

## WHALE ANCESTRY: The Ankle Bone Connection

For many years now, we've known that the fossils of the most primitive whales (archaeocetes) and a particular group of extinct four-legged animals known as mesonychids shared several traits (especially their unique tricuspid teeth). Mesonychids also have hooves on their toes, suggesting they are probably related to the ancestors of today's animals with hooves (ungulates). All of this suggested, therefore, that the cetaceans (whales and porpoises) probably shared a close common ancestry with the mesonychids, and both of those groups apparently shared a common ancestry with all of today's hoofed animals (ungulates). But which ungulates are closest to the whales?

Modern ungulates (hoofed animals) are divided into two major sub-groups:

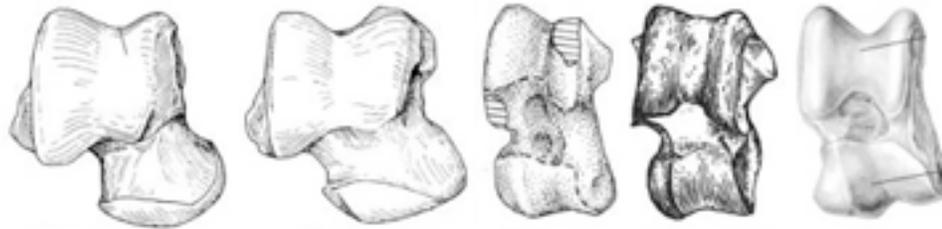
**Perissodactyls** (ungulates with an *odd* number of toes (1, 3 or 5) on each foot

Examples: horses, zebras, rhinos, and tapirs

**Artiodactyls** (ungulates with an *even* number of toes (2, 4 or 6) on each foot

Examples: cows, deer, giraffes, camels, pigs, hippos

As more primitive archaeocetes were found, some with leg bones (!), it was noticed that their *ankle* bones provided evidence pointing to a close relationship to one of those major sub-group of ungulates. Below are pictures of some of those ankle bones (astragali), and the corresponding bones of some other mammals thought to be related (due to other similarities). Compare the bones, and note how each bone is classified.



*Phenacodus* (early. Perissodactyl)    *Pachyaena* (Mesonychid)    *Pakicetus* (Archaeocete)    *Diacodexis* (early Artio.)    *Sus* (Pig) (mod. Artiodactyl)

Figures adapted from Christian de Muizon. 2001. "Walking with whales." *Nature*, vol. 413, 20 September 2001

*Phenacodus* = early Eocene Perissodactyl (~63 mya)

*Pachyaena* = a Mesonychid (~55 mya)

*Pakicetus* = early whale (Archaeocete) (~50 mya)

*Diacodexis* = earliest Artiodactyl (~55 mya)

*Sus* = domestic pig (a modern Artiodactyl)

Discussion: Based on generalizations from the above information, ...

1. Are Mesonychid ankles more like the ankles of Perissodactyls, or of Artiodactyls?
2. Are early whale ankles (*Pakicetus*) more like those of Perissodactyls, Mesonychids, or Artiodactyls?
3. Therefore, which do whales most likely share their most recent common ancestry with: Perissodactyls, Mesonychids, or Artiodactyls?
4. So what does this change in our ideas about ancestry tell us about the nature of science?

ANSWERS [Remove before making copies for students]

1. more like ankles of Perissodactyls;

2. more like artiodactyls;

3. artiodactyls.

4. Science is always tentative. New information and new analyses bring us revised understanding.