

NEW RECORD OF FOX SQUIRREL (*SCIURUS NIGER*) IN NEW JERSEY FROM A HISTORICAL ARCHAEOLOGICAL SITE

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THE EASTERN GRAY squirrel, *Sciurus carolinensis* Gmelin 1788, is commonly found in suburbs, parks, and forests throughout New Jersey. The larger, but otherwise similar in appearance, fox squirrel, *Sciurus niger* Linnaeus 1758, is not found in New Jersey, and there has been uncertainty about whether it ever was present in the state, and if so, where it was found and when it became extirpated. Although the fox squirrel is more abundant in other parts of the eastern and central United States, it is not present in New England, much of eastern New York, and eastern Pennsylvania (Koprowski 1994a). Currently, the nearest modern populations of fox squirrel are found in central Pennsylvania, where it is rare; and in Delaware and Maryland. The latter subspecies, the Delmarva fox squirrel (*Sciurus niger cinereus*), was listed as an endangered species in 1967. Federal, state, and private conservation efforts since that time have led to an increase in the population such that in 2015, the Delmarva fox squirrel was removed from the list of Endangered Species.

The fox squirrel is usually at least 20% greater in size than the gray squirrel and has

a body mass ranging from 507 to 1,361 g, (1.12-3 lbs), compared to the gray squirrel body mass range of 300 to 710 g (0.66-1.57 lb) (Koprowski 1994a,b). The average weight of the fox squirrel is almost twice that of the gray squirrel. Consequently, the bones of fox squirrel are also larger than those of gray squirrel. Bone size, however, may not always be a reliable way to differentiate the skeletal remains of the two species, due to potential size variation within both species due to geography, change over time, or sex and age of individual specimens. Due to a genetic condition, fox squirrel bones fluoresce (glow pink) under ultraviolet (UV) light (Dooley and Moncrief 2012; Parris *et al.* 1995). Gray squirrel bones do not, providing a possible alternative method of distinguishing the two species. This fluorescence has been observed in paleontological specimens at least 7,000 years old (Dooley and Moncrief 2012), but taphonomic changes in bones may remove this fluorescence in some situations.

There is, fortunately, another osteological characteristic that can be used to separate the two species: the maxilla (upper jaw) of the gray squirrel retains a vestigial, peg-like third premolar tooth that is not found in the fox squirrel maxilla (e.g., Burt 1972:101; Koprowski 1994a, 1994b; Parris *et al.* 1995:63), providing unambiguous criteria for distinguishing the two species.

Early reviews of New Jersey's native fauna (e.g., Nelson 1890) reported several different species of tree squirrel in the state. However, the majority of these alleged species probably represent within-species variation in the fur color of gray squirrel. A review of the literature by Parris and colleagues (Parris *et al.* 1995:63) indicates that there are no reliable historic records of fox squirrel in New Jersey. Given the paucity of relevant historic records, evidence for fox squirrel in New Jersey must

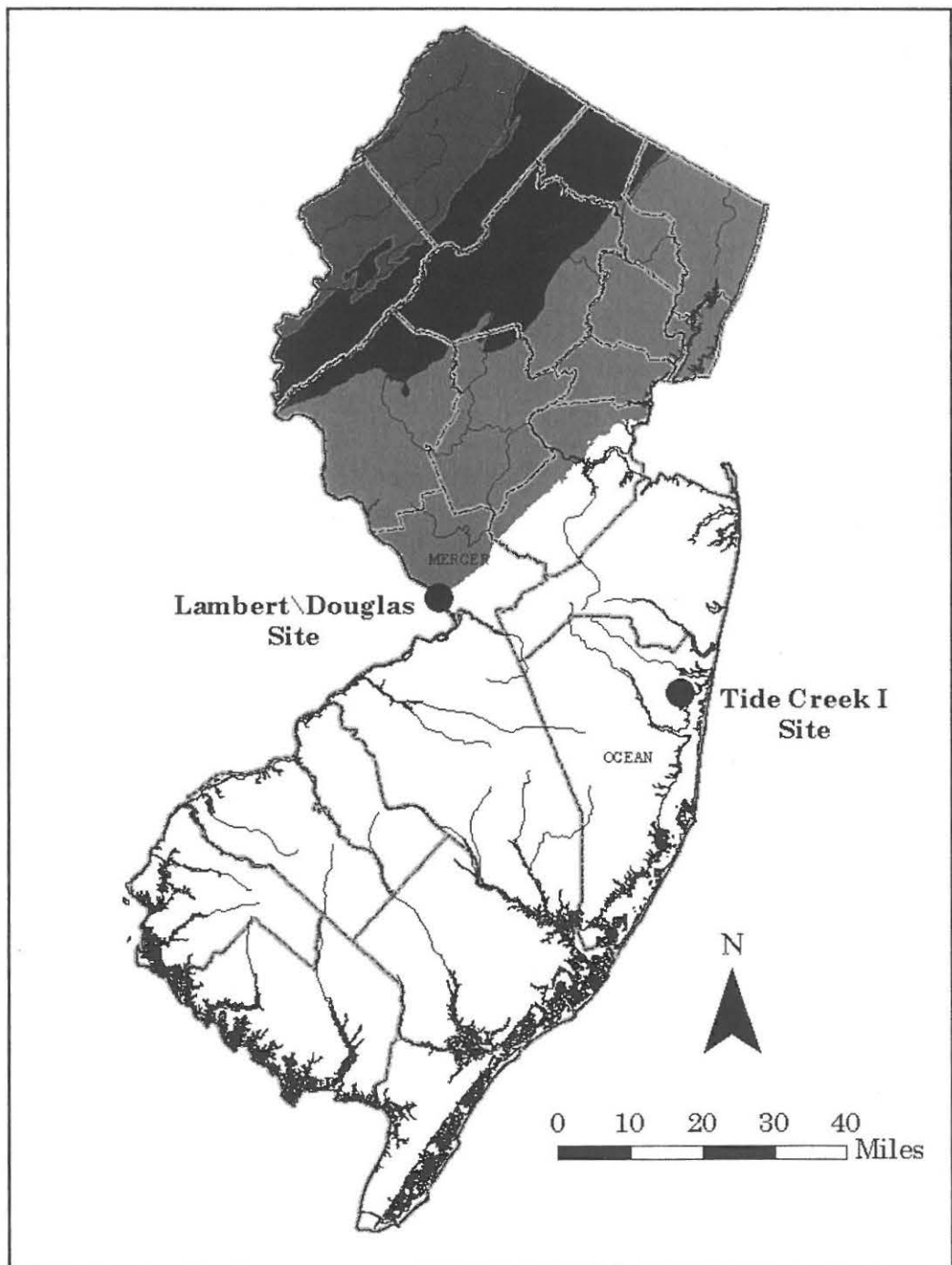


Figure 1. Map of New Jersey showing location of Lambert/Douglas Site and Tide Creek I Site.

come from zooarchaeological or paleontological data. Reliable evidence for the presence of fox squirrel in New Jersey was first reported by Parris and colleagues (1995), who identified fox squirrel paired left and right maxillae from a single individual at the Tide Creek I archaeological site (28Oc90) in Ocean County (Figure 1). The Tide Creek I Site is thought to date to AD 1690-1720. In this paper, additional fox squirrel specimens from the Lambert/Douglas archaeological site in Mercer County are reported. Faunal remains from archaeological sites can provide new data on the history of fox squirrel in New Jersey and contribute to a better understanding of the historical distribution of this species.

Results

The Lambert/Douglas Site is located in the City of Trenton, Mercer County, New Jersey (Figure 1), near the Delaware River (Hunter Research, Inc. 2005, 2011). A total of 14,631 vertebrate animal bones or bone fragments were studied from the Lambert/Douglas site (Madrigal 2000, 2011). Most specimens are from the basement of a house thought to have been constructed about A.D. 1701 and destroyed around A.D. 1790. The faunal remains are thought to represent primarily food and butchery waste discarded by the occupants of the site. The most common domesticated animals at the site are pig, cow, sheep or goat, and chicken. Several wild species that were likely procured for food are also present at the site, including, in additions to squirrel, sturgeon and passenger pigeon. Some of the animal bones are presumably the result of natural deaths, in particular those of the rat (*Rattus* sp.), the most abundant wild mammal at the site.

One set of paired maxillae was positively identified as fox squirrel (Figure 2). This specimen consists of most of the left maxilla,

including the incisor, the fourth premolar, and the alveoli for the first and second molars, and a portion of the right maxilla, including the fourth premolar and alveoli for the incisor and first and second molars. The left and right maxillae articulate and are counted as a single specimen. Significantly, there is neither a third premolar nor an alveolus for such a tooth, which are found only in gray squirrels, and not in fox squirrels (Koprowski 1994a, 1994b; Parris *et al.* 1995:63).

UV light testing was not conducted for the bones from the Lambert/Douglas Site, but the positively identified fox squirrel maxilla from the Tide Creek I Site did not fluoresce under UV light (Parris *et al.* 1995:63). An additional 12 bones were attributed to fox squirrel based on their overall large size, which matched bones of modern fox squirrels in the collections of the New York State Museum. Elements present at the Lambert/Douglas Site include three mandibles, one innominate (pelvis) and several leg bones: five humeri, two tibiae, and a femur. Based on the number of humeri identified, a minimum of four individuals are represented at the site.

A single mandible was identified as gray squirrel based on overall size and morphology. Eighty-one other bones are identified conservatively only as tree squirrel (Genus *Sciurus*; i.e. either fox squirrel or gray squirrel), although all of these are comparable in size to gray squirrel. At least nine individuals are represented by these bones.

An indication of the size difference between the two species is witnessed in Figure 3, which shows a left humerus identified as fox squirrel and a right humerus identified as tree squirrel but most likely from a gray squirrel, both found in the same context at the site. The distal breadth (Bd) of the fox squirrel humerus is 13.70 mm, compared to 11.35 mm for

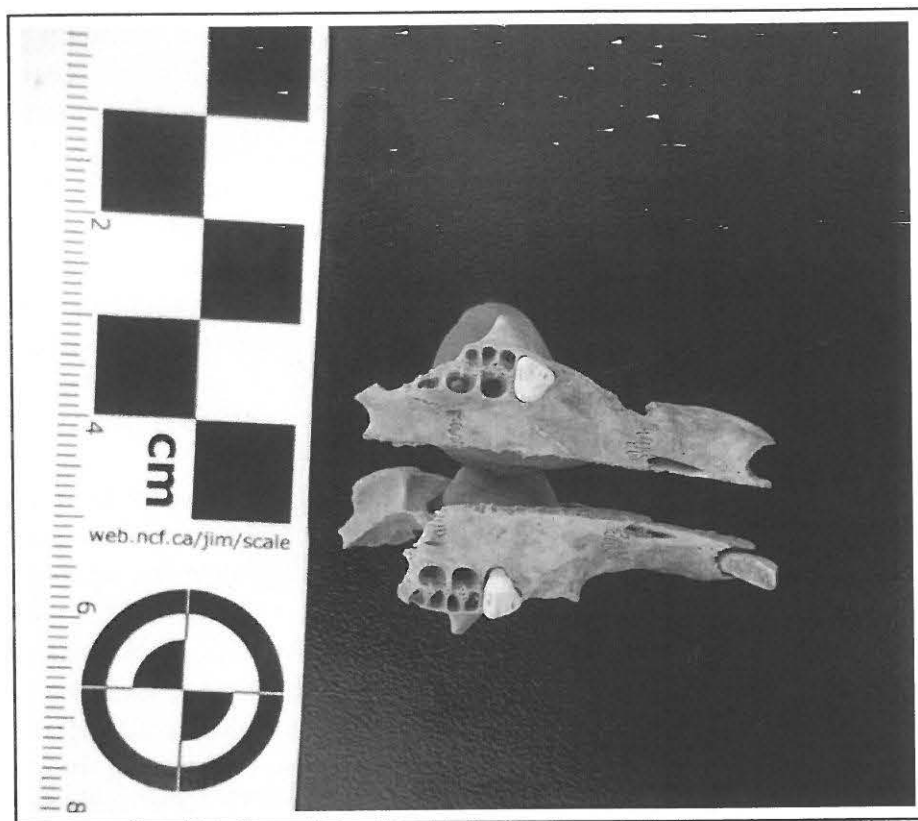


Figure 2. Paired left and right maxillae of fox squirrel (*Sciurus niger*) from Lambert/Douglas Site.



Figure 3. Top: Left humerus of fox squirrel (*Sciurus niger*). Bottom: Partial right humerus of probable gray squirrel (*Sciurus carolinensis*).

the other humerus.

The fox squirrel paired maxillae was recovered from general eighteenth century basement fill (Trench A, EU 99, Context 25). Ten other fox squirrel bones were also identified from this context. A single fox squirrel humerus was found in the later eighteenth century basement floor (Context 38) deposit and a tibia was recovered from a less diagnostic context (Context 2). The majority of tree squirrel bones were found in the same general eighteenth century basement fill context as the fox squirrel maxilla.

Discussion and Conclusion

The Tide Creek I Site is located in the Silverton section of the Township of Toms River (Parris *et al.* [1995] reported this site as being located in the Township of Dover; the Township changed its name to Toms River in 2006), Ocean County. As its name implies, the site is located near Tide Creek, which empties into Barnegat Bay, on the Outer Coastal Plain of New Jersey. The site is believed to date to circa A.D. 1690-1720 (Parris *et al.* 1995). The Lambert/Douglas site is located in the City of Trenton, Mercer County, on the shores of the Delaware River on the border of the Piedmont Province and the Inner Coastal Plain. Fox squirrel remains were found in deposits dated broadly to the eighteenth century, with one bone found in a basement level dated more precisely to the late eighteenth century.

The first record of fox squirrel from the Tide Creek I site both established the past presence of *Sciurus niger* in New Jersey and indicated that the extirpation of fox squirrel in this state happened in historic times. The new identification of fox squirrel from Lambert/Douglas extends the known historic range of fox squirrel in this state approximately 58 km (36 miles) west and north into a different environ-

ment. The context of the find also suggests that this large rodent was still present in New Jersey until near the beginning of the nineteenth century. Furthermore, it may have been fairly abundant: at least four individuals are present, compared to a minimum of nine other squirrels from the site.

The fox squirrel and gray squirrel have different but overlapping diets and habitat preferences. Fox squirrels spend more time on the ground than gray squirrels, are slower moving, and are considered less graceful in trees. The fox squirrel also prefers smaller forest patches (less than 40 ha) with an open understory, while the gray squirrel prefers larger forest patches with a dense understory (Koprowski 1994a, b). Both species, however, can be found in the same area; the modern range of the Delmarva fox squirrel, for example, overlaps with that of the gray squirrel.

The precise population of each of the two species prior to European settlement is unknown. Just west of New Jersey, "When the early settlers came to Pennsylvania the fox squirrel was here, but apparently not in anything like the same abundance as the gray" (Doutt *et al.* 1973:118). Changes in habitat composition, hunting pressure, and competition between the two species may have been a factor in the extirpation of fox squirrel from New Jersey. Studies of modern populations have found situations where fox squirrels displace gray squirrels from feeding areas (Koprowski 1994a:4), but with the replacement of wooded areas with suburban developments, gray squirrels may replace fox squirrels (e.g., Sexton 1990).

Arguably, the clearing of forests for agriculture in historic times would have favored the fox squirrel. The larger size and less arboreal nature of the fox squirrel, however, may have made it a more popular target of early hunt-

ers, resulting in a reduction in its range and abundance in historic times. In eastern Pennsylvania, for example, fox squirrels "rapidly disappeared before the onslaught of civilization and the guns of our forefathers" (Doutt *et al.* 1973:118). Farmers also killed squirrels due to their fondness for corn crops, and the numbers of both species of squirrel, like many other native species in New Jersey, became greatly reduced by the nineteenth century. In 1868 (perhaps less than a century after the fox squirrel bones were deposited at the Lambert/Douglas site) Abbott noted that "partly on account of a general culling off of large timber, and largely in consequence of the persistent shooting, at all times of the year, the squirrels have become, we may almost say, uncommon" (Nelson 1890:500).

The gray squirrel was able to survive and adapt to the increasing suburbanization of New Jersey such that, by 1907, Stone could write that the gray squirrel, despite remaining scarce in southern New Jersey due to hunting pressure, was "a familiar feature of public parks and private grounds in many of our towns and cities" (Stone 1907:83). The fox squirrel, in contrast, was "Now quite extinct in New Jersey" (Stone 1907:82).

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