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THE PLASTER JACKET

NUMBER 45 JULY 1984

A HISTORY OF RUMINANTS: PART 1

S. David Webb

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O F F I C I A L   N E W S

Fall Meeting, October 6, 1984

The 7th Annual Meeting of the Florida Paleontological Society, Inc. will take place on Saturday, October 6, 1984, at 8:00 A.M. at the J. Wayne Reitz Student Union on the University of Florida Campus. Park early as there will be a football game on campus that afternoon.

Nominations for 1984-1984

The Nominating Committee, consisting of Dr. Clifford Jeremiah, Mr. Don Serbousek, and Dr. Bruce MacFadden, has submitted the following slate of FPS officers for 1984-1985:

President:	Frank A. Garcia
President Elect:	Bessie G. Hall
Vice President:	Don Serbousek
Secretary-Treasurer:	Howard H. Converse, Jr.
Board of Directors:	Phil Whistler
	Mike Brothers
	Ray Robinson
	Roger Alexon

Article V, Section 5, of the Society's By-Laws states that "Nominations of candidates for office, in addition to those presented by the Nominating Committee, may be submitted to the Secretary in writing no later than September 1 of each year, and any such nominations received shall be voted on at the Annual Meeting."

Report on FPS Spring Meeting

The May 5 Annual Spring Meeting of the Florida Paleontological Society was held in Gainesville and consisted of a morning field trip, afternoon lab session, and evening banquet.

The group assembled at 10:A.M. in Reddick, Florida, a tiny town in north Marion County. The convoy of cars drove to a dirt road near an abandoned mine site, which served as a parking area. From there they hiked about a half mile to the old limestone quarry. During this interesting hike, many of the hikers marvelled at the lush, spring greenery of trees and wild flowers that abound in this area of the state.

At the old Reddick Quarry, everyone got out their hand spades and burlap bags. Drs. David Webb and Bruce MacFadden led the field trip, while other staff members remained back at the Museum to help organize the lab session and banquet scheduled for later in the day. They gave a briefing on the Eocene marine fossils and the Pleistocene vertebrates in the fissure fill. Bulk samples were taken by the group in amounts of from 2 to 40 pounds. This material is called "microvertebrate matrix." After spending about an hour collecting this fossil material, the group explored the sinkhole area and "primeval vegetation" growing around it, and then headed back to their cars lugging their bulk sample bags.

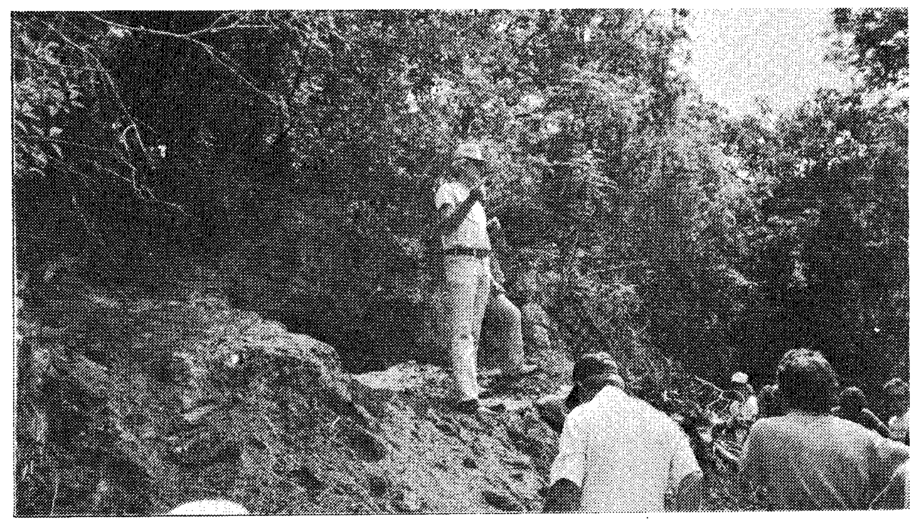
The next stop was on Orange Lake where the group ate lunch and where the microvertebrate matrix was placed in fine mesh screen boxes and washed to remove the clay-like soil and concentrate the tiny fossil bones. This process revealed an amazing variety of Eocene and Pleistocene microfossils.

In the mid-afternoon everyone proceeded back to the Museum for lab work. There, the screened material was spread on counters throughout the lab to separate and identify the microfossils. To make this job a bit easier, the flat crates were set under large lighted magnifying glasses. Soon numerous fossil bones from tiny creatures--such as field mice, bats, frogs, lizards, and even small snakes and birds--were

retrieved from the wet clay and pebble matrix surrounding them.

The banquet that evening was catered by the Museum and included everything from a southern style dinner to soft drinks and a cold barrel of beer. Since the weather was perfect, the banquet was held on the Museum plaza. Dinner entertainment consisted of string music by two Museum musicians, Deborah Harding and Russ McCarty, and a documentary movie (produced by Disney World Epcot Center) showing Dr. Webb and a lady interviewer uncovering Miocene fossils and explaining the animal species and time periods in which they lived.

The following photography of the spring meeting were provided by Ray Robinson.

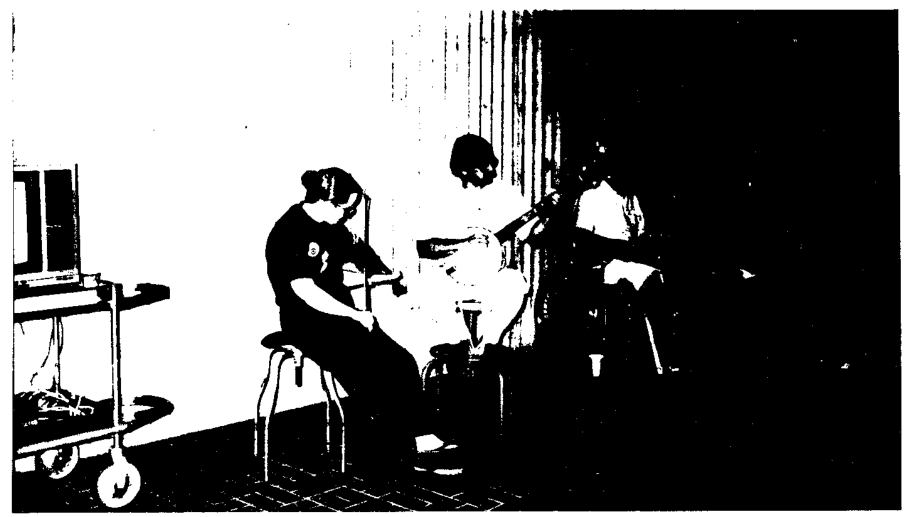


Dr. David Webb briefing FPS members on the origin and types of microfossils to be found at the site.

FPS members loading burlap bags with microfossil matrix scheduled for screen washing at Lake Orange.

FPS members screenwashing microfossil matrix at Lake Orange. The screened matrix was then taken to the Florida State Museum Paleontology Lab.

Members searching for microfossils in the screened matrix during the lab session at the Florida State Museum.



Dinnertime music by Deborah Harding and Russ McCarty.

Thomas Farm Field Camp

For one week in June, a dozen participants have again undertaken intensive investigations at the Thomas Farm Field Site, the most renowned fossil vertebrate site in eastern North America. The site contains a dense concentration of fossil bones and teeth in a complex depositional environment that probably includes aspects of a cave, a pond, and a stream system, and has yielded at least 70 species of large and small vertebrates, representing life in central Florida about 20 million years ago.

The site has been worked since 1930. Harvard parties worked there extensively during the 40's, and it is now being pursued by the University of Florida. Because it is remote, the only effective way to work this site is to camp and dig intensively. To that end, the University of Florida has established a camping facility that can support about 20 persons. Since 1982, the Florida State Museum and Florida Paleontological Society have run a Thomas Farm Fossil Dig program. The daily routine for five days involves about six hours per day of hands-on training in excavation, record keeping, site mapping, fossil identification, microfaunal screening, and fossil preparation.

In addition to the practical instruction at the site, Drs. David Webb and Bruce MacFadden are offering four evenings of two lectures each on the following related but more general subjects in earth and life sciences:

1. Thomas Farm and Taphonomy
2. Paleontology and the Meaning of Fossils
3. What is Miocene? and the Principles of Historic Geology
4. Florida Geologic History
5. A History of Vertebrates and their Skeletons--part 1
6. A History of Vertebrates and their Skeletons--part 2

7. A History of Vertebrates and their Skeletons--part 3
8. A History of Paleontology and its Role in Science and Society

Fossil Conservation Bill Becomes Law

On June 8 Governor Bob Graham signed into law the Fossil Vertebrate Conservation Bill. It passed the Senate by a vote of 27 to 5 and the House by 105 to 2. The FPS Committee on Legislation is working with the Office of Vertebrate Paleontology in Gainesville to develop simple practical regulations to carry out the law. A full report on those regulations will be presented at the FPS Annual Meeting in October.

Current Research on Early Man

The Center for the Study of Early Man, which is a sub-unit of the Institute for Quaternary Studies, University of Maine at Orono, is introducing its Current Research series this spring. This publcation will appear annually with state-of-the-art note length summaries prepared by specialists and will serve as a clearinghouse of multidisciplinary information relevant to the peopling of the western hemisphere. For details, please write Jim I. Mead, Center for the Study of Early Man, University of Maine, Orono, ME 04469.

Handbook of Paleo-Preparation Techniques

Howard Converse, Jr., of the Florida State Museum, has produced this new handbook and will mail it at a cost of $10.00 a copy postpaid. Subjects covered in this much-needed book are record keeping in the laboratory and collection, field collecting techniques, laboratory preparation and specimens, restoration of fossils and exhibit preparation, casting techniques, materials and suppliers, in addition to a bibliography and conversion data. According to the author, the purpose of the book is to provide an aid to persons wanting to learn basic skills of paleo-preparators. New and less expensive methods of applying top quality silicone compounds have been developed at the Florida State Musuem and are covered in detail. Simple line drawings are used for a clearer picture of the many procedures. The book is a 125-page, ring-bound laboratory manual made of sturdy paper.

Vertebrate Fossils Book

Year after year the best-seller in Florida Paleontology has been Peg Thomas' book, Vertebrate Fossils: Beach and Bank Collecting for Amateurs. The FPS, Inc., is very fortunate to have received the rights to this book from Peg last year. During the past year the Florida State Museum Gift Shop has sold the 1500 copies donated by Peg and has recently ordered another printing of 3000 copies. It is also available at many Florida bookstores and at the Smithsonian Institution.

NUMBER 45 JUNE 1984

A HISTORY OF RUMINANTS: PART 1

S. David Webb *

The ruminants, such as cattle, sheep, and goats, are more important to man than any other group of animals. They include most of the familiar horned and antlered beasts, such as deer, giraffes, bison, and antelopes. The name Ruminantia refers to their habit of "chewing the cud." Every ruminant has an elaborate three- or four-chambered stomach. In the first chamber, the rumen, fibrous vegetation is partly digested and then regurgitated for a second chewing. In the further chambers, reticulum, omasum, and abomasum, resident bacteria break down the plant fibers, including cellulose, an otherwise indigestible structural protein of plants, as well as some nitrogenous wastes from the animal itself. These now useable proteins are passed into the ruminant's intestine. This remarkably efficient digestive system may well be the secret of the ruminants' great success.

Cranial Osteology

The closest living relatives of Ruminantia are the Camelidae, with which they share many features, including selenodont teeth and a similar digestive system. Nonetheless, mammalian paleontologists and osteologists have recognized a number of technical differences that consistently distinguish most members of these two groups. Here we will illustrate some of the key differences that distinguish the skeletons of Ruminantia from those of Camelidae.

Dr. Webb is Curator in Vertebrate Paleontology at the Florida State Museum and Editor of the Plaster Jacket.

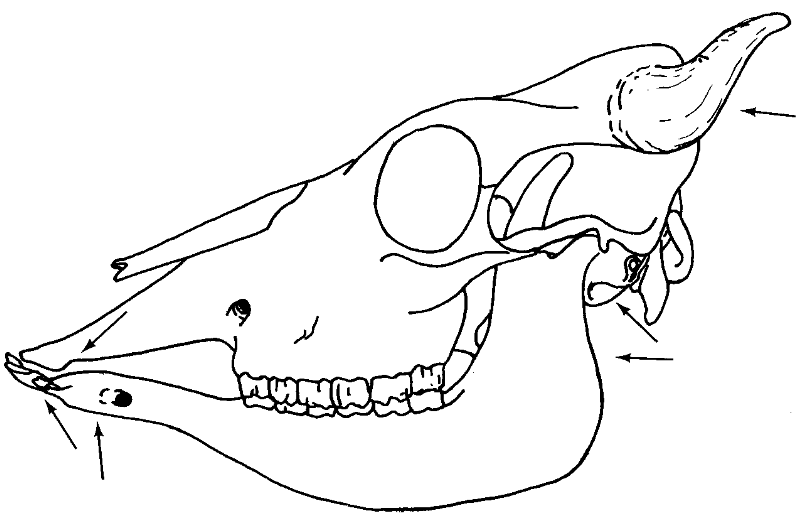


FIGURE 1. Left side view of Bos taurus skull. Arrows indicate (a) loss of upper incisors and incisors and canine and presence of horny pad; (b) incisiform lower canine; (c) unfused symphysis of lower jaw; (d) absence of angular process at back of mandible; (e) spheroidal bulla with central pit; and (f) presence of frontal horns.

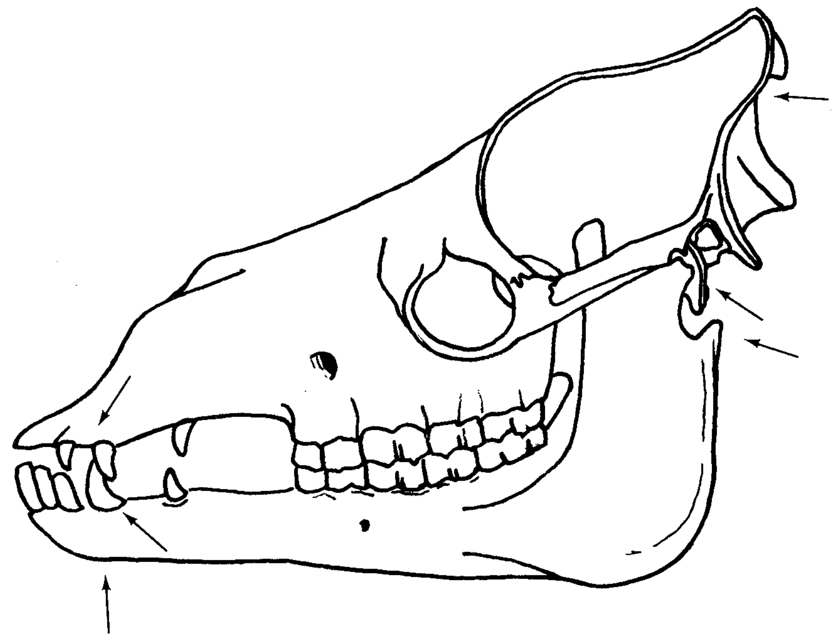


FIGURE 2. Left side view of Camelus dromedarius skull. Arrows indicate (a) presence of upper third incisor, true canine, and first premolar; (b) upright lower canine; (c) fused symphysis; (d) hook-like angular process; (e) folded bulla; and (f) absence of horns or antlers.

In their dentitions, camels and ruminants, even in the late Eocene, tend to open up a gap (diastema) between the grinding cheek teeth (molars and most of the premolars) and the grasping teeth (incisors and canines) (Figs. 1 and 2). The teeth in the area of the diastema either function as biting (caniniform) teeth or are soon lost. Early ruminants retain only the upper canine as such a tooth, and later most lose even that canine; whereas camels retain two or three upper caniniforms, I^3, C^1, and P^1. A remarkable feature of ruminants (and some other selenodonts) is that the lower canine is pressed into service as a fourth incisiform tooth. This is why the moose jaw, for example, presents an incredibly broad array of eight spatulate incisors across the front of its mandible. And, in a giraffe, with a bilobed lower canine, the lower incisor battery appears to include 10 cutting edges. Early in the history of ruminants, as in that of camels, the upper row of incisiform teeth becomes reduced and is soon lost. In the ruminants the lower incisiforms bite against a horny pad, and in camels they work in conjunction with strong split upper lips.

The diastema in front of the cheek teeth tends to become more elongate in most groups of ruminants and camels in the course of their history. The anterior premolars (both upper and lower) are soon lost and the next premolars tend to become reduced (in ruminants) or even lost (in progressive camels). The function of the diastema is to allow the tongue to manipulate vegetation as it is carried from incisors to grinders.

Both ruminants and camels have retained the four-crescent pattern characteristic of selenodont teeth (Plaster Jacket #39). And early in their history, the upper premolars of both camels and ruminants independently take on the appearance of half molars by raising the low lingual wall (cingulum) to form a new crescent. The lower premolars develop in quite a different way in the ruminants than in the camels. As they become shorter the lower premolars become wider in the ruminants by forming three or more transverse lophids. In camelids, however, when the lower premolars become wider, it is accomplished by adding a longitudinal ridge.

The lower jaw shape differs markedly between camels and ruminants, and the same distinctions (though subtler) can be made between smaller Oligocene examples of these groups as between large Recent species. One obvious difference is the weakly fused symphysis between the jaw halves in ruminants as contrasted with the solid fusion of the symphysis in camels. Another key difference is the presence of a distinct angular process in camelids and its absence in ruminants.

Another ancient distinction between camels and ruminants is found in the auditory bullae, or bony capsules, surrounding the middle ear region. Although the detailed bullar shapes vary considerably among the ruminants, they are all more or less hemispherical, surrounding the pit for the hyoid bone. In camels, by contrast, the bullae are all V-shaped, as if they had been "folded" back on both sides of the hyoid bone.

Postcranial Osteology

Turning to the skeleton, one can further distinguish ruminants from camels (Figs. 3, 4). The vertebral series of camels are notable for supporting "humps," but that is a relatively modern feature, not distinctive of the whole group and only subtly indicated by the heights in a series of thoracic spines. A more ancient and more useful peculiarity of camel cervical vertebrae is the course of the pair of vertebral arteries. In camels the canal lies inside the wall of each cervical vertebra, whereas in ruminants (and other mammals) the arterial canal is more readily visible, penetrating the base of each transverse process, essentially "outside" the wall of each cervical vertebra.

The limbs of living camelids and ruminants differ in many respects, as anyone can readily see. In the early Tertiary, however, there are fewer, and in many cases different, distinctions between the two groups.

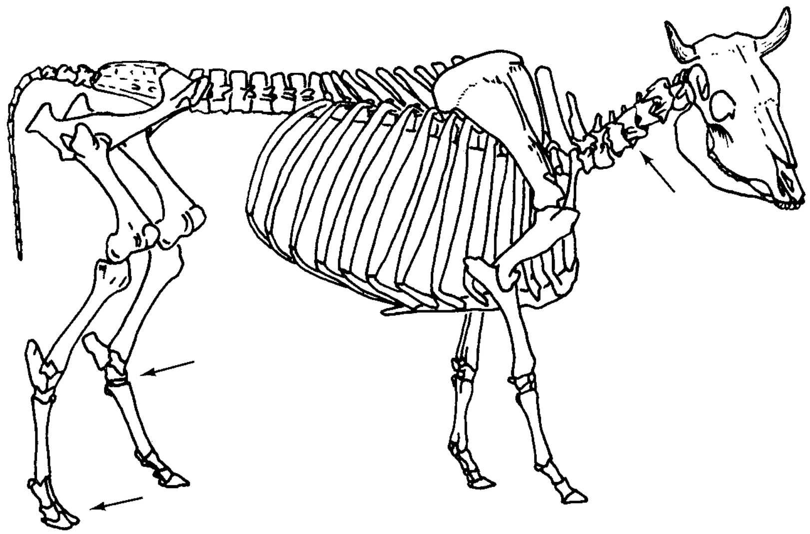


FIGURE 3. Skeleton of Bos taurus. Arrows indicate (a) presence of vertebral artery canal outside cervical vertebrae; (b) fused cubonavicular elements in tarsus; and (c) "cloven hooves" and unguligrade feet.

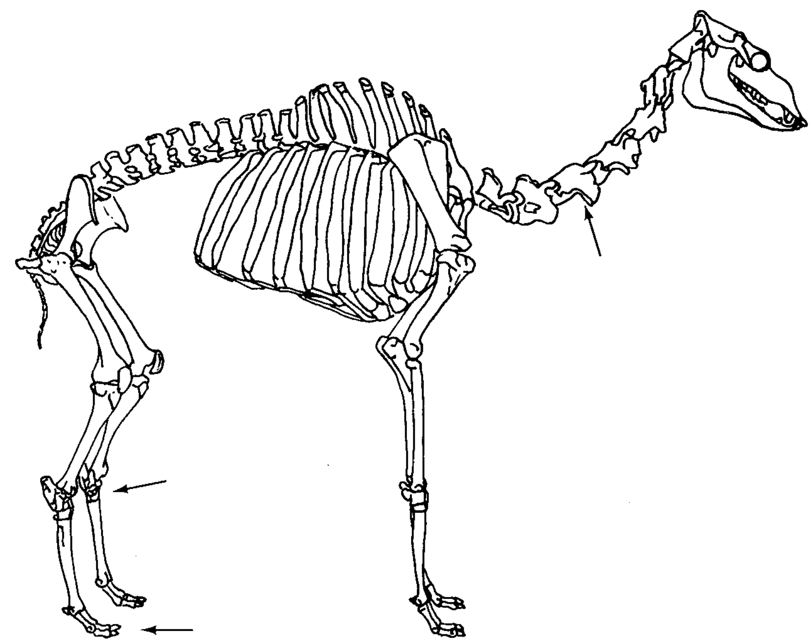


FIGURE 4. Skeleton of Camelus dromedarius. Arrows indicate (a) canal for vertebral artery not visible externally on cervical vertebrae; (b) cuboid and navicular elements (below astragalus) separate; and (c) padded feet in digitigrade stance.

Both camels and ruminants tended to develop long limbs for running. Major sites of elongation were the radius in the forelimb and the tibia in the hindlimb; and as these bones took on the principal function of running, the adjacent shafts of the bones (ulna and fibula) were reduced or lost, leaving only proximal and distal vestiges variously attached or fused onto the radius or tibia. The metapodials became elongate, providing in effect an extra limb segment between the wrist (in front) or ankle (in the rear) and the toes. At the same time the feet were extended to support the animal's weight entirely on the tips of the toes.

The central pair of toes, equivalent to our middle and fourth fingers and toes, shared the weight and became elongate together. Each foot bore an enlarged pair of hoofs which are often (but inaccurately) called "cloven hoofs" in ruminants.

As the cursorial (running) limbs became more elongate, they also reduce their other functions. For example, no ruminant can grasp with its feet, and it therefore has very limited need to rotate the limb around its own long axis. Most limb movement is confined to swinging, pendulum-like, in a fore and aft plane, and most locomotor muscles are confined for efficiency to the upper part of each limb. When one looks at a ruminant the humerus and femur seem lost in powerful muscle masses near the shoulder and hip, respectively.

With these functional specializations come the reduction and fusion of various expendable bony elements. As the radius and tibia become the long strong bones of the limbs, the ulna and fibula lose their shafts, and are each reduced to a proximal and a distal vestige. The proximal end of the ulna, onto which the most powerful extensor muscles of the forelimb insert, fuses to the radius. The distal end of the fibula, which helps lock the bones of the ankle joint as they rotate, does not fuse to the tibia, but is heavily tied into place with ligaments.

In the feet the metapodials and phalanges outside of the central pair are reduced to vestiges under the skin or are eventually lost.

Although similar specialization of the limbs for running occurs in many mammal groups, the details work out differently. In horses, for example, the distal limb elements and side toes are reduced to vestiges, but the fibula becomes solidly fused to the tibia and the fourth toe, which remains functional in ruminants, becomes one of the vestigial side splints in horses.

In most respects the limbs of ruminants and camels are modified in much the same manner. About the only completely diagnostic features are the fusion of two proximal carpal elements, the trapezoid and magnum, and two proximal ankle elements, the cubonavicular, that characterize the ruminants.

In the late Eocene and Oligocene most members of the Tylopoda were more progressive than most members of the Ruminantia in elongation of limbs and reduction of side elements. On the other hand, in the mid to late Miocene, there was a general reversal of these roles. During that time the great radiation of horned and antlered ruminants generally produced animals with essentially modern kinds of limb structure. One key feature that developed by then, but which camelids never developed, were complete keels on their metapodials. At the same time the camels, then still confined to North America, produced the "fallen feet" which still characterize the group today. Thus, as noted in Plaster Jacket No. 39, they no longer stand on the tips of their toes but on pads beneath the whole digit, their hooves are reduced and splayed out, and their metapodials and feet are correspondingly modified in several other ways that seem retrogressive compared to ruminants.

Ruminant Dispersals to the New World

In their early history, the ruminant ancestors were remarkably obscure. They originated as part of the late Eocene radiation of selenodont artiodactyls, the same one that produced camels (Plaster Jacket #39). The primary center of the selenodont radiation was presumably in Asia, with secondary radiations in Europe, Africa, and North America.

Ruminant Immigrants

Among the early families of selenodonts that reached North America in the late Eocene were camels, oreodonts, and two families of early ruminants, the Hypertragulidae and the Leptomerycidae. These first selenodonts, as well as the first rabbits from Asia, came when climatic conditions in north temperate regions had turned cooler and drier, and predominantly subtropical rain forests had given way to extensive thorn scrub and open savanna habitats. Such settings favored the earliest ruminants in North America when they arrived in the late Eocene.

The range of environments in North America continued to shift toward cooler drier conditions in the Oligocene and the later Cenozoic. This was part of a worldwide climatic trend that culminated in the Pleistocene Ice Ages. As the climate deteriorated, predominant midcontinental habitats shifted from forest to savanna and then from savannas to grassland and steppe. This environmental trend, which shifted the predominant vegetation from lush tropical foliage to dry fibrous herbs and siliceous grasses and from leaves to thorns and grasses, had much to do with the success of the ruminants.

The primary center of ruminant evolution was in the Old World. North America received representatives of most, but not all, successive stages of ruminant development during the Cenozoic epochs. For example, the family Tragulidae, the second most primitive ruminant family (next to Hypertragulidae), never reached this continent. Yet it still survives as relict genera restricted to enclaves of equatorial rain forest in the African Congo and in southeastern Asia. The succession of at least eight ruminant families that immigrated to North America are indicated in Figure 5.

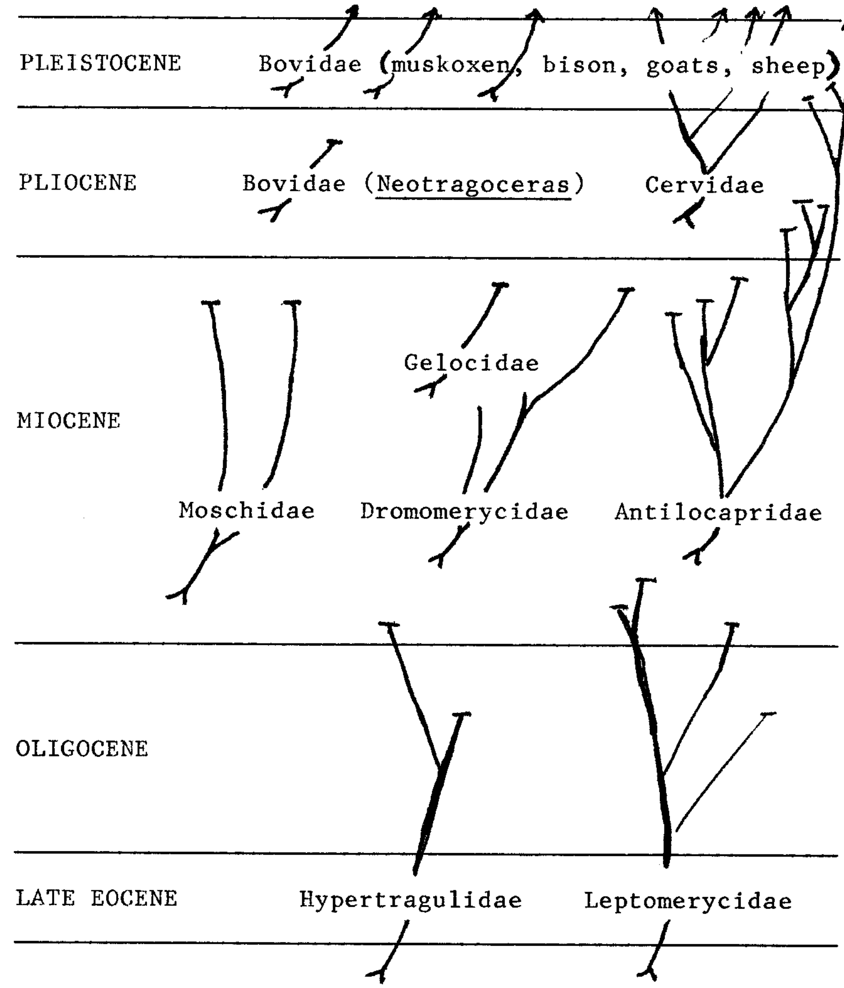


FIGURE 5. Ruminant immigrants into North America during the Cenozoic Era.

Two of these families, Dromomerycidae and Antilocapridae, are recognized as endemic North American families, even though they surely came from the Old World during the early Miocene. These arbitrary family definitions are convenient because their exact Old World antecedents are obscure and because their subsequent North American descendents were highly successful. Only one other major ruminant family (besides Tragulidae) did not reach North America, and they were the Giraffidae, but Dromomeryidae are clearly related. The Bovidae did not come until late in the Cenozoic; in the Pleistocene several steppe and grassland species came to North America. Likewise of the Cervidae, several successive genera reached North America in the Pleistocene.

All eight ruminant families that reached North America in the middle and late Tertiary are represented in Florida. Part 2 of this history of ruminants will feature typical fossil ruminants from Florida.