The PLASTER JACKET is a newsletter about fossil vertebrate animals of Florida. Its purpose is to circulate authoritative material on vertebrate paleontology and to foster communication among the growing number of enthusiasts of this subject.

Questions, announcements and other communications are solicited from all readers. Information of general interest will be included in future issues.

It is our intent to produce this series at the rate of about one issue per quarter year. We hope to add as many genuinely interested paleontologists as possible to our mailing list. If you are interested please send your name and address to the PLASTER JACKET. These issues are distributed free of charge to all interested people.

- FLORIDA STATE MUSEUM
- UNIVERSITY OF FLORIDA
- GAINESVILLE
FOSSIL HORSES OF FLORIDA

by

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INTRODUCTION

Horses first appear as fossils in North America and Eurasia during the Eocene, about 50 million years ago. Subsequent evolution of the family, the Equidae, has centered in North America and is better understood than most other groups of mammals because of the great abundance of fossils, representing virtually its entire history.

The climate of the Eocene was much warmer than today, and tropical forests inhabited by the earlier horses covered much of North America and Eurasia. During the Miocene, about 25 million years ago, the climate slowly began to get cooler and drier, and grasslands became progressively abundant. Those horses moving into the grassland habitat became faced with a new environment to which they were not fully adapted. Although more nutritious than leaves and twigs, grass is much tougher and has adhering particles of abrasive sand and silt. These particles, ingested along with the grass, cause serious attrition to low-crowned teeth, often wearing them down to the gum line before the horse reaches maturity. Through natural selection, horses have solved this problem in two ways. The first adaptation involved heightening of the crown of the tooth, which lengthened its functional life, secondly the tooth was strengthened by filling in spaces in the enamel with cementum, an adaptation which also provided the tooth with a larger grinding surface. This evolutionary change from a low-crowned cementless tooth to a high-crowned cemented tooth resulted in a more efficient grazing dentition (Fig. 8).

Another problem faced by the horse in this open grassland environment was that of escaping predators. The forest provided cover for hiding, but in this new, more vulnerable situation, the horse had to depend more on alertness afoot for survival. The earliest horses were four-toed animals, about the size of a medium-sized dog, and like the dog, had a tough pad associated with each toe. For the small, early forest-dwelling horse, this was an efficient running mechanism. As the horse became larger and began a shift to the grassland environment, this pad foot became less efficient and natural selection favored the horses with longer, stronger, and fewer toes, and stronger, more complex ligament attachments. The result was a powerful springing foot which greatly increased running efficiency. Along with this change in the foot was a reduction, fusion, and modification of bones in the foot and limbs, especially in the wrist and ankle. This restricted the movement of the limbs to a fore-aft motion and greatly reduced the chances of a sprain. Thus, in response to changes in size and environment, the horse has perfected the running method to better escape predators.

![Figure 1. Grinding surface of the tooth. The heavier black line represents the enamel, the stippled area, cementum, and the white area, dentine. (After Simpson, 1951)](image-url)
Most fossil mammal taxonomy is based on teeth as these are found most commonly and tend to reflect major evolutionary changes, since the food habits greatly influence evolutionary direction the the mammals. Figure 1 illustrates the principal features of horse teeth. Identification is based on the relationship of these features to one another, the presence or absence of a feature, the relative size and shape of the chewing surface, the presence or absence of cement, and whether the tooth is high crowned (hypsodont) or low crowned (brachydont).

Parahippus Merychippus Pilohippus
brachydont subhypsodont hypsodont

Figure 2. Relative height of crowns of three horse genera showing the transition from low to high crowns.

Several complicating factors must be considered in attempting species identification. Tooth characters vary with position in the tooth row as well as with stage of wear. As in most mammals, the premolars tend to have simpler enamel patterns than the molars. In early and late wear stages, the pattern of enamel folding is more simple than in middle wear stages. Maximum complexity occurs at approximately one-third the total tooth length. In determining whether a tooth is high crowned or low crowned, the wear stage must be considered. Keeping these factors in mind, one should be able to identify the common horse teeth found in Florida.

Horses are first found in Florida in deposits of Oligocene age and they abounded here until the end of the Pleistocene when they became extinct over all of North America. The equids now living here were reintroduced from the Old World by the Spanish conquistadors.

The following pages are a summary of the common horses of Florida with the characters for their identification. Unless otherwise stated, the discussion concerns only upper cheek teeth.

OLIGOCENE

The only Oligocene horse found in Florida and tentatively identified as Mesohippus, was recovered from a small deposit near Gainesville.

MIocene

Parahippus (Fig. 3A), the common Miocene genus in Florida, represents a stage about half-way up the phylogenetic tree of horses. It was about the size of a modern domestic goat. The cheek teeth have moderately complex enamel folding and are lightly covered with cement. The crowns are about an inch high. Each foot bears three toes; however the middle toe is the largest and supports most of the weight. Two species are present in Florida, Parahippus leonensis, a large form, and Parahippus blackbergi, a small one.

Figure 3. Occlusal views of A) Parahippus B) Merychippus. (Natural size)
Another Miocene genus, *Merychippus* (Fig. 3B), is sometimes found in Florida deposits that are younger than those in which *Parahippus* is found. *Merychippus* differs from *Parahippus* in having slightly more hypsodont teeth and more cement on these teeth.

**PLIOCENE**

Several genera of horses are found in the Pliocene deposits of Florida. These have high-crowned, fully cemented teeth and fall into two categories; the hippocironines, characterized by separate protocones in the upper molars, and the equines with protocones connected to the rest of the enamel. The hippocironines have three toes, while the equines characteristically are single toed. The three-toed group is by far the more common and diversified in Florida. The four hippocironine species most frequently found are, in order of increasing size: *Nannippus minor*, *Nannippus ingenuus*, *Hipparion plicatile* and *Neohipparion euryystyle*. The equine line is represented by the genera *Caliippus* and *Pliohippus*; however, due to the rarity of specimens, the exact specific names of the latter are uncertain.

*Nannippus minor*

*Nannippus minor* (Fig. 4A) is fairly easily recognized by its diminutive size. The protocone is separate and almost oval; the enamel of the fossettes is complexly folded. The only horses with which it may be confused are *Nannippus ingenuus*, which is slightly larger, and *Caliippus*, which has a connected protocone and a much simpler enamel folding. *Nannippus minor* is endemic to Florida and has no small hippocironine counterpart in the Pliocene faunas of the western United States.

*Nannippus ingenuus*

*Nannippus ingenuus* (Fig. 4B) is easily confused with *Nannippus minor*. However, it is distinguished from the latter by its slightly larger size and less complicated enamel folding. The separate protocone tends to be elongate rather than oval as in *Nannippus minor*. *Nannippus ingenuus* differs from *Nannippus phlecon*, which occurs later in time, by having a more nearly square crown and being less hypsodont.

![Figure 4. Occlusal views of A) Nannippus minor, B) Nannippus ingenuus, C) Nannippus phlecon. (xl) Hipparion plicatile](image)

This species (Fig. 5A) is easily identified by its large size and the extreme complexity of its enamel folding. The protocone is separate and almost oval. In this genus, the trend toward enamel complexity in the three-toed horses reaches its climax. In the drawing notice especially the extreme complexity of the fossette folding.

**Neohipparion euryystyle**

*Neohipparion euryystyle* (Fig. 5B, C) is always larger than *Hipparion plicatile*. It is distinguished from that species by its simpler enamel pattern and its very elongated protocone. The lower teeth of this horse can be identified by the extra fold (pli cabal-linid) (Fig. 5C) on the inside of the tooth. The Florida specimens were originally named *Neohipparion phosphorum* by Simpson in 1930, but this species has since been found to be identical with *Neohipparion euryystyle*, described earlier from the Pliocene of Texas and therefore *N. phosphorum* must assume the earlier name.
Calippus

Calippus (Fig. 6A), like Pliohippus, exhibits a very simple enamel pattern and a connected protocone. Calippus is readily separated from Pliohippus, however, by its small size and nearly straight tooth as viewed from the side. Calippus is as small as Nannippus minor but has a simpler enamel folding and a connected protocone.

Pliohippus

Two kinds of Pliohippus (Fig. 6B) are found in Florida, a large and a medium sized species. The protocone is connected as in modern Equus, but unlike Equus, it is nearly circular and the enamel folding of the fossettes is less complex. Pliohippus teeth are strongly curved as viewed from the side, whereas in Equus the teeth are nearly straight. Some member of the Pliohippus group gave rise to Equus in the Pleistocene.

Early Pleistocene

Nannippus phlegon (Fig. 4C) occurs in deposits of early Pleistocene age in Florida. This species is about the size of Nannippus ingenuus and both have only moderately folded fossettes and separate protocones. The cheek teeth of Nannippus phlegon are more nysodont and the chewing surface tends to be more elongate in the anterior-posterior direction than in N. ingenuus. Nannippus phlegon is usually found with primitive species of Equus. This last surviving hipparionine horse became extinct in the earliest Pleistocene.

Figure 5. Occlusal views of A) Hipparion plicatile and Neohipparion eurystyle B) Upper molar, C) Lower molar. (Natural size)

Pleistocene

The modern genus, Equus (Fig. 6C), is a characteristic member of Pleistocene faunas. Equus teeth are distinguished from teeth of most of the Pliocene three-toed horses by the connected protocone, and from teeth of Calippus by the long toe and heel developed on the protocone. Equus teeth are large, high-crowned, and have fairly complex enamel folding. Several fossil species of Equus have been described from Florida, but they are usually difficult to separate from each other without large samples, so it is not attempted in this paper. All are difficult to separate from the reintroduced Old World species, Equus caballus.

Figure 6. Occlusal views of A) Calippus, B) Pliohippus, C) Equus. (Natural size)

Skeleton

The post-cranial (skeletal) elements of horses are strongly modified for a swift-running (cursorial).
function. Except for the metacarpals and phalanges, the front limb elements of horses generally resemble those of other cursorial ungulates. The hind limb elements are a little more characteristic. The femur is separated by having a third trochanter (or process) for muscle attachment (Fig. 7A). The tibia lacks the deep fibular facet of the artiodactyls and has the grooves for the astragalus running at an oblique angle across the distal end (Fig. 7B). The tibia of a tapir is similar, but the grooves are shallower and more widely spaced. The astragalus of the horse is easily distinguished from the astragalus of the artiodactyls by having only one deeply grooved end; the other end being broadly flattened (Fig. 7C). Again, the astragalus of the tapir is similar but the groove is shallower and wider. Figure 7D shows a metapodial (metacarpal or metatarsal), phalanges or toes, and the hoof bone of a three-toed horse. *Equus* differs from this in having the side toes reduced to functionless splint bones.

Figure 7. Diagnostic post-crani al elements:
A) Right femur. The arrow indicates the third trochanter. B) Distal end of the tibia, C) Astragalus, D) Front foot of a three-toed horse.

Figure 8. Evolution of horse teeth. Teeth are not drawn to scale. (After Simpson. 1951. *Horses*. Oxford U. Press, N.Y.)