COMMON PATTERNS OF EVOLUTION AMONG UNGULATES EVOLVING INTO MARINE MAMMALS: EXAMPLES FROM CETACEA AND SIRENIA

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The Cetacea and the Sirenia both evolved from ungulate ancestors in the Tethys realm during Eocene time in shallow, epicontinental seas. Although the two groups evolved in similar environments and from broadly similar ancestors, they diverged quickly and radically into very divergent life forms. The Sirenia remained herbivores, evolving into two main groups (trichechids and dugongids), and utilized a variety of plant resources in freshwater and nearshore marine habitats. The Cetacea became much more diverse, all being carnivorous, developed more highly modified anatomy, occupied both freshwater and marine habitats, and adapted to pelagic environments as well. Despite the dramatic changes in morphology and habitus which each group experienced, there are some very intriguing common themes in their early evolution.

The earliest Cetacea and the earliest Sirenia both were amphibious animals about two to three meters in body length with substantial tails and with four limbs. The Middle Eocene members of both orders retained functional hind limbs, movable elbow joints, separate digits, skulls that are small compared to the body length, and relatively short tails (for an aquatic mammal) without large transverse processes on the caudal vertebrae (indicating that the tail had not developed into an organ of propulsion). The Sirenia retained movable elbow joints and separate phalanges, and the external bony narial opening moved back halfway along the rostrum. The Cetacea developed a locked elbow joint, added phalanges in a firm paddle, and the bony narial opening moved to the back of the rostrum or over the eyes. In both groups the hind limb was reduced to a rudimentary pelvis and femur, the cervical vertebrae became shortened, and the tail developed a transverse terminal fluke with elongate transverse processes on caudal vertebrae for attachment of strong muscles for propulsion. Some groups of early cetaceans, just as the sirenians, also developed pachyostosis and osteosclerosis as buoyancy control mechanisms. The ribs of *Basilosaurus* and some Late Oligocene and Early Miocene mysticetes, and the ribs and vertebrae of *Pachyacanthus,* are osteosclerotic and pachyostotic, and the ribs of *Zygorhiza* are osteosclerotic. This sirenian-like adaptation did not remain conspicuous in the Cetacea, however, and other methods of diving and buoyancy control were developed among the Neogene cetaceans.