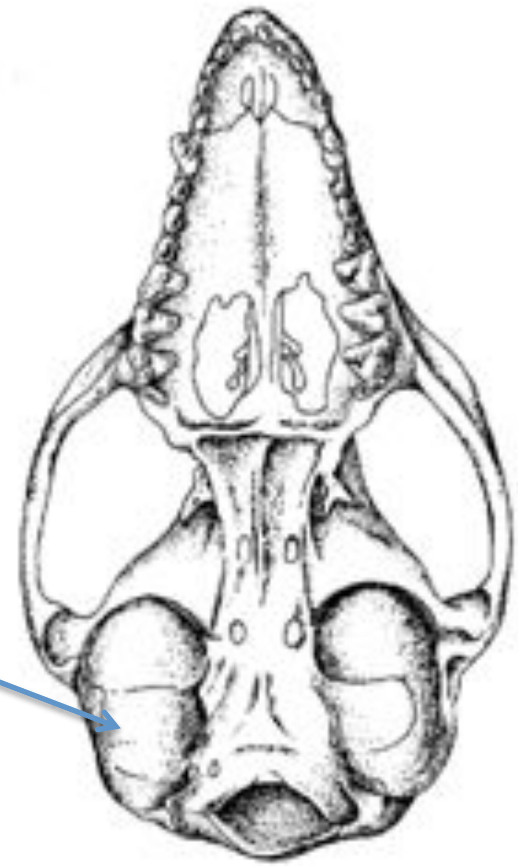
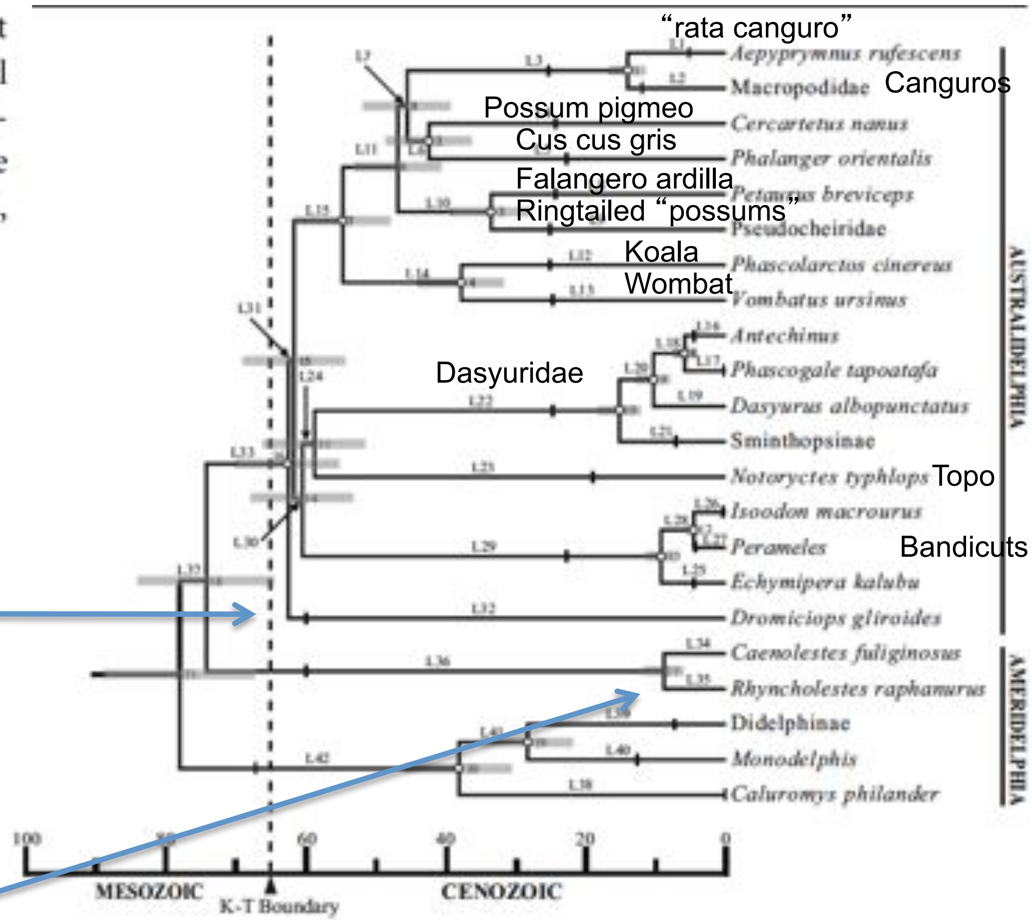


Figure 19-13. PALATAL VIEW OF *DROMICIOPS*. The microbiothere is from the recent fauna of South America. The auditory bulla is greatly expanded. The foot structure resembles that of Australian marsupials. *From Marshall, 1982b.*

Australian marsupials form a clade, the Australidelphia, broadly distinct from the South American marsupial clade. One surprise, however, has been the finding that one South American mammal, the small monito del monte and its extinct relatives (Microbiotheria), appears to associate with the Australian, rather than the South American, clade (Szalay, 1994; Springer *et al.*, 1998).

Nótese: **Ameridelphia es parafilético!**

The earliest and most primitive South American marsupials are closely related to those that are known from the Upper Cretaceous of North America. Clemens (1979)




Comadrejita trompuda (Chile)

**Fig. 2** Timeline in millions of years before present for marsupial evolution based on the *Multidivtime* partitioned analysis (diprotodontian maximum=65 Ma). *Node numbers* refer to those given in Table 5; *grey bars* indicate confidence intervals; *filled rectangles* indicate the oldest known fossil on a given lineage; and fossil constrained nodes are indicated with *open circles*. L = lineage; K–T = Cretaceous–Tertiary Boundary.

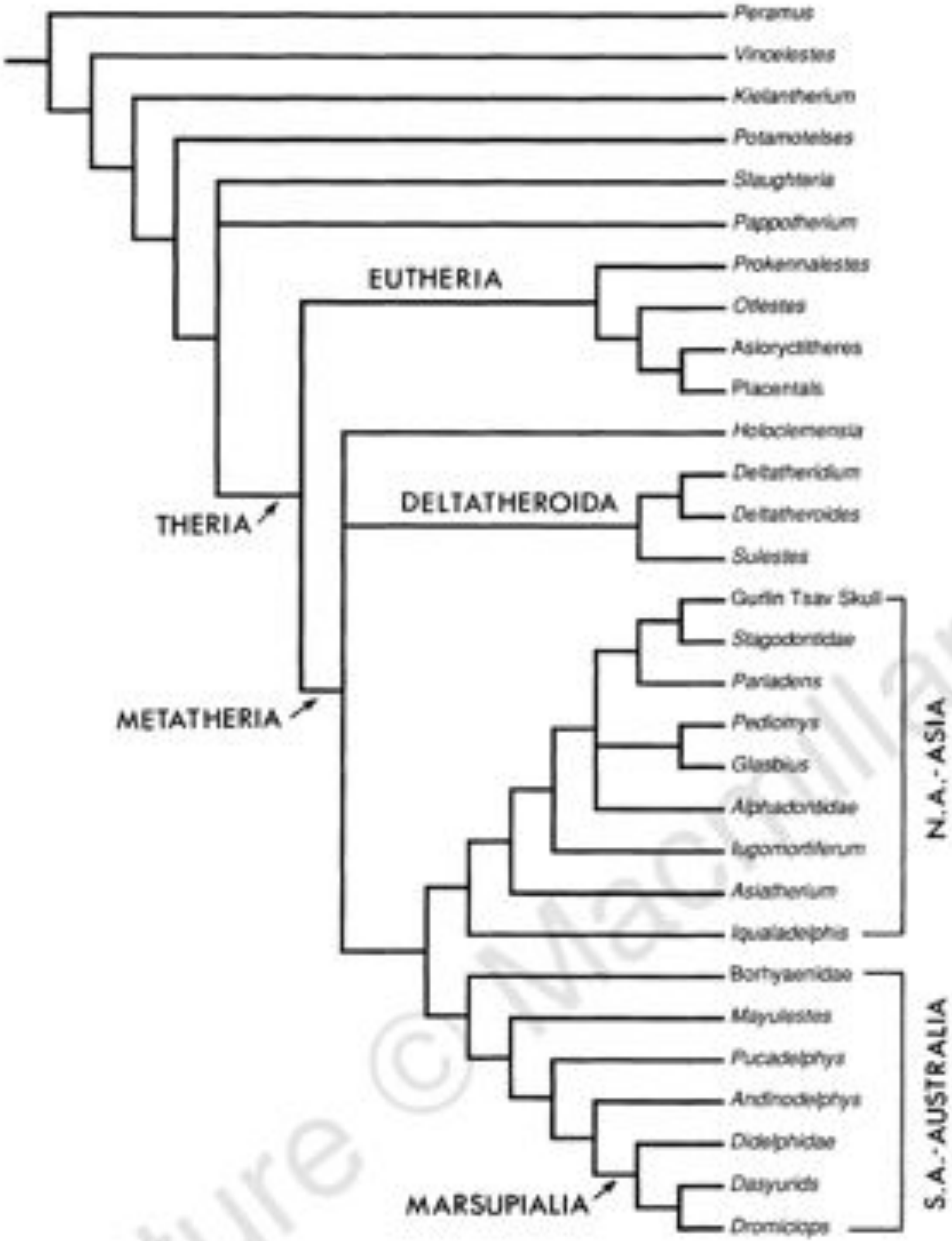



**Figure 5** Simplified cladogram based on the consensus tree of 144 equally most parsimonious trees. Trees were obtained by 150 replications of heuristic searches using PAUP with a database of 156 craniodental characters, representing 365 morphological transformations across 48 taxa. Six of these taxa are represented by only one tooth and were subsequently deleted from the study because of their incompleteness. Tree length of the individual trees is 570; consistency index = 0.444; retention index = 0.663. Within Metatheria, the South American–Australian clade and the North American–Asiatic clade were not very stable, and portions of them collapsed in slightly less parsimonious trees. In many of those slightly longer trees, the 'carnivorous' metatherian lineages, such as borhyaenids, the Gurlin Tsav specimen and stagodontids, formed a paraphyletic series at the base of the post-deltatheroidan metatherians. Diagnostic features of Metatheria are: three premolars; seven postcanine tooth families; single rooted upper canine; procumbent first upper premolar separated by diastema from $P^2$; deep ectoflexus on the penultimate and preceding molars; metacone slightly smaller than paracone; last lower molar rotated during eruption; deciduous canine absent; replacement of deciduous $P^1/P_1$ and deciduous $P^2/P_2$ absent; labial mandibular foramen absent; 'Meckelian' groove absent; 'coronoid' facet absent; palatal process of premaxilla approaches or reaches canine alveolus; sulcus for anterior distributary of transverse sinus posterolateral to subarcuate fossa; foramen for ramus superior of the stapedial artery absent; sulcus for stapedial artery absent; jugular foramen separated from inferior petrosal sinus opening; ascending canal absent. See Supplementary information for the full tree, diagnoses of other nodes, data matrix, character list and other parameters.

Origen de **Metatheria** es Norteamérica-Asia, pero el origen de **Marsupialia** es Sudamericano

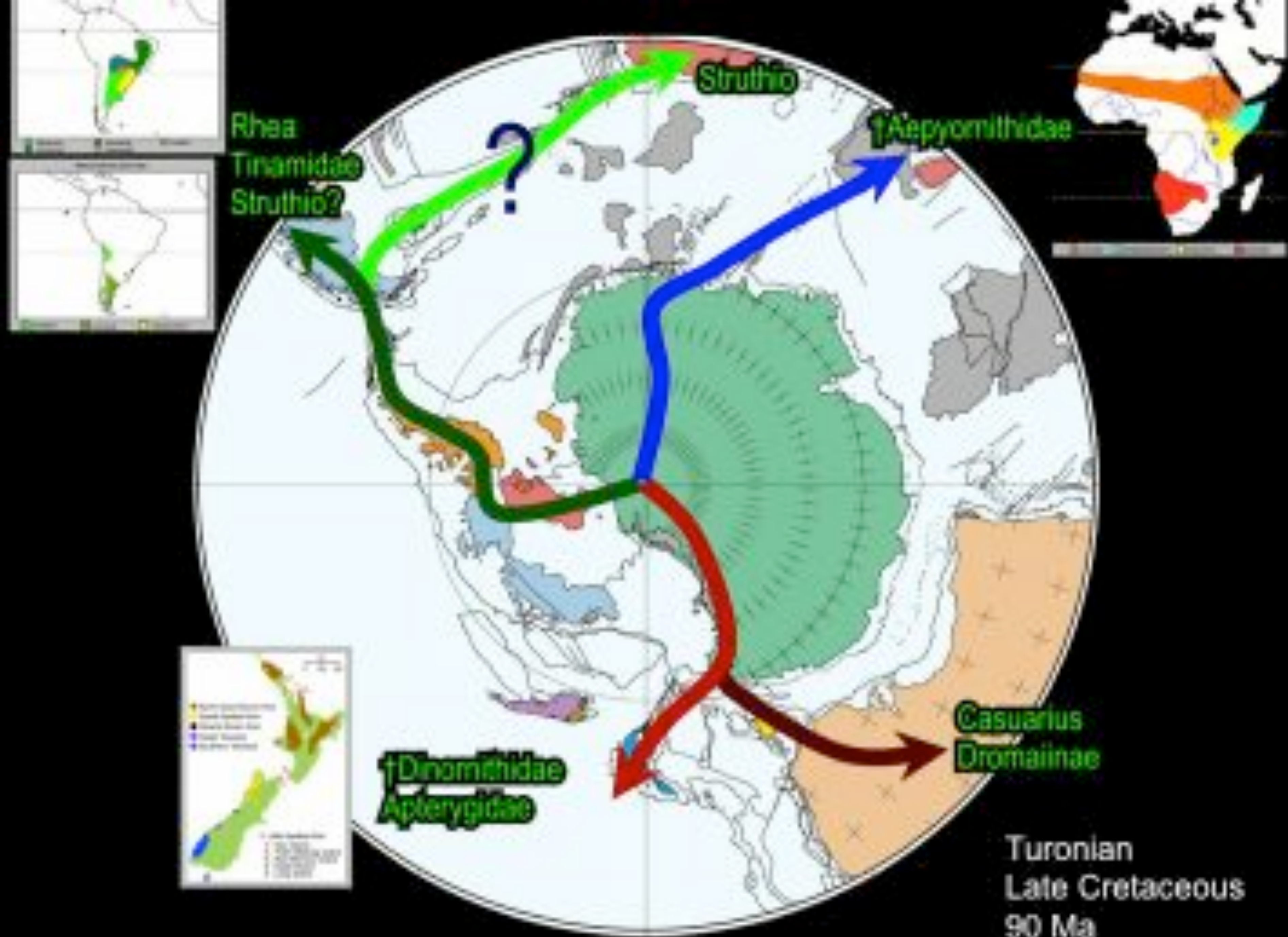
# Deep time mysteries of Chilean Biogeography


Ronquist 2007


**#2: The Weddelian Biogeographic Province**

Current relatedness of Fauna and Flora of Southern South America, New Zealand, and Australia

Similar late Cretaceous-Eocene fossils from Antarctica, Southern South America, New Zealand and Australia


Rhea
Tinamidae
Struthio?
Struthio
?
†Aepyornithidae
†Dinornithidae
Apterygidae
Casuarius
Dromaiinae
Turonian
Late Cretaceous
90 Ma

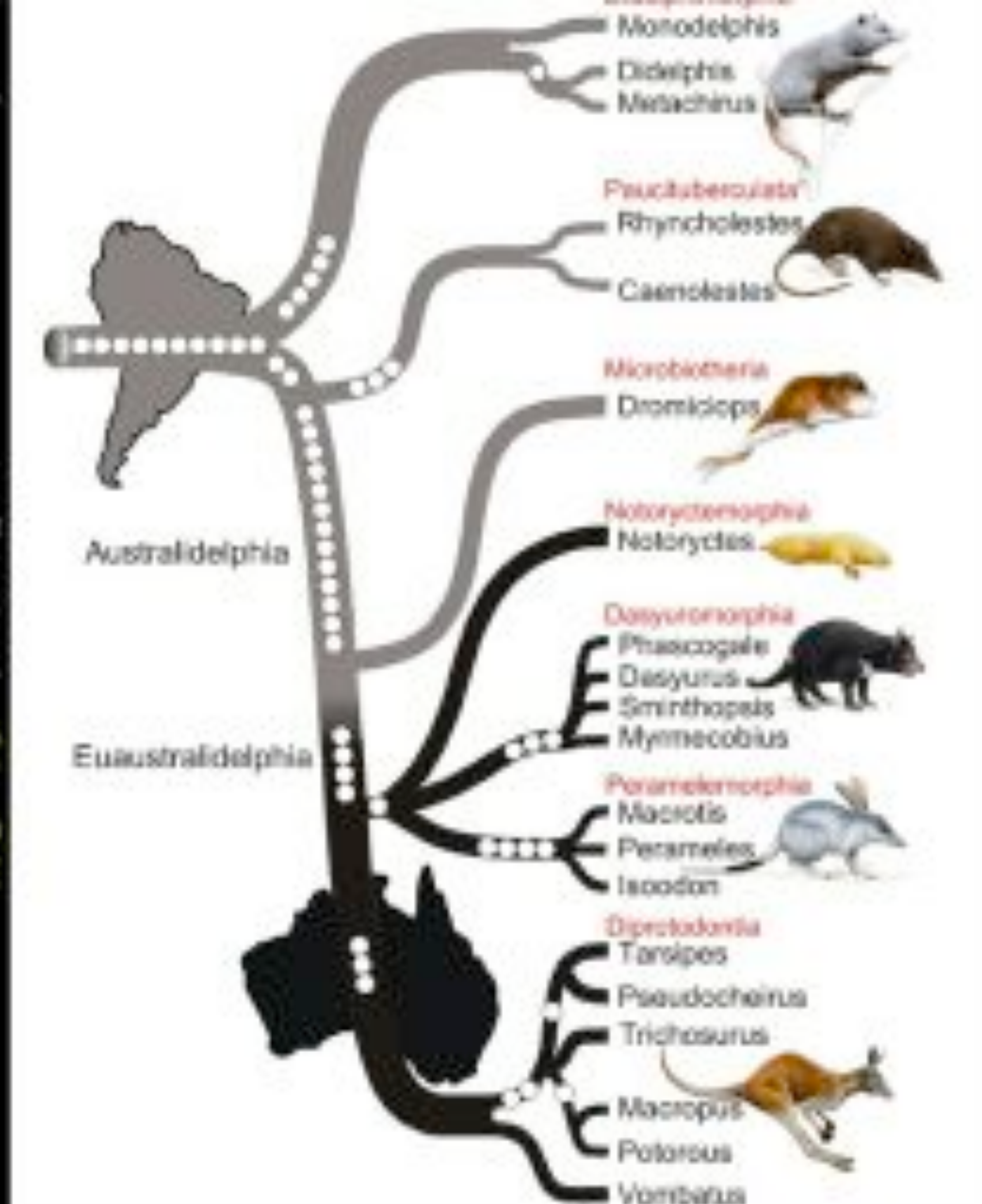
Tracking Marsupial Evolution Using Archaic Genomic Retroposon Insertions

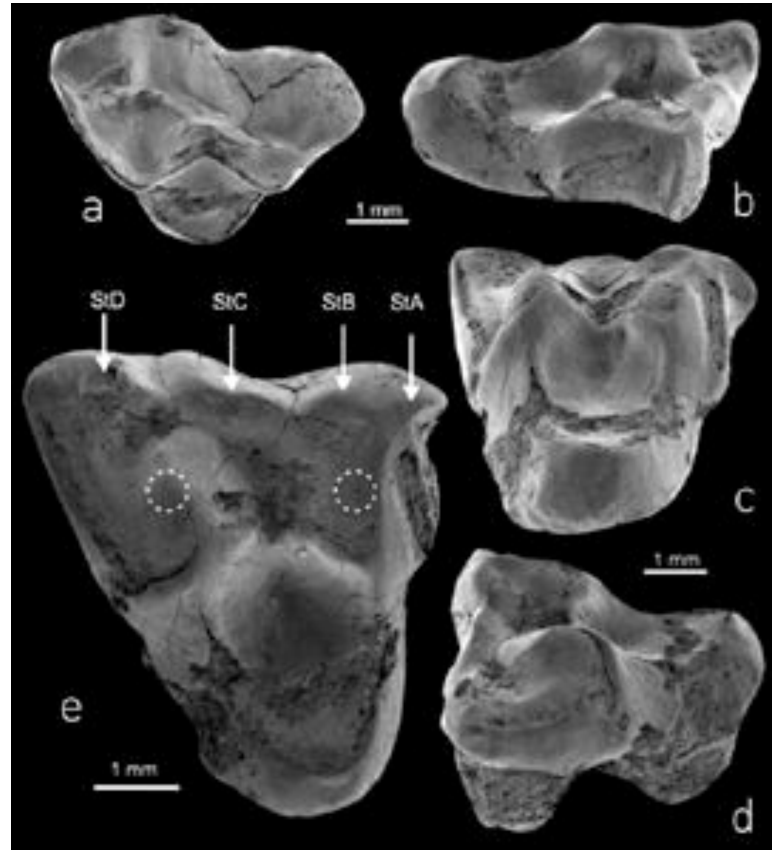
Maria A. Nilsson, Gennady Churakov, Mirjam Sommer, Ngoc Van Tran, Anja Zemann, Jürgen Brosius, Jürgen Schmitz

# Molecular estimates have placed the earliest divergences of Marsupialia in the Late Cretaceous 65–85 MYA

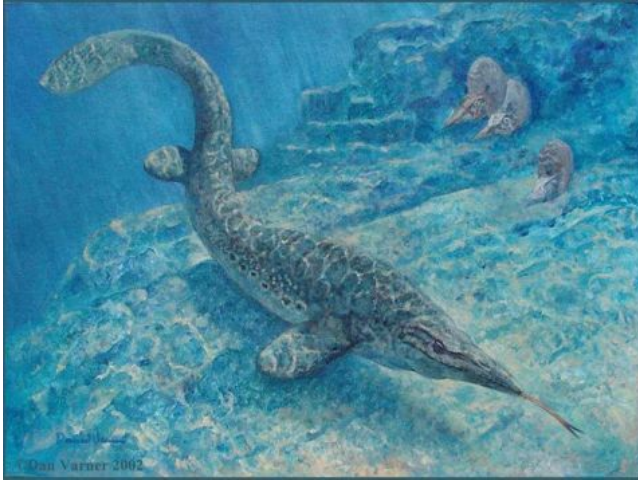
Nilsson M, Arnason U, Spencer PBS, Janke A (2004) Marsupial relationships and a timeline for marsupial radiation in South Gondwana. Gene 340: 189–196.

Meredith RW, Westerman M, Case JA, Springer MS (2008) A phylogeny and timescale for marsupial evolution based on sequences for five nuclear genes. J Mamm Evol 15: 1–36.




Gracias a los hallazgos en el campo de la biología molecular y la paleontología se ha logrado establecer que los marsupiales fueron animales que poblaron también nutridamente Sudamérica y Antártica, desarrollando linajes propios después de la separación continental.




**Research Rings in Antarctic Science, ACT105, CONICYT. 2010-2012.**
**Geological and paleontological evolution of the Magellan and Larsen Basins During the Mesozoic and Cenozoic: source areas and possible similarities. PI: Teresa Torres**

CONICYT
COMISIÓN NACIONAL DE INVESTIGACIÓN CIENTÍFICA Y TECNOLÓGICA

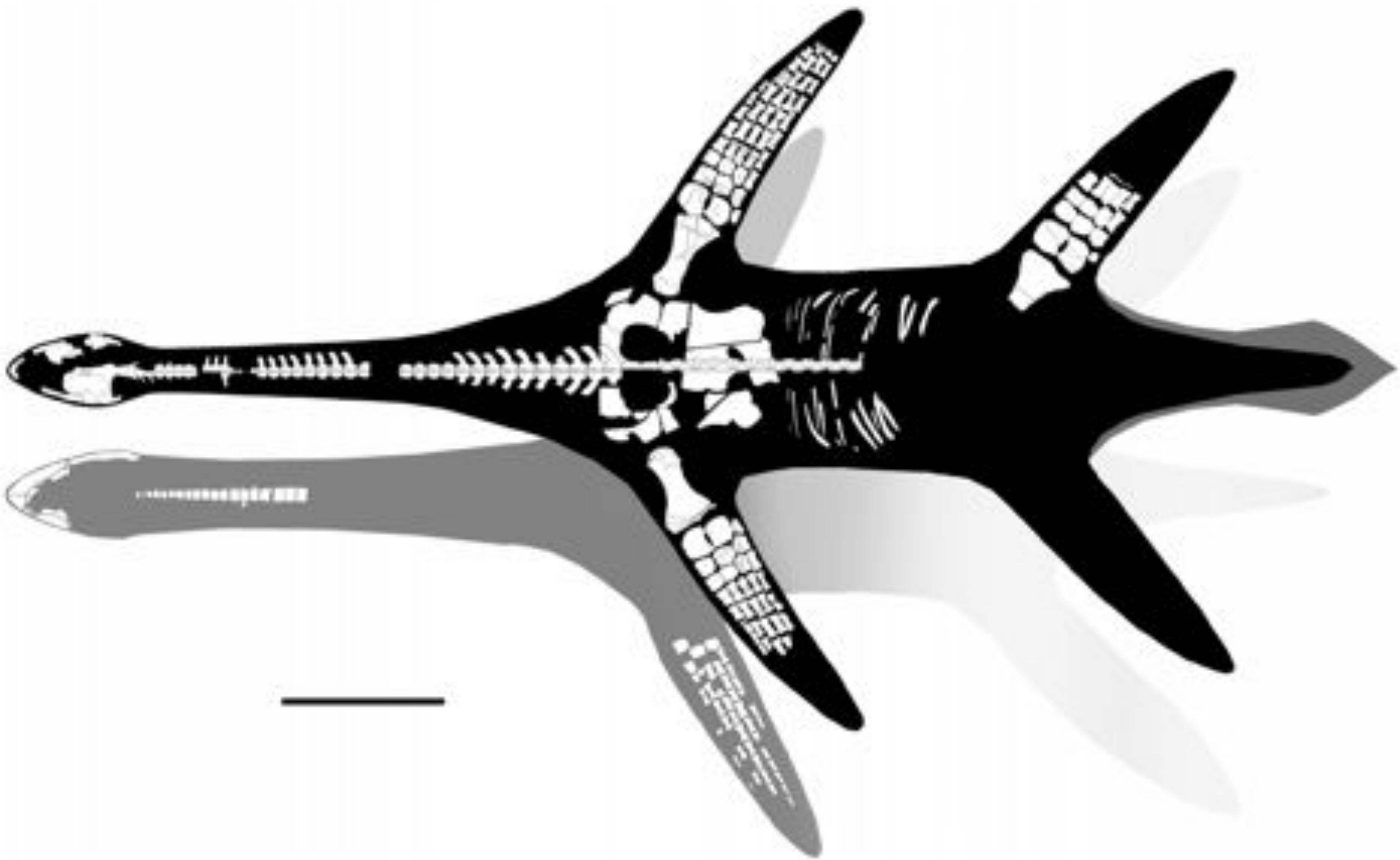
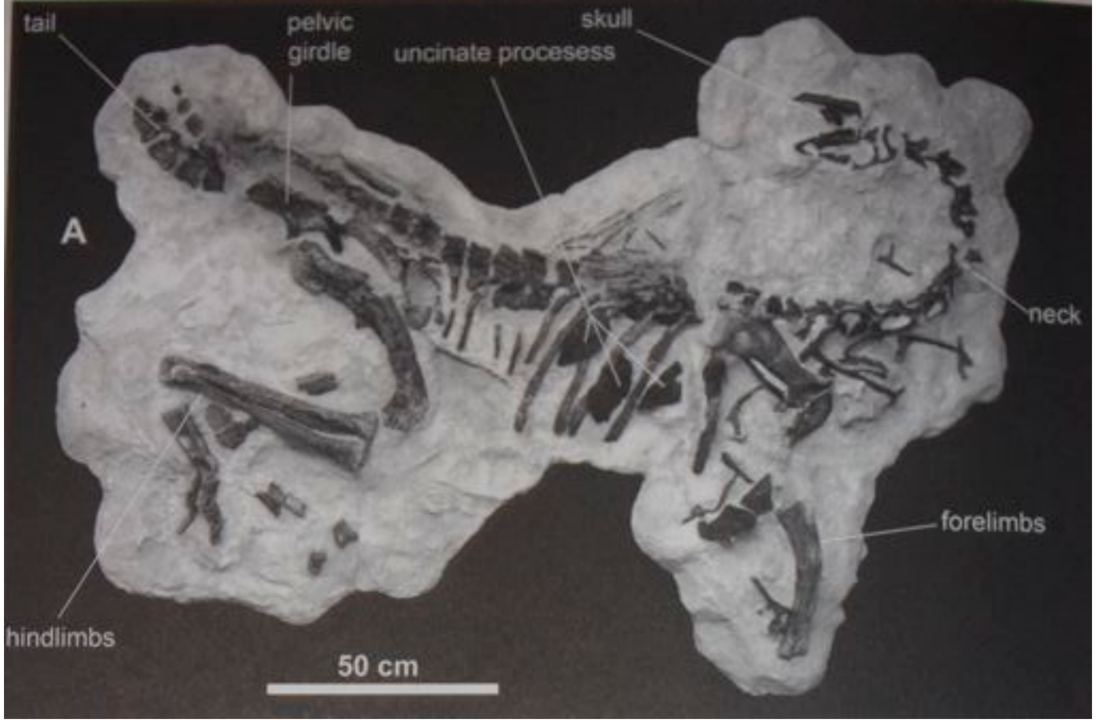


FIGURE 19. Reconstructed outline of *Aristonectes quiriquinensis*, sp. nov., based on the portions preserved in the holotype. The holotype of *Aristonectes parvidens* is included in grey outline, excluding the caudal centra due their uncertain anatomical position along the skeleton. Scale bar equals 1 m.


tail
pelvic
girdle
uncinate procesess
skull
A
neck
forelimbs
hindlimbs
50 cm

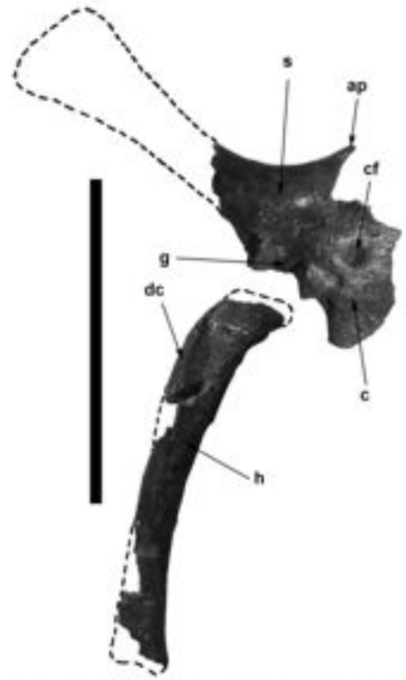


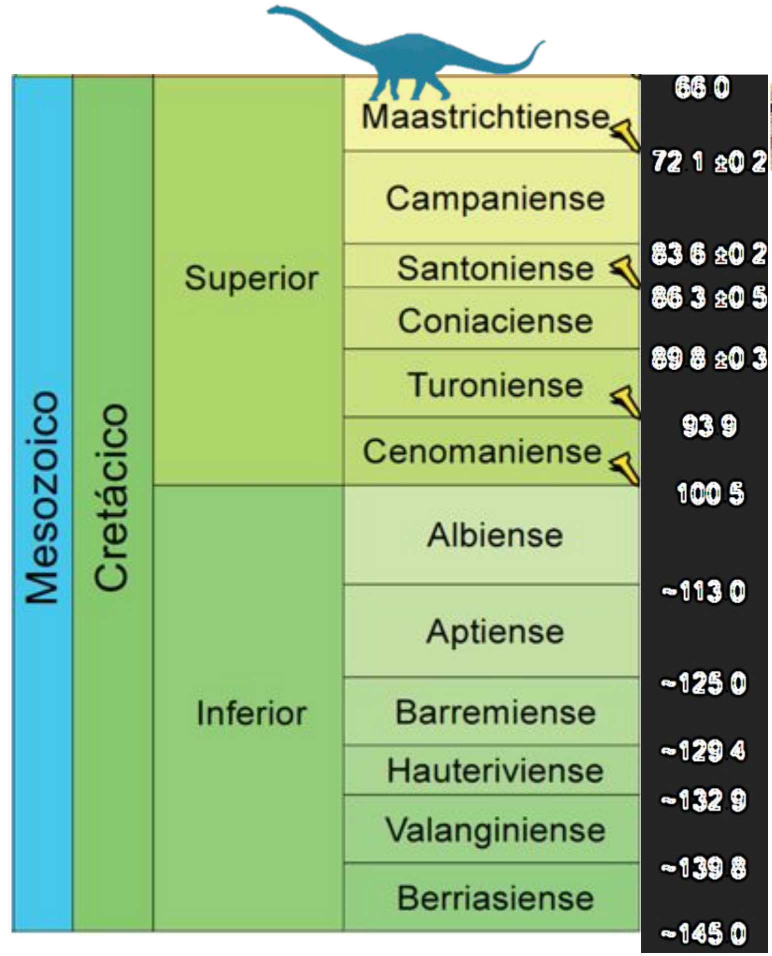

Fig. 3. Right scapulocoracoid and humerus of Trinisaura santamartaensis in lateral views. Abbreviations: ap, acromial process; c, coracoid; cf, coracoid foramen; dc, deltopectoral crest; h, humerus; g, glenoid; s scapula. Scale bar: 10 cm.

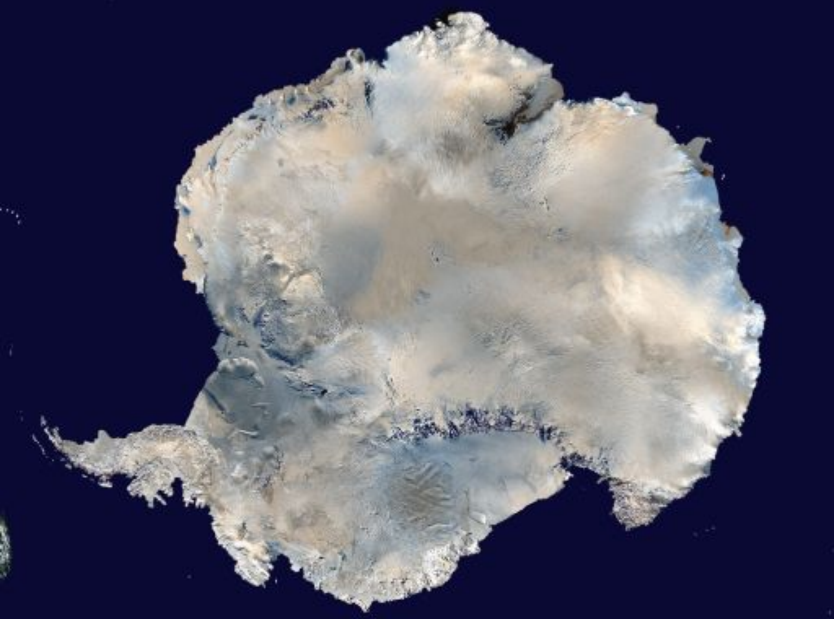









Mesozoico
Cretácico
Superior
Inferior
Maastrichtiense
Campaniense
Santoniense
Coniaciense
Turoniense
Cenomaniense
Albiense
Aptiense
Barremiense
Hauteriviense
Valanginiense
Berriasiense
66 0
72 1 ±0 2
83 6 ±0 2
86 3 ±0 5
89 8 ±0 3
93 9
100 5
~113 0
~125 0
~129 4
~132 9
~139 8
~145 0

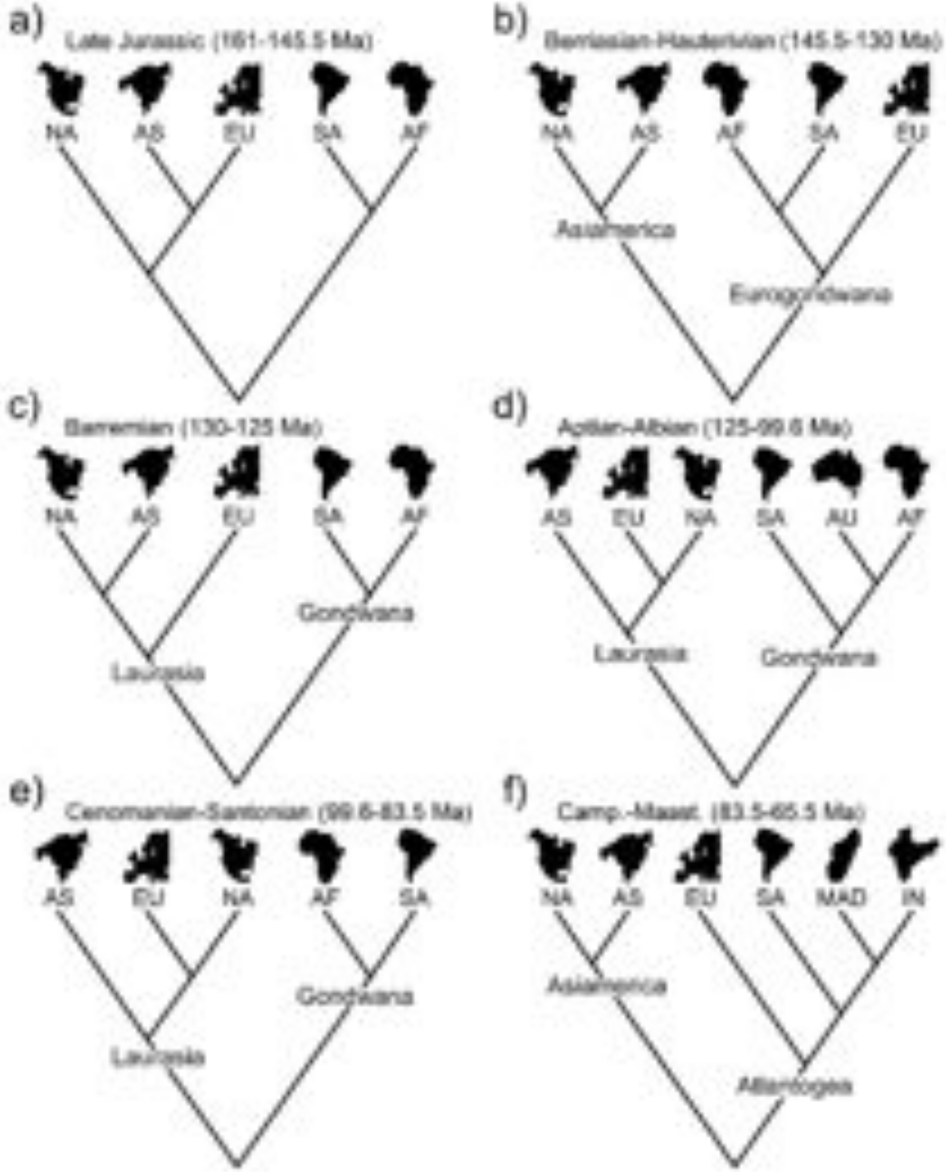




FIGURE 1. Recovered cladograms of optimized geographic areas for the (a) Late Jurassic, (b) Berriasian–Hauterivian, (c) Barremian, (d) Aptian–Albian, (e) Cenomanian–Santonian, and (f) Campanian–Maastrichtian time-slices. Abbreviations: AF, Africa; AS, Asia; AU, Australasia; EU, Europe; IN, India; MAD, Madagascar; NA, North America; SA, South America.

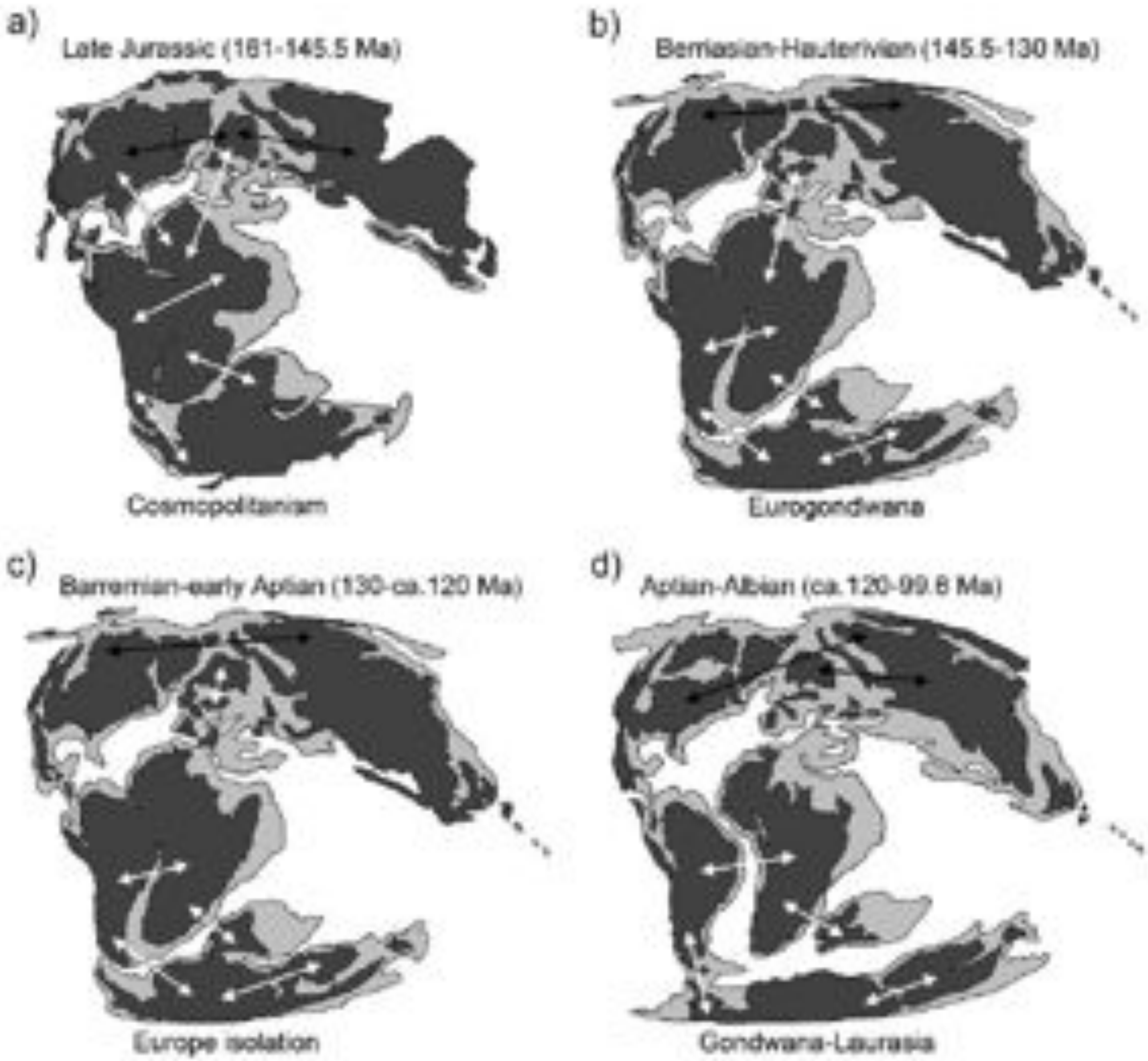



FIGURE 2. Global palaeogeographic reconstructions showing the main biogeographical model and connections here proposed for the (a) Late Jurassic, (b) Berriasian–Hauterivian, (c) Barremian-earliest Aptian, and (d) Aptian–Albian time-slices. The white arrows depict biogeographical connections among southern landmasses and/or Europe and the black arrows between Asia and North America or within Laurasia (a–d redrawn from Blakey 2006 and modified following Canudo et al. 2009 regarding the position of the Apulian Plate).

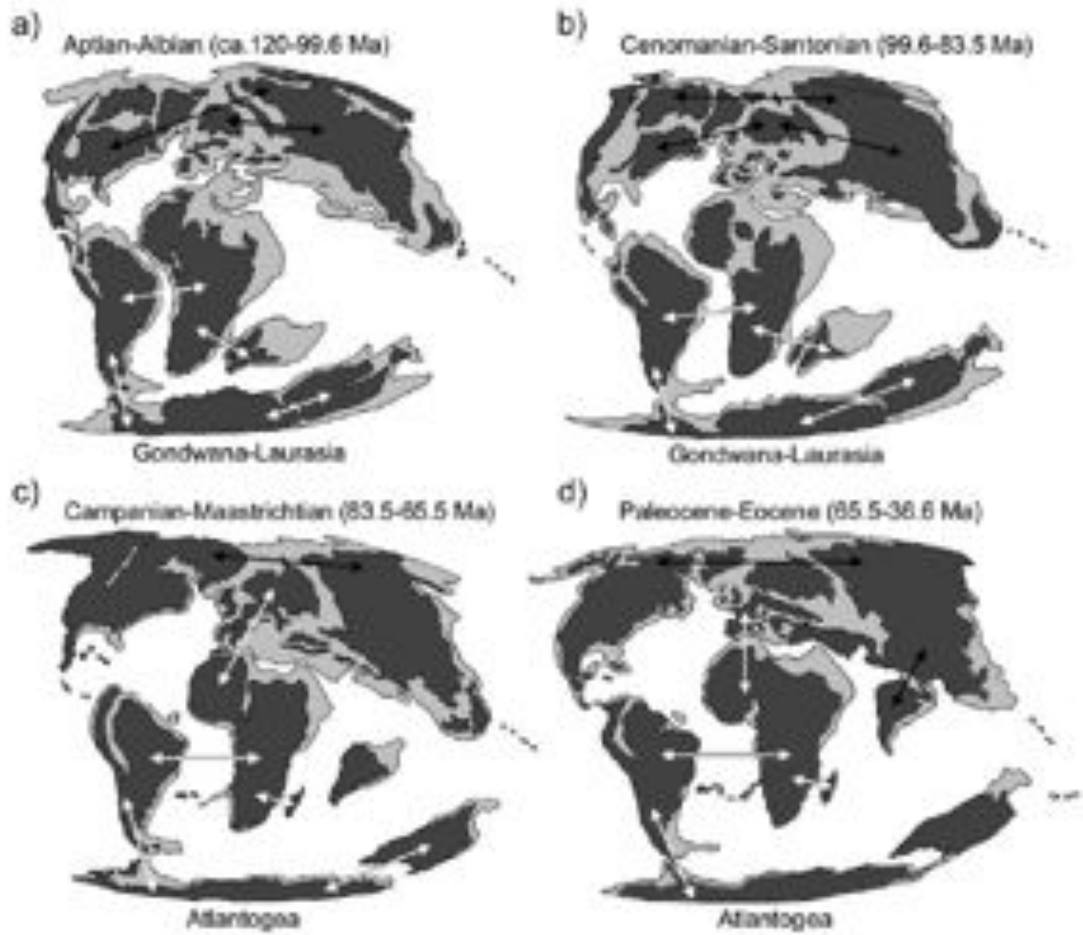
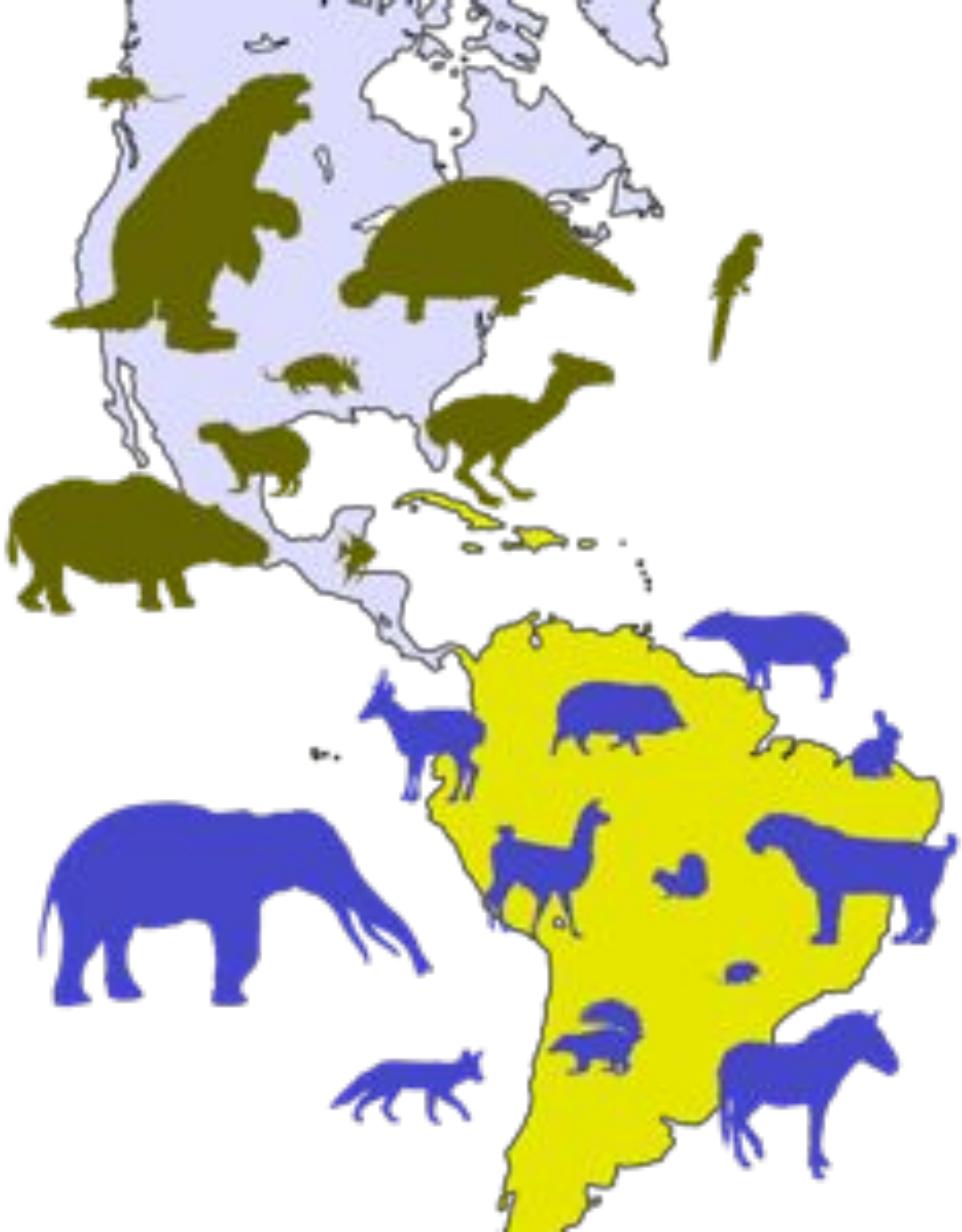



FIGURE 3. Global palaeogeographic reconstructions showing the main biogeographical model and connections here proposed for the (a) Aptian–Albian, (b) Cenomanian–Santonian, (c) Campanian–Maastrichtian, and (d) Paleocene–Eocene time-slices. The white arrows depict biogeographical connections within Gondwana and Atlantogea and the black arrows within Laurasia and Asiamerica (a–d redrawn from Blakey 2006 and modified following Oliveira et al. 2010 regarding the South Atlantic palaeogeography).

The Atlantogeic Biogeographical Palaeoprovince included the modern territories of South America, Caribbean, Antarctica, Africa, Europe, and Australia.

In order to explain these unexpected disjunct distributions on both sides of the South Atlantic previous authors have suggested the presence of unidirectional westward dispersals by rafting floating islands helped by palaeocurrents and palaeowinds (Hoffstetter 1972; Parrish 1993). However, the phylogenetic relationships and geographical distribution of several groups of plants and animals are incongruent with the hypothesis of a unidirectional dispersal from Africa to South America. Our dispersal–vicariance analyses of 3 paradigmatic clades indicate the presence of bidirectional (caviomorphs) and eastwards dispersion fluxes (malpighiaceans and amphisbaenians), contrasting with the westward directed floating island model (see Appendix 4). In addition, the transoceanic rafting of fossorial amphisbaenians and freshwater lacantuniid and cichlid fishes is highly unlikely. The fact that they had to achieve two transoceanic dispersals (i.e., North Atlantic and Caribbean) weakens a northern Europe–North America–South America migration route, statement that is bolstered by the complete absence of fossil remains of these numerous plant and animals groups in North America (with the exception of rhineurid amphisbaenians; Hembree 2007) during the Tertiary. Accordingly, the available geological and biological information suggests the presence of bidirectional faunistic and floristic interchanges between Africa and South America during the Campanian–Eocene time span (80–40 Ma; Fig. 3c,d).



3 m.a.
Plioceno superior

Misterio: Porqué en chile no hay gliptodontes???

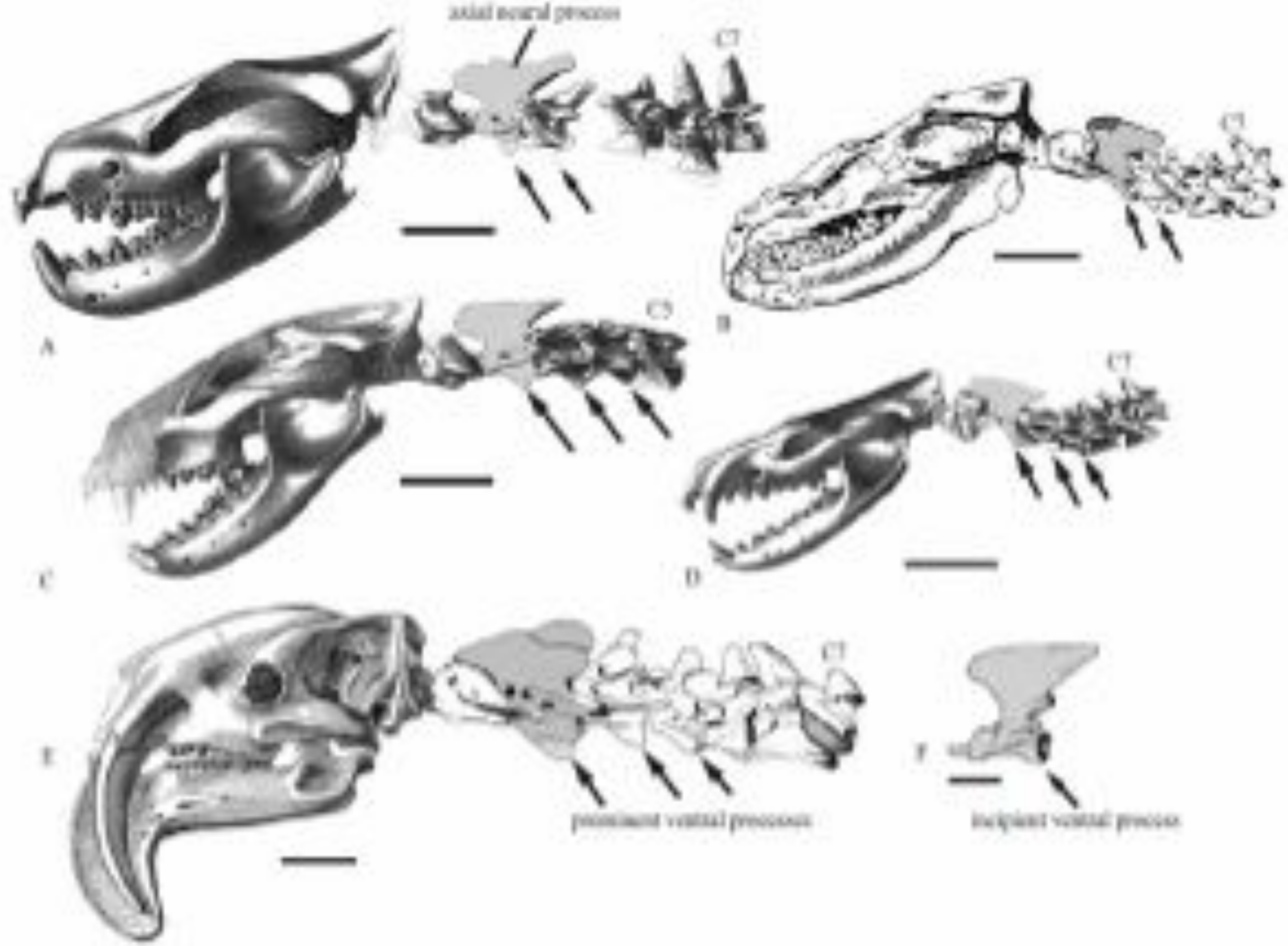



**Figure 1.** Skull and cervical vertebrae in lateral left view, showing the anteroposterior extension of the axial neural process, and the development of strong ventral triangular processes on the axis, C3, and C4 (arrowed). A, *Borhyaena tuberata* PU 015701 (the fourth cervical is unknown) modified from Sinclair (1906). B, *Lycopsis longirostris* UCMP 38061 modified from Marshall (1977a). C, *Prothylacinus patagonicus* PU 015700 (the sixth and seventh cervicals are unknown) modified from Sinclair (1906). D, *Cladosictis patagonica* PU 015046 (skull) and PU 015170 (cervicals) modified from Sinclair (1906). E, *Thylacosmilus atrox* FMNH P 14531 (skull, modified from Riggs, 1934), and FMNH P 14344 (cervicals). F, axis in *Mayulestes ferox* MHNC 1249. The natural curvature of the cervical area is preserved only in *Lycopsis* (B) and *Cladosictis* (D). Scale bars: 50 mm in A–E, 5 mm in F.

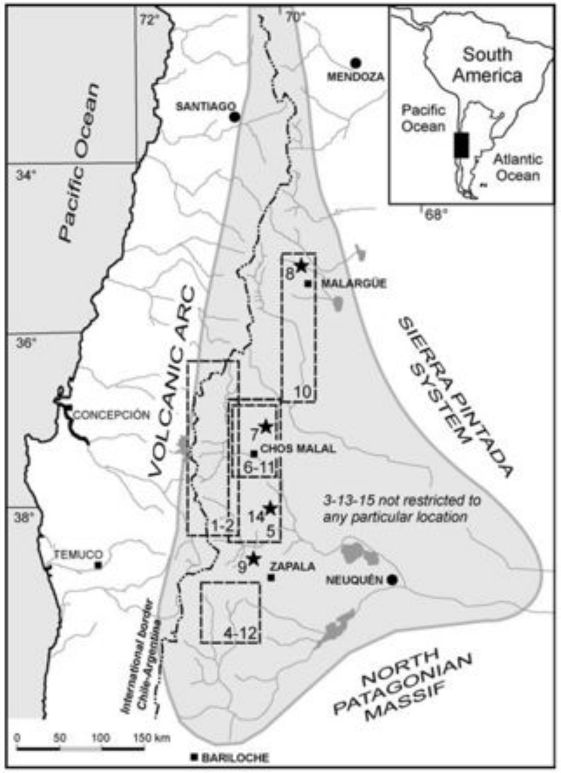
Large ventral processes on the neck vertebrae demonstrate that the musculature here was powerful. Reasonably long and powerfully muscled necks of this sort are typical of borhyaenoids.

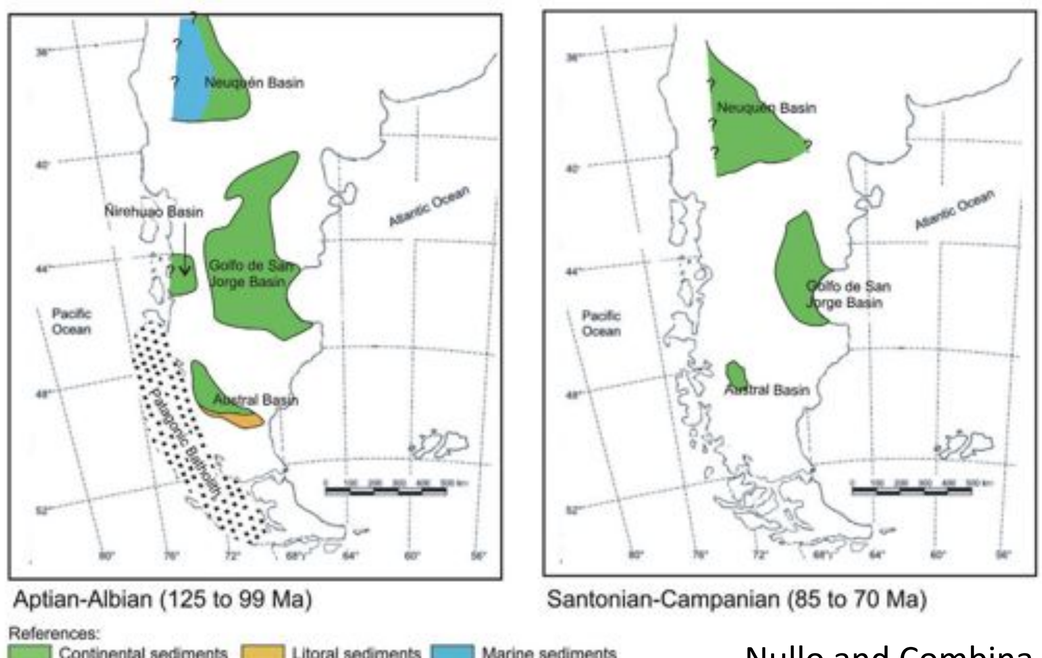
Prothylacinidae: *Lycopsis longirostris*

2008-2012. DFG-Germany ichthyosaurs and their paleoenvironment during the late Jurassic / early Cretaceous age in the Torres del Paine National Park, Southernmost Chile

# Deep time mysteries of Chilean Biogeography

## #1: Debated Connectivity of the pacific with The "Neuquén Basin" through time.




Nullo and Combina 2011

uRedes
Vicerrectoría de Investigación y Desarrollo

Tendencias

# Descubren en Chile uno de los ancestros más antiguos de los dinosaurios

- Se trata de un protodinosaurio de unos dos metros de largo que vivió cerca de Calama entre 238 a 240 millones de años atrás.
- Fósil comenzó a ser analizado hace tres años por expertos chilenos que presentarán la especie a fin de mes en Estados Unidos.
- Una familia de dinosaurios de 100 millones de años y un pariente de los cocodrilos, de 240 millones, son otros de sus nuevos hallazgos.

la última campaña de exploración, realizada en agosto, recolectaron un húmero izquierdo que no se conocía y huellas de huesos de la piel del Chilenosuchus que quedaron impresas en rocas, cuya datación sería de 238 a 240 millones de años atrás.

El espécimen habría medido

## Red Paleontológica de la U. de Chile

▸▸ Funciona desde mayo de este año financiada por un proyecto U-Redes. La confor-

EL CLIMA HACE 200 MILLONES DE AÑOS ATRAS

**Rodrigo Otero**, experto de la U. de Chile, explica que la evidencia apunta a que el clima en el triásico del norte de Chile era templado y seco, con fuertes cambios estacionales por el contraste entre la gran y única masa continental Pangea y el océano. "La vegetación muestra elementos pertenecientes a varios linajes extintos, pero también elementos como helechos y ginkgos (un tipo de árbol) que aún existen", dice. El jurásico tardío y cretácico fueron más tropicales.

## *Encuentran familia de Atacamatitan chilensis*

▸▸ En el año 2000, en Conchi Viejo, al norte Calama y cercano a una faena minera, un grupo de investigadores encontró no determinada, sino que a una familia de Atacamatitan.

"Encontramos huesos del fémur de distintos tamaños de la

*General statement of the turnover-pulse hypothesis.*—The hypothesis is diagrammatically illustrated in figure 4: Evolution is normally conservative at least in relation to speciation and extinction. Speciation does not occur unless forced by changes in the physical environment. Similarly, forcing by the physical environment is required to produce extinctions and most migration events. Thus, most lineage turnover in the history of life has occurred in pulses, nearly synchronous across diverse groups of organisms, and in predictable synchrony with changes in the physical environment. Most of these turnover-pulses are small peaks involving few lineages and/or restricted geographic areas. Some of them are massive and of global extent (Vrba, 1982, 1985). This is an extreme statement of the hypothesis. Even in a form that is stated in more attenuated, statistical terms (see below), it has not yet been studied much.

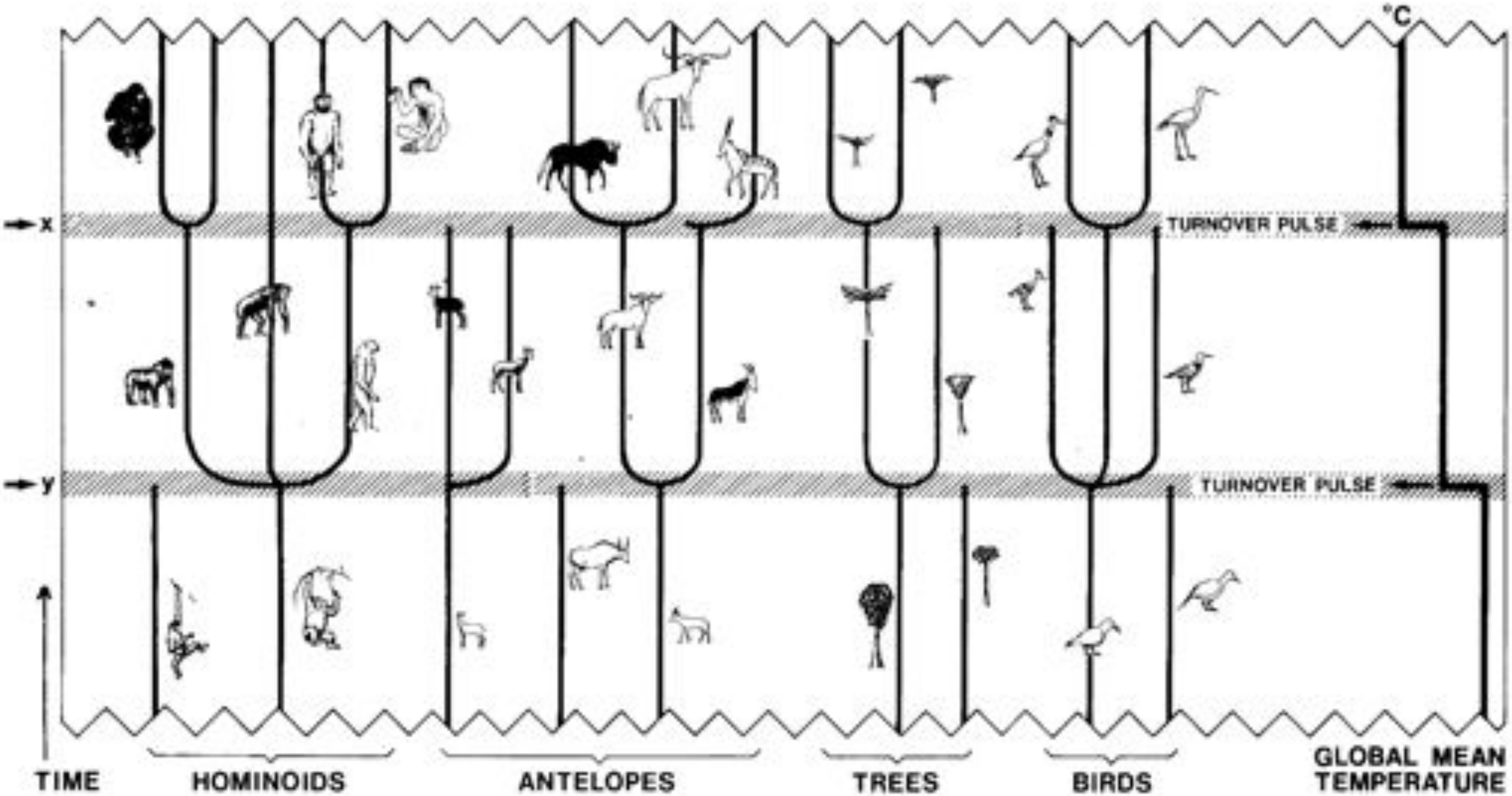



Fig. 4. Turnover-Pulses: In this hypothetical diagram, major climatic changes at times y and x initiated turnover-pulses, that is, coincident speciations and extinctions in groups as different as hominoids, antelopes, trees, and birds.

*Primary emphasis of this model.*—The primary focus is on the direct causation of *speciation*—the two other elements of turnover fall out of the same principle as secondary alternatives (fig. 2). To return to the analogy with the "Hindu Triad": while the passive case, migration without macroevolutionary change—Vishnu the Preserver—is by far the most common; and while extinction—Siva the Destroyer—has received most attention; it is speciation—Brahma the Creator—that is of most explanatory interest in evolutionary theory and in this model. And the cause of speciation is not circuitous—by way of radiation into niches that have first to be emptied or through competition from other species that somehow first had to reach their newly competitive status—but direct from the physical environment.

*At times of widespread climatic change, diverse lineages may show parallel changes in size and in similar kinds of heterochrony associated in time and consistently with the climatic change—a "heterochrony pulse." "Pulse" here does not imply that the lineages responded in unison in a short time, but only that the events are significantly concentrated in time*

*In my view the results to date already offer support for the notion that common rules give qualitative and temporal coherence to the evolutionary responses across many mammalian— including hominid—lineages. These common rules arise from the regularities of physical change and from attributes of organismal ontogenies and phenotypes, and species, which are widely shared by common inheritance. The evidence implies closer linkages between the physical and biotic dynamics on earth than has traditionally been acknowledged. This perspective contrasts with a neo-Darwinian view: that selection of small-step random mutations is the vastly predominant evolutionary cause, with the implication that each evolutionary advance is to a larger extent an independent piece of history. Evolution is more rule bound than that, and our evolution is no exception.*

Um interessante exemplo citado por Vrba é a aparição paralela de diversos roedores bípedes no Oligoceno. Como visto no post anterior, os membros de tetrápodos são altamente sensíveis às condições em que se desenvolvem. Roedores bípedes se caracterizam pelo aumento pedomórfico do tamanho dos pés das patas traseiras (o que facilita a postura ereta). Tal modificação ocorreu paralelamente em vários gêneros durante o resfriamento e desertificação da América do Norte. Ao invés de um caso extremo de convergência levando à adaptações análogas, este conjunto de evidências leva Vrba a apostar em um pulso heterocrônico devido a respostas desenvolvimentais similares em ambientes comuns. Mais frio, menor taxa de crescimento, diferentes proporções alométricas