Photo: Levi Heffelfinger

dinosaur DEER

By Jim Heffelfinger

One cold morning I found myself laying under a truck pounding on the starter with a big shed antler trying to get it to engage. It occurred to me that after several million years of technological advancements, humans have come full circle in their tool use. The truck did start (so easy even a caveman can do it). The origins of deer can be traced to well before cavemen were using antlers for tools. Back, perhaps, to a time when primitive humans and deer where hiding from the same predators.

The full history of deer starts back with primitive critters that might not look very deer-like to us. In fact, at that point we would have trouble classifying them as related to deer, giraffe, cow, or sheep. All hoofed animals were just beginning to split into those families we now recognize. These are the animals that literally learned how to walk on their toenails (hooves) and have not touched the ground since.

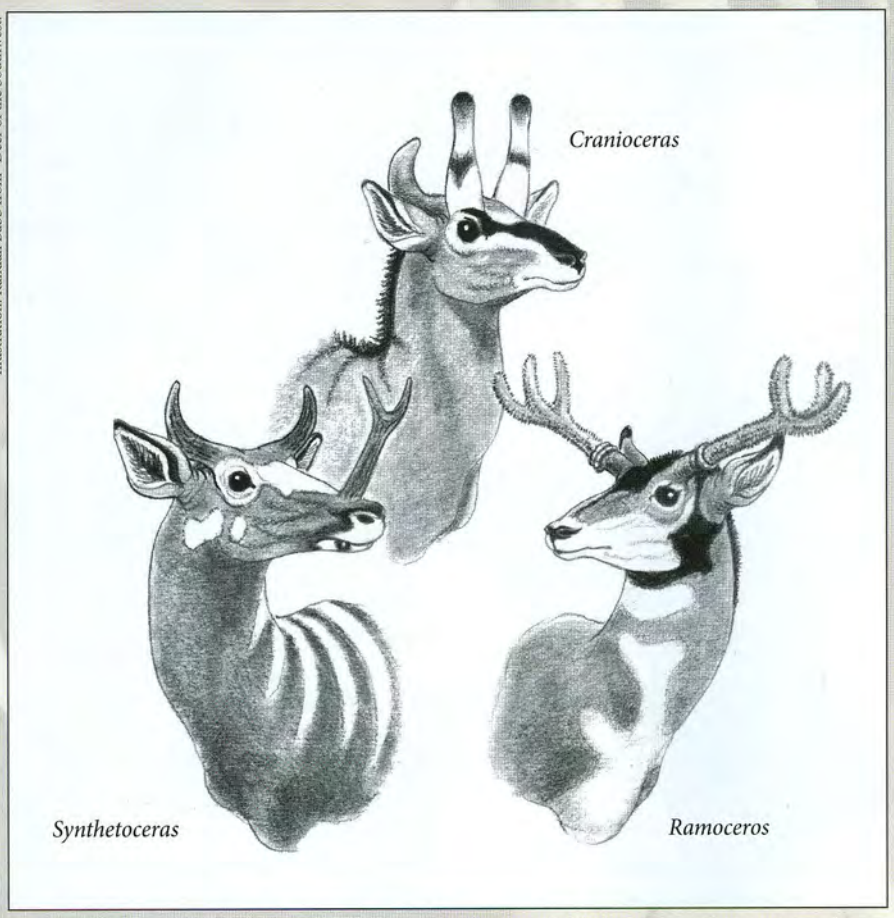
The earliest hoofed animals appeared in the fossil record during the Eocene Epoch, 34-56 million years ago. Rabbit-sized ungulate ancestors, such as *Diacodexis* and several others were distributed throughout North America, Europe and Asia. *Diacodexis* was the first to possess a unique ankle bone, which acts as a double pulley providing great flexibility in the hind foot. This feature marks this animal unmistakably as the first example of what has developed into all our North American big game animals. These animals possessed long limbs for running and, although they had four toes with hooves on them, they supported most of their weight on the two central hooves on each foot. Primitive hoofed animals branched into different forms and increased in abundance.

Further development of these ungulates continued through the next period (Oligocene Epoch) 24-34 million years ago with the appearance of *Leptomeryx* in North America and *Eumeryx* in Eurasia. *Leptomeryx* was only about 10 pounds, but already possessed many characteristics that are seen in today's deer and cattle, such as: no upper incisors, incisor-like lower canines, and sharp molars.

Illustration: Randall Babb from "Deer of the Southwest."

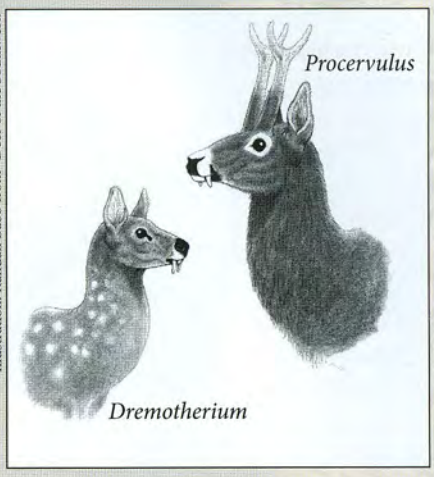
Eumeryx was one of the earliest animals to walk on hooves and represents the type of primitive animal that eventually evolved into deer.

Illustration: Randall Babb from "Deer of the Southwest."



Cranioceras (top), Synthetoceras (left), and Ramoceros (right) represent three spectacular groups of large grazers that roamed North America during the Miocene Epoch.

Illustration: Randall Babb from "Deer of the Southwest."



Deer-like ancestors such as Dremotherium (left) and Procervulus (right) are part of the evolution of the deer we see today. Dremotherium had no antlers, but the males had large saber-like canines like the Chinese water deer living today. Procervulus had the first evidence of antlers that may have been shed at times.

HORNS, BUT NOT ANTLERS

About 24 million years ago saw an incredible flush of diversity in the families of grazing animals (deer, cattle, pronghorns) in North America and Eurasia. The most interesting North American forms are represented by groups of medium to large grazing and browsing animals that had large, bony horn-like structures called "ossicones" extending upward from the skull over the eye sockets. These were not shed as are antlers and do not appear to have been covered by a horn sheath like pronghorn antelope. The horns were probably covered simply with a layer of skin just like today's giraffes. *Cranioceras* and *Synthetoceras* are just a few examples of a remarkably diverse group of animals that roamed North America at that time. Unfortunately, none of these spectacular animals remained at the close of the Miocene (about five million years ago). *Ramoceros* looked very deer-like, but it was actually a primitive pronghorn and its horns were not shed. The pronghorn that we see today is the only remnant of a very large and diverse group that did not survive the gauntlet of evolution.

During that time North America and Eurasia had a primitive deer with no antlers, but instead had exaggerated tusk-like canines. *Dremotherium* is an example of an Asian form of these sabre-toothed deer, and is the most probable ancestor to all true deer (those with antlers). These large canine tusks may seem out of place on a deer, but the present-day musk deer and Chinese water deer of Asia are remarkably similar and probably represent direct descendants of these primitive deer.

ENTER THE DEER

Despite the abundance and diversity of horned critters in North America during the Miocene, none of these animals gave rise to whitetails or mule deer. There is no record of real deer in North America until about 6 million years ago. All deer with us today are descendants of the Eurasian, deer-like animals such as *Dremontherium* or *Procervulus*. *Procervulus* not only possessed large canine tusks, but also forked antlers that may have been shed at least some years (maybe not every year). This means *Procervulus* is the primitive deer that is in position to be the root of the entire deer family.

The earliest true deer that we know of appeared in Eurasia during this time (6 million years ago) and one of these ancestral deer had small antlers that normally formed a single fork (*Dicrocerus*). Another primitive deer species, called *Stephanocemas*, had tusk-like canines and antlers that formed a bowl-shaped palm like a miniature moose. The antlers of these early deer were elevated on long antler bases and may have looked a lot like the present-day muntjac of Asia. No doubt humans started to admire and compare antlers as soon at primitive deer started showing up with them. If recent Native American cultures are any indication, cave men probably found these hard antler tips useful for all sorts of tools such as leather punches, arrowhead flakers, diggers, and weapons.

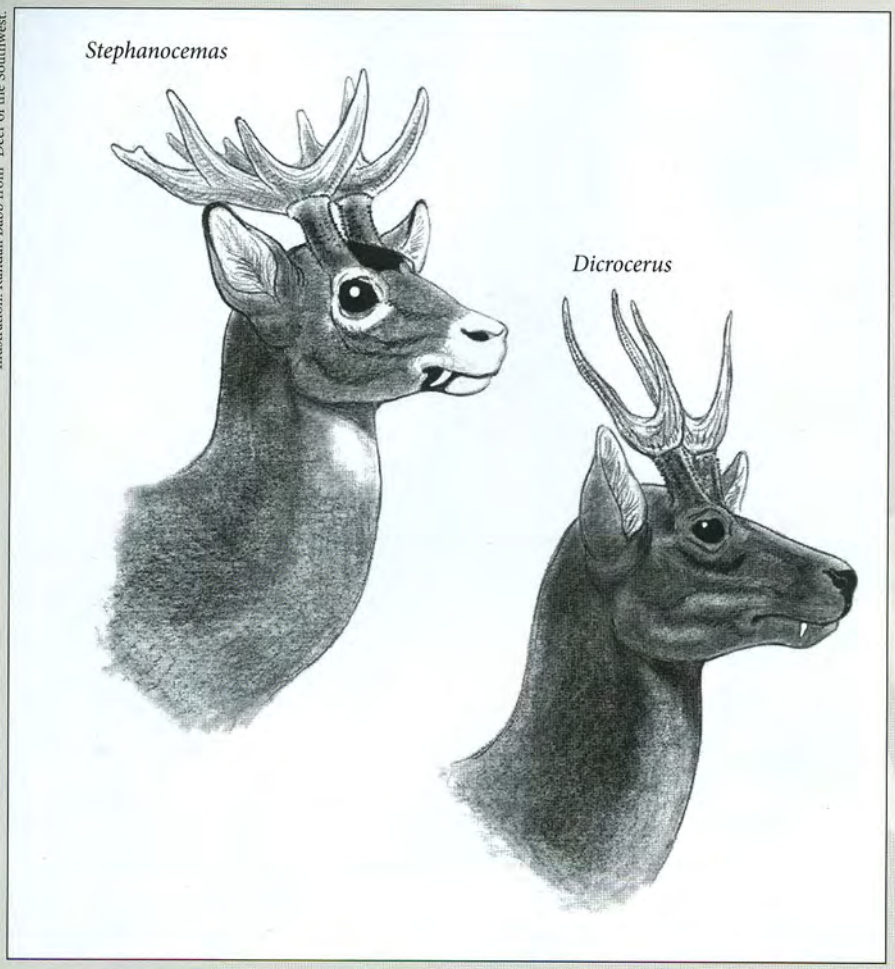


Illustration: Randall Babb from "Deer of the Southwest."

Stephanocemas and Dicrocerus are the first animals to shed their antlers on a regular basis. All of today's true (antlered) deer arose from early deer such as these.

Photos: Jim Heffelfinger

Actual fossils of Dicrocerus (Left) and Stephanocemas (Right) housed in the American Museum of Natural History in New York City.

With the evolutionary development of elaborate antlers, the occurrence of tusk-like canines started to disappear in the deer family. The antlerless water deer, musk deer, and mouse deer all have prominent canines, while other antlered deer have lost their canines entirely or they are very much reduced (such as the "ivories" in elk). The muntjac and tufted deer of Asia are intermediate with small antlers and small canines. It is thought that the well-developed antlers may have taken the place of these teeth as objects of display to the opposite sex. It was an early deer species, similar to *Dicrocerus* that crossed into North America about five to six million years ago. The earliest fossils of real deer in the Americas are *Eocoileus gentryorum*, which represents the most likely ancestor to whitetails, blacktails, mule deer and all South American deer species.

AMERICA FINALLY GETS DEER

Unravelling the complete story of deer evolution throughout the late-Pliocene/early-Pleistocene (600,000 years to four million years ago), is difficult because of the repeated glaciers that scoured back and forth across the landscape for thousands of years during the Pleistocene, destroying most evidence of early North American deer evolution. Whitetail and mule deer remains have never been found in Eurasia, which is pretty strong evidence that our deer evolved solely in North America from *Eocoileus* or something similar. A single European deer species, the Roe deer, is related to whitetail and mule deer and probably came from the same deer ancestor that migrated to North America.

During the early Pleistocene, deer were not as abundant or widely distributed as they are now. The diversity and sheer abundance of other large animals at that time resulted in an intense competition for food and other resources. With the melting of the glaciers (8,000 - 11,000 years ago) mass extinctions of many large animals occurred throughout the world. Most of the large mammals that were native to North America died out in a remarkably short time period (camels, giant sloths, mastodons, saber-toothed cats, long-horned bison, and native horses). Many theories have been proposed for the cause of these extinctions but, it is most-likely the extinctions were related to large-scale habitat changes at the time. Deer did not become the widespread, dominant ungulates we know today until the multitude of large grazing mammals disappeared.

The archaeological evidence from the Pleistocene that does exist reveals fossil deer that were essentially the same as we find them today. It is very hard to differentiate between mule deer and whitetails from bone fragments because the most obvious differences are small portions of the skull that are not well preserved after thousands of years. Other cervids, such as the elk and moose migrated to North America

Illustration: Randall Babb from "Deer of the Southwest."

Sometime around 5 million years ago, an early deer ancestor crossed into Alaska and thus true deer arrived in North America. Fossils of Eocoileus indicate it is a direct ancestor of today's mule and white-tailed deer.

through Alaska more recently (late Pleistocene) and therefore more closely resemble their European counterparts (red deer, European moose).

FROM CAVES TO DNA

We know very little about the evolutionary history and splitting of mule deer and white-tailed deer from the fossil record. The traditional theory is that a primitive type of deer split into a western species (blacktails) and an eastern species (whitetails) during the Pliocene. The mule deer then originated as an off-shoot of the blacktail line, becoming larger and more elaborate in antlers and body markings as they spread out into the fertile habitat left when the glaciers melted.

Early genetic analyses showed that mitochondrial DNA (mtDNA), that is passed down from mother to daughter, is basically the same in mule deer and whitetails, but they are both very different from blacktails. This odd genetic relationship was unexpected because mule deer and black-tailed deer are the same species (different subspecies) and they are both a different species than whitetails. This early evidence spawned an alternative theory that proposed mule deer are a relatively "new" species, resulting from the hybridization of female whitetails and male blacktails brought together after the retreat of the glaciers at the close of the Pleistocene 10,000 years ago.

This second theory continues to show up in popular media, but later genetic research and some fossil evidence indicates that was not the case. In the last decade, I have collaborated with Dr. Emily Latch, now at University of Wisconsin - Milwaukee on a continent-wide mule deer genetic analysis. For millennia, humans have used big parts of deer as tools (antlers, bones, hide). Now we can use the technology crafted by our big brains to use very, very small parts of deer (DNA molecules) as tools to learn more about mule deer, their origin and relationship to other deer. Using these new genetic tools, not available just a decade ago, we were able to explore all sorts of interesting questions along with the help of other collaborators.

Our work, and that of others, used Y chromosomes and nuclear DNA to clearly show that mule deer and blacktails are very similar genetically and different from whitetails. This, along with the physical differences between the species and a few fossils, argues against a hybrid origin of mule deer. Our work, published in the scientific journal *Molecular Ecology,* used the latest genetic analysis methods to show that mule deer waited out the glaciers of the last ice age in several pockets in the southwestern United States and Mexico, while blacktails were trapped along the ice-free coastal areas in Washington and Oregon. After all the ice melted, these 2 subspecies expanded their ranges and met once again along their current points of contact in the Northwest. The isolation of these 2 types of deer during the ice age accounts for their physical and genetic differences. Our research did not include whitetails, but Florida is well-known for its Pleistocene whitetail fossils that are indistinguishable from today's whitetail skeletons. White-tailed deer most-likely waited out the last ice age in the southeastern United States.

With the current heavy human footprint on the landscape I'm not sure the history of mule deer tells us much about the future. Mule deer, and all wildlife species, face incredible challenges in the future as human population grows and demands more and more resources to live on the planet. I'm more optimistic than most because Americans, as a whole, possess a strong conservation ethic and organizations like the Mule Deer Foundation have gained incredible momentum in preserving, protecting, and enhancing the habitat that is so critical to maintaining robust mule deer herds. Get involved in a local MDF chapter and we can keep mule deer from going the way of the dinosaurs.

Jim Heffelfinger is a Certified Wildlife Biologist with the Arizona Game and Fish Department, Adjunct Faculty at the University of Arizona, and Professional Member of the Boone & Crockett Club.

For more information on deer and to order an autographed copy of Jim's book "Deer of the Southwest" visit www.deernut.com.