PRELIMINARY CORRELATION OF FLORIDA AND CENTRAL GREAT PLAINS PLIOCENE AND PLEISTOCENE MAMMALIAN LOCAL FAUNAS BASED ON RODENT BIOSTRATIGRAPHY

Robert A. Martin[1]

A preliminary attempt is made to correlate the late Pliocene and Pleistocene mammalian local faunas of peninsular Florida with those of the central Great Plains. Critical taxa among the rodents are the cotton rats, genus *Sigmodon*, and the arvicolids, especially *Ondatra* and *Microtus*. The dense rodent fossil record and accompanying radiometric dates of the Meade Basin of southwestern Kansas provide a chronological template for North American rodent faunas, and suggest that mammalian local faunas from the late Blancan Haile 15A through Rancholabrean of Florida may be fit into five of Martin's Great Plains rodent zones.

Key Words: Florida; rodent; biostratigraphy; correlation; Pliocene; Pleistocene

INTRODUCTION AND METHODS

Florida's late Pliocene and Pleistocene mammalian record is one of the richest in North America. More than 50 local faunas (l.f.s), from cave, sinkhole, estuarine, and possibly freshwater lacustrine sediments, span late Blancan through late Rancholabrean time. Most are less than 2.0 million years (my) old, but a few extend into the period of 2.0-2.5 Ma (million years ago). Absence of land mammalian fossils from the period representing most of the Pliocene (a period from about 4.5-2.5 Ma; Morgan & Hulbert 1995) probably results from a high stand of sea level that either covered Florida or reduced it to an island archipelago. Various high stands of sea level are known throughout the later Pliocene in Florida; indeed even the Blancan Haile 15A l.f. from north-central Florida, now 30 m above sea level and 80 km inland from the Gulf of Mexico, represents a time of high sea level, as evidenced by an accompanying fish fauna that includes estuarine and marine species (Robertson 1976). Because of an almost universal absence of stratigraphic superposition, Florida's mammalian assemblages have been sequenced primarily on hypotheses of vertebrate history, augmented by a limited amount of geological information based on presumed eustatic changes in sea level (e.g., Webb 1974; Webb & Wilkins 1984; Lundelius et al. 1987). Although early attempts at correlation tried to fit Florida l.f.s into the then standard four continental glacial sequence, this approach was abandoned by the 1990's (e.g., Morgan & Hulbert 1995). Also, more sophisticated methods, including magnetic polarity and strontium isotope stratigraphy, are now being applied where appropriate (Jones et al. 1995; MacFadden 1995). This work, in concert with an increasingly dense mammalian record, enabled Morgan and Hulbert (1995) and Morgan and White (1995) to develop a chronological hypothesis for Florida mammalian assemblages. They suggested a sequence of eight mammalian horizons, including the following: late Blancan (2.5-2.0 Ma), latest Blancan (ca. 2.0 Ma), earliest Irvingtonian (2.0-1.6 Ma), late early Irvingtonian (1.6-1.0 Ma), middle Irvingtonian (1.0-0.6 Ma), late Irvingtonian (0.6-0.3 Ma), early Rancholabrean (0.3-0.13 Ma), and late Rancholabrean (0.13-0.01 Ma). With the revised definition of the beginning of the Irvingtonian by Bell et al. (2004), the earliest Irvingtonian faunas of Morgan and Hulbert (1995) are now latest Blancan.

During the later 1990's, a team of paleontologists coordinated from Murray State University began a new period of fieldwork in the Meade Basin of southwestern Kansas, from where the late C. W. Hibbard and his students from the University of Michigan had recovered a series of mammalian microfaunas spanning the past five million years (reviewed by Zakrzewski 1974, 1988; Martin et al. 2000). Many new localities were discovered, and the geology of the region was re-mapped,

[1]Department of Biological Sciences, Murray State University, Murray, KY 42071<robert.martin@murraystate.edu>

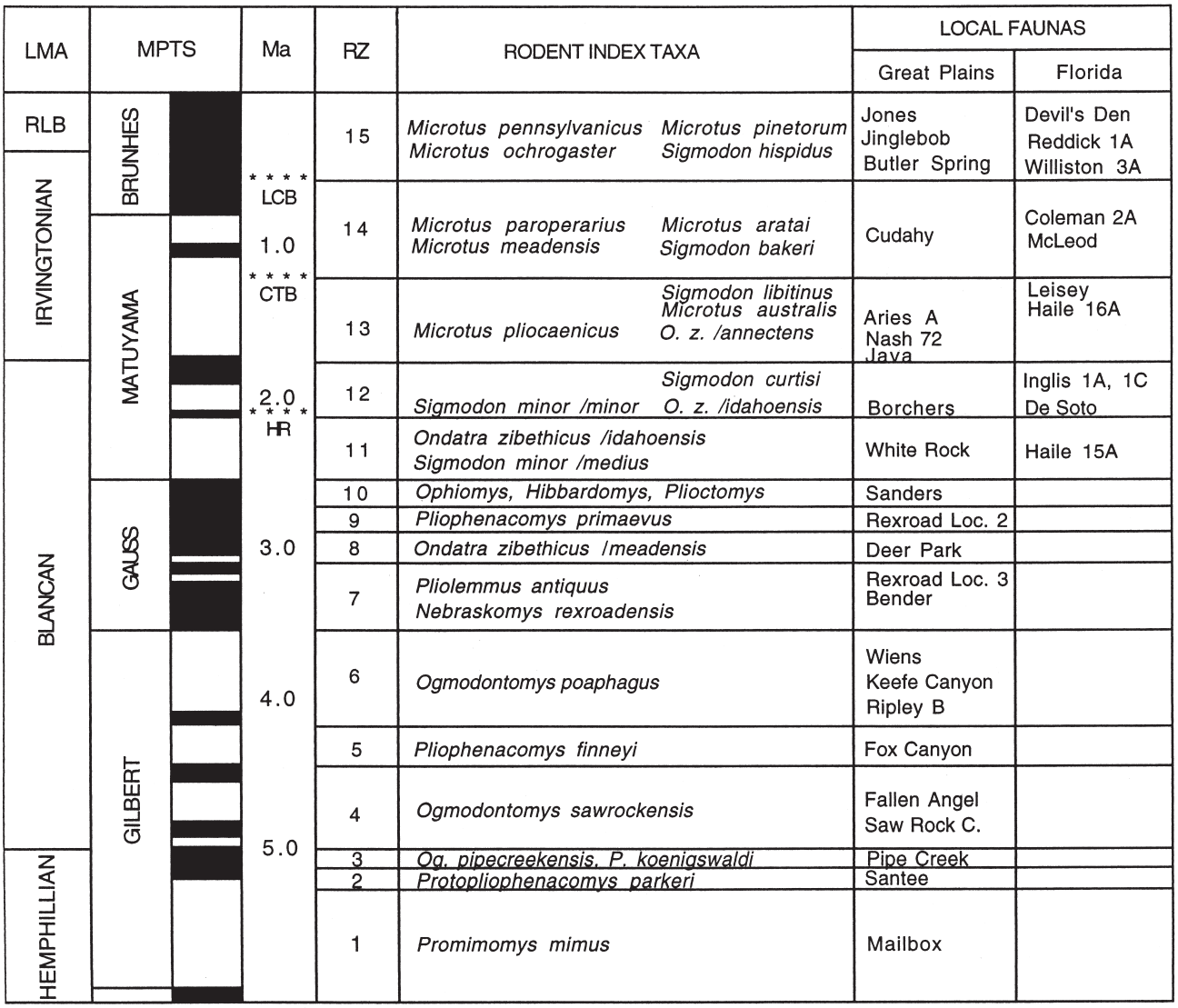

Figure 1. Biochronologic correlation chart between Pliocene and Pleistocene local faunas of Florida and the Great Plains using the Rodent Zones (RZ) of Martin (2003). LMA, land mammal ages; MPTS, magnetic polarity time scale; LCB, Lava Creek B ash; CTB, Cerro Toledo B ash; HR, Huckleberry Ridge ash.

resulting in a revised stratigraphic hypothesis (Izett & Honey 1995; Martin et al. 2000, 2002b, 2003; Fig. 1). The combination of radiometric calibration points, stratigraphic superposition, some paleomagnetic data, and a dense rodent record, makes the Meade Basin a strong reference sequence for the later Cenozoic. In concert with information from studies of small mammal fossils from other localities in the Great Plains states and nearby Indiana (e.g., L. Martin 1974, 1979; Voorhies 1988; R. Martin et al. 2000, 2002a), Martin (2003) developed a regional rodent zonation, proposing 15 horizons covering the Pliocene and Pleistocene. This paper attempts a preliminary correlation of the Florida sequence of mammalian local faunas with that of the central Great Plains, relying especially on evolutionary and dispersal patterns of the rodents.

Species lists of Florida Pliocene and Pleistocene rodents from Martin (1974), Webb and Wilkins (1984), Morgan and Hulbert (1995), and Morgan and White (1995) were compared to those generated from local faunas of the Meade Basin of Kansas (Martin et al. 2000) and to the index rodent taxa for Great Plains local faunas suggested by Martin (2003). A detailed review of these species and the faunas from which they were

recovered was presented by Martin (2003), and will not be repeated here. A primary assumption for this study is that rodent dental evolution progressed at roughly equivalent rates in Florida and on the Great Plains. Given the geologically instantaneous dispersal of introduced modern muskrats throughout Eurasia and the relative temporal consistency of North American muskrat dental features at a given time horizon throughout its fossil record (Martin 1996), this assumption seems reasonable, and is further supported by other studies on a variety of rodent taxa (Martin 1993; Martin et al. 2000). Following Martin et al. (2002b), the Blancan is informally broken into three intervals of roughly equal duration: late Blancan = 1.8-3.0 Ma (million years ago), middle Blancan = 3.0-4.0 Ma, and early Blancan = 4.0-5.0 Ma.

RESULTS AND DISCUSSION

Figure 1 portrays a tentative correlation of Florida l.f.s with those from the Great Plains. As suggested by Morgan and Hulbert (1995) and Morgan and White (1995), the Florida assemblages likely span a period of about 2.5 my. North American late Blancan mammalian local faunas older than this, presumably deposited within the period 2.6-3.0 Ma, include *Ondatra zibethicus* / *meadensis*, a more primitive muskrat lacking cementum in the molar re-entrant folds than those first recorded from Florida Blancan sites. Example localities include Deer Park A, Kansas (Martin et al. 2002b), Sand Draw, Nebraska (Hibbard 1972), and Boyle Ditch, Wyoming (Barnosky 1985). Local faunas in Florida with the diminutive cotton rat *Sigmodon minor* (= *S. medius*) are considered Blancan. Morgan and White (1995) first reported the presence of two *S. minor* size classes in Florida. This species was shown to dwarf simultaneously in Kansas and Arizona at the close of the Blancan (Martin 1970). In Kansas, this event is closely associated with deposition of the Huckleberry Ridge ash at 2.10 Ma (Izett & Honey 1995). Martin et al. (2002b) referred the larger, earlier morph, to *S. m.* /*medius*, and the dwarf form to *S. m.* /*minor*. This taxonomy is applied to Florida assemblages, and on this basis the De Soto Shell Pit l.f. (with *S. m.* /*minor*) is assumed to be younger than that from Haile 15A (with *S. m.* /*medius*), the former possibly deposited about 2.0-2.1 Ma. Morgan and White (1995:85) included the De Soto Shell Pit l.f. in their early Irvingtonian zone, with the Inglis 1A l.f., but Inglis 1A does not include *S. minor*. This is not likely an artifact of sampling, as Inglis 1A is a very rich locality. It seems probable that *S. minor* was extinct in Florida by Inglis 1A time. Inglis 1A and 1C are considered here as late Blancan, rather than early Irvingtonian, because they include *Ondatra zibethicus* /*idahoensis* and lack *Microtus*. In Kansas *Sigmodon curtisi* is associated with *Microtus* cf. *pliocaenicus*. The Inglis l.f.s apparently existed prior to the dispersal of *Microtus* to North America, and they are therefore considered to represent a late segment of Blancan time not exactly contemporaneous with the Borchers l.f. This is consistent with the large mammals, a number of which are more typically considered as Blancan indicators and the absence of *Mammuthus* (Bell et al. 2004; Morgan 2005). The De Soto Shell Pit and Inglis 1A and 1C l.f.s are therefore assigned to RZ (Rodent Zone) 12.

The first appearance data (FADs) for *Microtus australis*, *Sigmodon libitinus*, and *Ondatra zibethicus* /*annectens* characterize RZ 13 in Florida, but they are not likely contemporaneous with Great Plains l.f.s that lie between the Huckleberry Ridge (2.1 Ma) and Cerro Toledo B (1.23-1.47 Ma) ashes that were used to define RZ 13. These assemblages, such as Java, Nash 72, and Aries A, include *Microtus* cf *pliocaenicus*, which has a considerably less advanced dental morphology than *M. australis* from Haile 16A and Leisey (Martin 1995). Fortunately, however, the advanced muskrat *O. z.* / *annectens* is found in all these assemblages, and with *Microtus* can be used as an effective marker for RZ 13.

Another wave of arvicolid dispersal/evolution is represented in Kansas by the RZ 14 Cudahy *Microtus*, with *M. paroperarius*, *M. meadensis*, and *M. ochrogaster* /*llanensis*. The Cudahy rodents were recovered directly below the Lava Creek B ash radiometrically dated at 0.67 Ma. In Florida, this general time period in the Irvingtonian appears to be represented by the Coleman 2A and McLeod Mine l.f.s (Martin 1974; Morgan & White 1995; Bell et al. 2004), which include *Microtus aratai* and *Sigmodon bakeri*, both advanced over their RZ 13 predecessors. Morgan and Hulbert (1995) suggest that McLeod is somewhat older than Coleman 2A, both falling in the time period 1.0-0.3 Ma.

Predominantly modern rodent faunas are represented by a host of latest Irvingtonian and early Rancholabrean l.f.s from the Great Plains (reviewed by Davis 1987) and Florida (Webb 1974; Morgan and Hulbert 1995). Two of the common rodent indicators in Florida for RZ 15 are *Microtus pinetorum* and *Sigmodon hispidus*, although *Sigmodon bakeri* extends into the early part of RZ 15. *Oryzomys palustris* also first appears during RZ 15.

In both the Great Plains and Florida, the rodent zones may be broken down into regional horizons. For example, in Florida RZ 12 could be split into RZ 12A and RZ 12B based on the differences discussed above. At least two subzones exist in the Florida RZ 15. The earliest faunas (e.g., Williston 3A, Haile 7A) include *Microtus pinetorum* /*hibbardi* and *Sigmodon bakeri*. Middle RZ 15 l.f.s include those with *Sigmodon hispidus* and *Microtus pinetorum* /*parvulus*, such as Reddick 1A, Seminole Field, Vero, and Devil's Den. Although originally developed primarily as a Great Plains regional biostratigraphic tool, the 15 rodent zones may have some utility to form the basis of a new North American rodent biochronology.

ACKNOWLEDGEMENTS

S. D. Webb, G. Morgan, and R. Hulbert have contributed to this project through their many years of professional courtesy and shared information on Florida paleontology. I am most grateful to R. Zakrzewski, C. Repenning, L. Martin, A. van der Meulen, K. Hordijk, and C. Bell for conversations and debates on arvicolid evolution and classification. The National Geographic Society ((5963-07, 6547-99) and National Science Foundation (EAR-0207582) are acknowledged for their support of the Meade Basin Rodent Project.

REFERENCES CITED

Barnosky, A. D. 1985. Late Blancan (Pliocene) microtine rodents from Jackson Hole, Wyoming: biostratigraphy and biogeography. Journal of Vertebrate Paleontology, 5(3):255-271.

Bell, C. J., E. L. Lundelius, A. D. Barnosky, R. W. Graham, E. H. Lindsay, D. R. Ruez, H. A. Semken, S. D. Webb, & R. J. Zakrzewski. The Blancan, Irvingtonian, and Rancholabrean Mammal Ages. Pp. 232-314 *in* M. O. Woodburne, ed. Late Cretaceous and Cenozoic Mammals of North America: Biostratigraphy and Geochronology. Columbia University Press, New York.

Davis, L. C. 1987. Late Pleistocene/Holocene environmental changes in the Central Plains of the United States: the mammalian record. Pp. 88-143 *in* R. W. Graham, H. A. Semken, Jr., & M. A. Graham, eds. Late Quaternary Mammalian Biogeography and Environments of the Great Plains and Prairies. Illinois State Museum Scientific Papers, Volume 22.

Hibbard, C. W. 1972. Class Mammalia. Pp. 77-130 *in* M. S. Skinner & C. W. Hibbard, eds. Early Pleistocene preglacial rocks and faunas of north-central Nebraska. Bulletin of the American Museum of Natural History, 148:77-130.

Izett, G. A., & J. G. Honey. 1995. Geologic map of the Irish Flats quadrangle, Meade County, Kansas. U. S. Geological Survey Miscellaneous Investigations Series Map I-2498, scale 1:24,000.

Jones, D. S., P. A. Mueller, T. Acosta, & R. D. Shuster. 1995. Strontium isotope stratigraphy and age estimates for the Leisey Shell Pit faunas, Hillsborough County, Florida. Bulletin of the Florida Museum of Natural History, 37(2):93-106.

Lundelius, E. L., M. F. Skinner, R. W. Fields, J. M. Rensberger, D. P. Whistler, T. Galusha, B. E. Taylor, J. R. Macdonald, & S. D. Webb. 1987. The North American Quaternary sequence. Pp. 211-235 *in* M. O. Woodburne, ed. Cenozoic Mammals of North America. University of California Press, Berkeley.

MacFadden, B. J. Magnetic polarity stratigraphy and correlation of the Leisey Shell Pits, Hillsborough County, Florida. 1995. Bulletin of the Florida Museum of Natural History, 37(3):107-116.

Martin, L. D. 1975. Microtine rodents from the Ogallala Pliocene of Nebraska and the early evolution of the Microtinae in North America. Pp. 101-111 *in* G. R. Smith & N. E. Friedland, eds. Studies on Cenozoic Paleontology and Stratigraphy: C. W. Hibbard Memorial Volume 3. University of Michigan, Museum of Paleontology.

Martin, L. D. 1979. The biostratigraphy of arvicoline rodents in North America. Transactions of the Nebraska Academy of Sciences, 7:91-100.

Martin, R. A. 1970. Line and grade in the extinct *medius* species group of *Sigmodon*. Science, 167:1504-1506.

Martin, R. A. 1974. Fossil mammals from the Coleman IIA fauna, Sumter County. Pp. 35-99 *in* S. D. Webb, ed. Pleistocene Mammals of Florida. University of Florida Press, Gainesville.

Martin, R. A. 1993. Patterns of variation and speciation in Quaternary rodents. Pp. 226-280 *in* R. A. Martin & A. D. Barnosky, eds. Morphological Change in Quaternary Mammals of North America. Cambridge University Press, New York.

Martin, R. A. 1995. A new middle Pleistocene species of *Microtus* (*Pedomys*) from the southern United States, with comments on the taxonomy and early evolution of *Pedomys* and *Pitymys* in North America. Journal of Vertebrate Paleontology, 15(1):171-186.

Martin, R. A. 1996. Dental evolution and size change in the North American muskrat: classification and tempo of a presumed phyletic sequence. Pp. 431-457 *in* K. M. Stewart & K. L. Seymour, eds. Palaeoecology and Palaeoenvironmenmts of Late Cenozoic Mammals: Tributes to the Career of C. S..(Rufus) Churcher. University of Toronto Press, Toronto, Canada.

Martin, R. A. 2003. Biochronology of latest Miocene and Pleistocene arvicolid rodents from the Central Great Plains of North America. Coloquios de Paleontologia, Vol. Ext. 1:373-383.

Martin, R. A., H. T. Goodwin, & J. O. Farlow. 2002a. Late Neogene (late Hemphillian) rodents from the Pipe Creek Sinkhole, Grant County, Indiana. Journal of Vertebrate Paleontology, 22(1):137-151.

Martin, R. A., J. G. Honey, & P. Peláez-Campomanes. 2000. The Meade Basin rodent project: a progress report. Paludicola 3:1-32.

Martin, R. A., J. G. Honey, P. Peláez-Campomanes, H. T. Goodwin, J. A. Baskin, & R. J. Zakrzewski. 2002b. Blancan lagomorphs and rodents of the Deer Park assemblages, Meade County, Kansas. Journal of Paleontology, 76(6):1072-1090.

Martin, R. A., R. T. Hurt, J. G. Honey, & , P. Peláez-Campomanes. 2003. Late Pliocene and early Pleistocene rodents from the northern Borchers Badlands (Meade County, Kansas), with comments on the Blancan-Irvingtonian boundary in the Meade Basin. Journal of Paleontology, 77(5):985-1001.

Morgan, G. S. 2005. Vertebrate fauna and geochronology of the Great American Biotic Interchange in temperate North America, with special reference to Florida. Bulletin of the Florida Museum of Natural History, 45(4):271-311

Morgan, G. S., & R. C. Hulbert. 1995. Overview of the geology and vertebrate biochronology of the Leisey Shell Pit Local Fauna, Hillsborough County, Florida. Bulletin of the Florida Museum of Natural History, 37(1):1-92.

Morgan, G. S. & J. A. White. 1995. Small mammals (Insectivora, Lagomorpha, and Rodentia) from the early Pleistocene (early Irvingtonian) Leisey Shell Pit local fauna, Hillsborough County, Florida. Bulletin of the Florida Museum of Natural History, 37(13):397-462.

Robertson, J. S. 1976. Latest Pliocene mammals from Haile XVA, Alachua County, Florida. Bulletin of the Florida State Museum, 20(3):111-186.

Voorhies, M. R. 1988. The giant marmot *Paenemarmota sawrockensis* (new combination) in Hemphillian deposits of northeastern Nebraska. Transactions of the Nebraska Academy of Sciences, 16:165-172.

Webb, S. D. 1974. Chronology of Florida Pleistocene mammals. Pp. 5-31 *in* S. D. Webb, ed. Pleistocene Mammals of Florida. University of Florida Press, Gainesville.

Webb, S. D., & K. T. Wilkins.1984. Historical biogeography of Florida Pleistocene mammals. Pp. 370-383 *in* H. H. Genoways & M. R. Dawson, eds. Contributions in Quaternary vertebrate paleontology: a volume in memorial to John E. Guilday. Special Publication of the Carnegie Museum of Natural History 8.

Zakrzewski, R. J. 1975. Pleistocene stratigraphy and paleontology in western Kansas; the state of the art, 1974. Pp. 121-128 *in* G. R. Smith & N. E. Friedland, eds. Studies on Cenozoic Paleontology and Stratigraphy: C. W. Hibbard Memorial Volume 3. University of Michigan, Museum of Paleontology.

Zakrzewski, R. J. 1988. Plio-Pleistocene rocks, Borchers Badlands, Meade County, southwestern Kansas. Pp. 69-74 *in* Geological Society of America Centennial Field Guide—South-Central Section.