

The History of Mammal Studies in Virginia

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ABSTRACT

Native mammals surely were among the first biota to be observed, admired, and described by the earliest European colonists to Virginia. It was natural for them to make comparisons with British mammals, such as deer, elk, and squirrels. More puzzling to colonists were mammals with no counterparts in England, such as raccoons (thought by John Clayton to be a kind of monkey) and especially the Virginia opossum, a pouched mammal. Perhaps the best early record of the mammal fauna of Virginia is from William Byrd's 1728 account of his group's journey while surveying the 'dividing line' between Virginia and North Carolina. Byrd later published his extensive notes on the mammals observed and eaten by the group: black bears, white-tailed deer, elk, and American bison (buffalo), as well as Virginia opossum, raccoon, and otter. The first scientific studies of Virginia mammals were conducted during 1895-1898, when field investigators from the US Bureau of Biological Survey and three museums spent a total of 23 weeks collecting mammals in the Great Dismal Swamp of southeastern Virginia. During the first half of the 20th century, a number of collectors made contributions to understanding the distribution of mammals in Virginia, but the major advances have been in recent decades by investigators in association with universities in Blacksburg, Richmond, and Norfolk, among others. Much remains to be learned about the distribution and status of Virginia mammals before a definitive work on mammals of the Commonwealth can be written.

Key words: history, mammalogy, mammal collections, people, Virginia mammals.

The discovery of the Americas and their early exploration and settlement were dominated by Spain, Portugal, and France (Horowitz, 2008). Nearly 100 years after Columbus's voyage, Sir Walter Raleigh's 1585 visit to the East Coast led to rapid interest in establishing English colonies in America for political and economic reasons. The first English settlers to eastern Virginia found mammals in great abundance, including many similar to those of their home country; early accounts often compared local mammals with those from England. Mammals of greatest interest and curiosity, such as raccoon, opossum, and American bison¹, were those lacking counterparts in England or western Europe. Later accounts described behavior or anatomy as writers began to think of native mammals as American rather than merely different from English mammals. By the time of the American Revolution, writers had taken ownership of our mammals and

rebutted charges that American mammals were fewer, smaller, and degenerate compared to those from England or Europe.

The first reports in English on the mammals of Virginia (Table 1) were those of Thomas Hariot, one of the founders of the Roanoke Island Lost Colony. At that time (1588), Virginia extended south to what is presently Florida. Hariot writes of (white-tailed) deer, "by the thousands," and of having seen the furs of (river) otters, of which he saw many, and of martens (he saw only two skins). [Note: what he calls martens likely were mink rather than pine martens; the latter, also members of the weasel family, Mustelidae, probably were then, as now, restricted to the montane or cool habitats of Appalachia and points north.] Hariot reports having seen a "civet cat" (bobcat) that had been "killed by a savage, and bears, which are black in color." He explains that black bears are good meat and are hunted by chasing the bear up a tree and then shooting it with bows and arrows." Conies "that

¹Common names are used throughout the text. For companion scientific names, see Table 1.

Table 1. Common and scientific names of the mammals reported by early observers of mammalian wildlife in Virginia, listed phylogenetically and with common names according to Wilson & Ruff (1999). The year of discovery or first mention of each species is listed, which is not always the publication year.

Opossum, <i>Didelphis virginiana</i> , Smith, 1608
Little brown bat, <i>Myotis lucifugus</i> , Clayton, 1686
Big brown bat, <i>Eptesicus fuscus</i> , Clayton, 1686
Rafinesque's big-eared bat, <i>Corynorhinus rafinesquii</i> , Clayton, 1686
Gray wolf, <i>Canis lupus</i> , Hariot, 1588
Common gray fox, <i>Urocyon cinereoargenteus</i> , Clayton, 1686
American black bear, <i>Ursus americanus</i> , Hariot, 1588
American marten, <i>Martes americana</i> , Hariot, 1588
Long-tailed weasel, <i>Mustela frenata</i> , Hariot, 1588
Mink, <i>Mustela vison</i> , Smith, 1608
Northern river otter, <i>Lontra canadensis</i> , Hariot, 1588
Striped skunk, <i>Mephitis mephitis</i> , Smith, 1608
Northern raccoon, <i>Procyon lotor</i> , Smith, 1608
Cougar, <i>Puma concolor</i> , Hariot, 1588
Bobcat, <i>Lynx rufus</i> , Hariot, 1588
Elk, <i>Cervus elaphus</i> , Byrd, 1728
White-tailed deer, <i>Odocoileus virginianus</i> , Hariot, 1588
American bison, <i>Bison bison</i> , Byrd, 1728
Eastern chipmunk, <i>Tamias striatus</i> , Byrd, 1728
Eastern gray squirrel, <i>Sciurus carolinensis</i> , Smith, 1608
Eastern fox squirrel, <i>Sciurus niger</i> , Smith, 1608
Southern flying squirrel, <i>Glaucomys volans</i> , Smith, 1608
American beaver, <i>Castor canadensis</i> , Smith, 1608
Allegheny woodrat, <i>Neotoma magister</i> , Cope, 1868
Muskrat, <i>Ondatra zibethicus</i> , Smith, 1608
Eastern cottontail, <i>Sylvilagus floridanus</i> , Hariot, 1588
Marsh rabbit, <i>Sylvilagus palustris</i> , Hariot, 1588

we have seen ... are of a grey colour like unto our hares." "Coney" is a British term for rabbit; Hariot likely is referring to marsh rabbits or eastern cottontails, both of which are present along the mid-Atlantic coast. Hariot ate "Saquenuckot & Maquowoc, two kinds of small beasts greater than Conies, which are very good meat." My guess is that these were opossums and raccoons, or, less likely, beavers. Finally, he says that the "inhabitants sometimes kill the lion (cougar) and eat him, and we sometimes as they came to our hands, of their wolves or wolfish dogs, which I have not set down for good meat." Clearly, cougars and wolves were known to the founding colony on Roanoke Island.

John Smith, who became the leader of the founding party at Jamestown Island after 1607, spent a year investigating the lower Chesapeake Bay and later wrote descriptions of the animals he had seen (Tyler, 1907). Regarding squirrels, most are gray, he says, but some are black and white; here he is referring to the coastal subspecies of the fox squirrel, which is blackish gray with a black face and white snout. Smith also describes a "small beast they call Assapanick, but "we call them flying squirrels because they spread their legs, and so stretching the largeness of their skins, that they have been seene to fly 30 or 40 yards." These would have been southern flying squirrels, a 70-g tree squirrel

that glides from tree to tree using its well-furred membranes that connect the limbs on each side of the body. His description of an opossum is particularly interesting: "hath a head like a Swine, and a taile like a Rat, and is of the bigness of a cat. Under her belly she hath a bagge, wherein she lodgeth, carrieth, and sucketh her young." The pouch of the Virginia opossum fascinated a number of English observers because they had nothing like it in their experience. Marsupials, except the Virginia opossum, presently are restricted to South America and to the Australasian region.

Smith (Tyler, 1907) also describes the *Mussacuscus* (muskrat) as a "beast of the forme and nature of our Water Rats, but many of them smell exceeding strongly of muske." The beaver, he reports, is "big as an ordinary water dogge, but his legs exceedingly short. His fore feet like a dogs, his hinder feet like a Swans. His taile somewhat like the form of a Racket bare without hair, which to eat, the Savages esteeme a great delicate." Both semi-aquatic rodents would have been common along the waterways and associated marshes of coastal Virginia. Another mammal Smith observed was "a beast they call Aroughcun, much like a badger, but useth to live on trees as squirrels doe." Our modern term 'raccoon' seems to have been derived from its Native American name. Other early English observers refer to the raccoon as a type of monkey, with its masked face and banded tail. As a member of the New World family Procyonidae, the raccoon was totally foreign to the experience of English observers.

Smith relates "there also is a beast they call Vetchunquoyes in the form of a wild Cat." This would be the bobcat, the only small cat in the eastern US. He also mentions seeing "martins, powlecats, weasels, and minkes" as skins, though seldom alive. Polecat refers to a member of the weasel family that in Europe gave rise to the domesticated ferret. In modern America, the term "polecat" now refers to the striped skunk (which probably was present in the newly created Jamestown settlement) and the spotted skunk (now rare and restricted to western Virginia). Early drawings of the polecat looked much like the striped skunk, so the English name for a smelly weasel was applied to our skunk of eastern Virginia.

John Banister provides a number of interesting observations of mammals in his writings made during the late 17th century (Ewan & Ewan, 1970). For example, in 1686, Banister hosted the Rev. John Clayton, the premier botanist of the era, to whom he exhibited the backbone of a whale. Like Clayton, Banister was a minister and also shared his interest in collecting plants. In 1690, Banister was one of the founders and first Trustees of the College of William and Mary. Two years later he was accidentally shot and

killed while botanizing along the Roanoke River (Ewan & Ewan, 1970). Among Banister's writings were good descriptions of the beaver lodge, how dams are built, and of castoreum, the "stinking oyle of beavers stones" (their castor glands). Banister says that the native deer has "flesh as sweet as mutton," there were three kinds of squirrels (fox, gray, and flying), and that the opossum was "a sort of creature with a false belly, which receives its young when in danger and it hangs by its taile." He mentions that muskrats eat mussels and defecate pearls (nice trick) and then describes their musk glands. Banister also made the observation that American (gray) foxes live in trees, whereas English (red) foxes nest in holes in the ground. It seems that Banister was an excellent artist because much later the Swedish botanist, Carl von Linne, used at least 64 of his drawings and referenced 127 of his plants in the 1753 publication of *Species Plantarum*, the first volume in which Linnaeus made detailed anatomical plant descriptions in Latin and introduced the binomial system of nomenclature, still in use today.

John Clayton spent only two years (1686-1688) in America, during which time he was rector of an Anglican parish in James City, Virginia (Berkeley & Berkeley, 1965). An accomplished scientist and member of the Royal Society before coming to America, Clayton returned to England and spent the remaining 40 years of his life relating his impressions of the biota and environments of Virginia. In this way, he contributed greatly to English perceptions of what Virginia and America were like. Like Banister, Clayton also noticed that gray foxes did not use ground holes ("but of this I am not positive"). In this regard, he was a careful scientist, by not giving his hunch the certainty of a statement based on observation. Clayton mentions having heard about elk(e) but they were present 'beyond the habitations', i.e., farther west from his location or travels. "Brave red Deare" were common "so that a good woodsman, as they call them, will keep a house with Venison."

Clayton said that the "Rackoone I take it to be a species of monkie, something less than a fox, gray haired, its feet formed like a hand, and the face too has likewise the resemblance of a monkie, besides being kept tame, they are very Apish, they are very prejudicial to their poultry, as I remember" (Clayton, 1694). Of the opossum, he said the "Skin of its belly is very large and folded so as to meet like a purse, wherein they secure their young whilst little, and tender, in this false bellys they will carry their young." Clayton gives detailed descriptions of three kinds of squirrels and of rabbits. Of the latter he relates that "I have seen Leverets (young rabbits or hares), there with the white spot in the head, which the old

ones have not, so it is in England; and the downe is perfectly the colour of their hairs, they sit as our haire doe." Thus, he notes that young rabbits in America, as in England, have white spots on their heads which later disappear in adults and that their behaviors are similar. Clayton's observation suggests a degree of relatedness of rabbits in both America and England not mentioned by other early naturalists. Clayton saw two kinds of bats, one with "long eares, and particularly long stragglng hairs;" this likely was Rafinesque's big-eared bat, now the State bat of Virginia. The other bat was "much like the English, something larger I think, very common." This probably was either big brown bat or, less likely, little brown myotis, both common bats in the region.

Clayton gives detailed descriptions of the structures built by muskrats and beavers but he erred by saying of muskrats "I suppose they live mostly on fish," and in believing the value of beaver lodges was "As I suppose ... to catch fish by standing to watch them thereon, and jumping upon them on a sudden (movement?)." He tore apart a muskrat house to find "4 different Lodging rooms, very neat, one higher than the other, as I conceive purposely made for retirement, when the Water rises higher than ordinary." Regarding the beaver's industry in building dams and lodges, Clayton wrote "They are very subtle Creatures and if halfe of the stories be true that I have been told they have a very orderly government amongst them, in their works each knows his proper work, and station, and the overseers beat those young ones that loiter in their business, and will make them crie, and work stoutly." Finally, Clayton saw a young bear but his remarks on other carnivores (cougars, wolves or coyotes, cats or polecats) are all second-hand reports; perhaps by the end of the 17th century most carnivores were uncommon in eastern Virginia.

An early 18th century account by Robert Beverley (1705) indicates an abundance of "Deer, Hairs, Foxes, Raccoons, Squirrels, Possums. And upon the Frontier Plantations, they meet with Bears, Panthers, Wild-Cats, Elks, Buffaloes, and Wild Hogs, which yield Pleasure, as well as Profit to the Sports-man." Beverley's only detailed information is on the Virginia opossum. After describing the pouch of females, he says "But, what is yet stranger, the young Ones are bred in this false Belly, without ever being within the true One (i.e., the *uterus*). They are formed at the Teat, and there they grow for several Weeks together into perfect Shape, becoming visibly larger ... I have observed them thus fasten'd at the Teat, from the Bigness of a Flie, until they became as large as a Mouse." Of course, later study revealed that opossums have a brief gestation in a bona fide uterus, after which the young, born in a

primitive state, crawl unaided into the pouch, attach to a teat, and complete their development there while being nourished by milk.

Perhaps the best accounts from the early period were those of William Byrd II of Westover, Beverley's brother-in-law. His father was a prominent landowner and official who died in 1704, causing the younger Byrd to return (at age 30) from England to assume his father's public and private duties (Bassett, 1901). Byrd II was educated in England, where he was elected a member of the Royal Society of London, despite having given only one paper to that organization. At the time of his death in 1744, his library, at 4,000 books, was probably the largest in the colonies, so besides being well educated he was also well read. Despite being 54 years old in 1728, Byrd was appointed as one of the Virginia Commissioners to oversee surveying the dividing line 'betwixt' Virginia and North Carolina.

On 6 March 1728, the group drove a cedar post in the sand at 36° 30' N at the south end of Currituck Inlet and began moving westward towards the Dismal Swamp. After the survey party crossed the Roanoke River, their Indian scout shot the first black bear. Byrd wrote that many woodsmen preferred bear meat to venison because "its flesh is very firm and may be eaten plentifully without rising in the stomach." Further, "the Paw ... is accounted a delicious morsel by all who are not shocked at the ungracious resemblance it bears to a human foot." Later, one of his group shot a wild-cat (bobcat), "which was at the fatal moment making a comfortable meal upon a fox-squirrel ... The flesh of this beast, as well as of the panther (cougar or mountain lion), is as white as veal, and altogether as sweet and delicious." Having eaten cougar meat at a mammal society banquet, I agree.

The Indian scout and others routinely brought white-tailed deer and turkeys every day to supplement their ration of 5 pounds of hardtack per man per week. Byrd often discusses the plants the group observed, such as rattlesnake root, a plant with supposed benefits to treat snakebite, and Colt's foot and maidenhair (fern), "both excellent pectoral plants." He also gives details of the life cycle and behaviors of bears, beavers, raccoons, and other mammals. In a remarkable insight, Byrd notes that Indians have not domesticated any animals except dogs. He does know, however, that South American natives had domesticated an animal he calls the "paco," which we know to be either guanaco or llama.

On October 24, one of the hunters shot a raccoon; "the fat of this animal is reckoned very good to assuage swellings and inflammations." "It climbs up small trees, like a bear, by embracing the bodies of them." He also reports having seen four kinds of squirrels: fox, gray,

flying, and "the ground-squirrel. These last ... have ... black and russet streaks that run down the length of their little bodies." These would be eastern chipmunks, the common ground squirrel of eastern forests. On October 26, after one of the men had picked up a pair of elk antlers, Byrd remarks that elk "keep commonly to the northward of 37 degrees, as the buffaloes, for the most part, confine themselves to the southward of that latitude." Then Byrd discusses at length the biology of elk, including size, sex differences, quality of their flesh, their shy behavior, good sense of smell, herding behavior, and other traits. Byrd's breadth and depth of knowledge on a wide range of subjects is remarkable.

One hunter brought in an opossum on October 30, "a harmless little beast ... if you take hold of it, it will only grin, and hardly ever bite. The flesh is well tasted and tender, approaching nearest to pig ..." Then Byrd describes its features, including differences between its front and hind feet, and especially the pouch of females. "Within this false belly may be seen seven or eight teats, on which the young ones grow from their first formation till they are big enough to fall off, like ripe fruit from a tree. This is so odd a method of regeneration, that I should not have believed it without the testimony of mine own eyes."

After one of the men shot a 2-year-old male American bison on November 11, Byrd writes an extensive description of the massive shoulders of the animal, as well as of its legs, horns, hair, and herding behavior. Two days later a beaver was brought in, prompting Byrd to write "Beavers have more instinct, that half-brother of reason, than any other animal." "In their houses, they always construct a Sally-Port, both towards the land and towards the water, that so they may escape by one, if their retreat should happen to be cut off at the other. They ... are kept diligently at work by the Master Beaver, which by his age or strength has gained himself an authority over the rest. If any of the Gang happen to be lazy ... this Superintendent will not fail to chastise him with the flat of the tail, wherewith he is able to give unmerciful strokes." Later he describes both how the Indians snare beavers and how the English make an extract from the castor glands to use as a lure to improve trapping efficiency.

The Indian shot a river otter three days later, commenting that the flesh tasted too much like fish to interest others as food. Soon thereafter, with winter coming and their horses in increasingly poor condition, the survey party turned back east, despite not having completed their duties of identifying the boundary all the way to the west.

Thomas Jefferson had a keen interest in science, especially in fossils of large mammals. He had been given fossil bones of *Megalonyx*, a giant ground sloth,

taken from a salt cave in Greenbrier County, [now West] Virginia (1799) and later he used the massive dimensions of mammoth bones to illustrate that North American mammals were not puny. His curiosity about the possible presence of these mega-mammals in the newly acquired 1803 Louisiana Purchase in part led to his organizing the expedition to the Northwest Territories. Further, he requested his hometown friends, Meriwether Lewis and William Clark, to send regular messages, and specimens, of new biota they might encounter on their search for a Northwest Passage. They sent reports of mountain goats (*Oreamnos americanus*), prairie dogs (*Cynomys* spp.), and grizzly bears (*Ursus arctos horribilis*), among other species new to science, but none on the extinct megafauna Jefferson was hoping they would find.

In his book, Jefferson (1781) wrote that “Our quadrupeds (mammals) have been mostly described by Linnaeus and Mons. de Buffon.” Although he admired the Count de Buffon greatly as the naturalist “who is the best informed of any who has ever written,” he faults him for his opinions that mammals “common to both old and new worlds are smaller in the latter ... and that those domesticated in both have degenerated in America ... and on the whole it exhibits fewer species.” Buffon attributed these shortcomings to the *cold* and *moisture* in America.

Jefferson (1781) then sets about providing the evidence to counter and overturn these charges that American mammals are puny, degenerated, and few, first with a 3-page table with column headings of mammals common to Europe and America and their comparative weights. “The result of this view then is, that of 26 quadrupeds common to both countries, 7 are said to be larger in America, 7 of equal size, and 12 not sufficiently examined. So that the first table impeaches the first member of the assertion, that of the animals common to both countries, the American are smallest, and that without any exception.”

Later, Jefferson (1781) wrote “there are 18 quadrupeds (*notice the number has shrunk*) in Europe; more than 4 times as many, to wit 74, peculiar to America; that the first of these 74 (i.e., the mammoth) weighs more than the whole column of Europeans (species); and consequently this second table disproves the second members of the assertion, that animals peculiar to the new world are on a smaller scale ...” Thus, Jefferson was a strong advocate for and defender of American science, including its mammals.

A nearly 100-year gap exists in the Virginia mammal record, from Jefferson to Edwin Drinker Cope’s (1868) report of finding an eastern (now Allegheny) woodrat nest in Spruce Run Cave in Giles County, Virginia. Despite the Smithsonian Institution’s

National Museum of Natural History (NMNH) having been founded in 1855, the first Virginia specimens were not deposited into the collection until 1885 and 1886 when C. H. Merriam deposited house mice (ironically, a non-native species) collected from Old Point Comfort.

The first systematic study of mammals in Virginia began in 1895 when C. Hart Merriam, soon to become head of the US Bureau of Biological Survey (the forerunner to the US Fish and Wildlife Service), sent his assistant A. K. Fisher to begin what was to become a four-year study of the biota in the Dismal Swamp of southeastern Virginia. After taking an overnight steamer from Washington, D. C. to Norfolk and a train to Suffolk, with the help of a man from Suffolk, Fisher reached the shores of Lake Drummond in the center of the Swamp near sundown on the second day, 1 June. After six days of tending 50 Cyclone (break-back) traps alone and of shooting birds by day and bats at night, he was joined by Merriam for two nights and one day; they trapped an additional night near Suffolk on the way back to Washington, D. C.

In what Charles O. Handley, Jr. (2000) considers to have been a reconnaissance trip, Fisher and Merriam collected a marsh rabbit, four bats of two species, two species of shrew, 5 species of rodents, and a ‘pick-up’ bear skull. Both shrews were described as new species that year by Merriam (1895), and in the next two years he named new species of southern bog lemming (1896) and muskrat (1897) from specimens collected in the Dismal Swamp. A fifth new species, a meadow vole, was named by Rhoads & Young (1897) from specimens collected for the Academy of Natural Sciences in Philadelphia. Collectors from two other eastern US museums also spent time in the Dismal Swamp during the 1895-1898 period. During 23 weeks of field work, they acquired nearly 270 specimens of 31 species of large and small mammals. Five species new to science were among them, all now reduced to subspecies status in later taxonomic revisions. Nevertheless, the efforts of these several collectors significantly advanced understanding of mammals in Virginia.

It might be asked why the Dismal Swamp was a focus for collections in the late 19th century. A recent invention, the Cyclone mousetrap, may have been important. (Previously, small mammals had been collected one at a time using guns, caught by hand, or dug from nests.) Merriam recognized that with a bag full of Cyclone traps, one person could collect a series of small mammals of a given species, leading him to champion the notion that series of specimens were important in the study of variation among geographic populations. Charles Handley (2000) believed the reasons related to interest derived from earlier studies of fishes in the Dismal Swamp (Jordan, 1888; Shaler,

1894). Merriam's interest in the taxonomy of bears was relevant too, because Shaler (1894) had commented on their abundance in the Swamp. A further reason might have been proximity; only short boat and train rides separated Washington, D. C., Suffolk, and the Swamp. The last part of the journey likely was the hardest, for although Fisher rowed a boat from Suffolk to Lake Drummond in June, when he returned from 15 days of collecting in October the ditches were dry and the water level had dropped four feet in Lake Drummond, necessitating a six-mile walk, with equipment and specimens, down the track paralleling Washington² Ditch. Fisher's notes from his June and October 1895 trips into the Dismal Swamp have been transcribed by Darelly Handley (2000).

Of the 7,453 Virginia specimens currently in the mammal collections at the NMNH, ca. 20 percent have C. O. Handley, Jr.'s catalogue numbers and I estimate that another 20 percent were collected by Handley's students and colleagues. Until his death in June 2000, Handley was the patriarch of Virginia mammalogy (Pagels, 2000). Handley grew up in Blacksburg where his father was one of the first professors to teach wildlife science courses at what is now called Virginia Tech. Handley's interest in mammals was manifested at a young age, and he catalogued his first specimen (a house mouse) in December 1938, when he was 14 years old. The next year he trapped mammals at Mount Rogers, Buffalo Mountain, near Wise and Blacksburg, among other places. During his teenage years, Handley sometimes collected with C. P. Patton, a mammalogist with whom he co-authored *Wild Mammals of Virginia* in 1947, when only 23 years old. (John Wendell Bailey [1946] had written the first book, *The Mammals of Virginia*.) By this age, Handley already was working at the Smithsonian, but he later took time off to complete his Ph.D. from the University of Michigan in 1955.

Although Handley retained a keen interest in Virginia mammals, his career research emphasis was with Neotropical mammals, especially bats and rodents. He made regular trips to Venezuela and later to Panama, where he documented the appearance of increasing numbers of bat species on Barro Colorado Island in Lake Gatun, both created 100 years ago during the construction of the Panama Canal. Handley was the head of the mammal technical advisory committee that worked with the Virginia Department of Game and Inland Fisheries (VDGIF) on assessing threatened and

endangered mammals in the Commonwealth, and he authored those sections of the books on Virginia's rare, threatened, and endangered species (e.g., Handley, 1991). He taught Mammalogy at Mountain Lake Biological Station in Giles County 10 times between 1962 and 1978, and he frequently returned to the same locations, thus accumulating information on persistence or changes of species in a community (Handley, 1992).

Besides these students, Handley taught specimen preparation workshops at the NMNH (often using frozen small mammals he had collected at Mt. Lake) and occasionally he later went into the field with neophyte preparators who wanted experience in the field too. For example, D. I. Rhymer collected with Handley near Kilmarnock in September 1959, and in 1960 and 1961 they made collections together near Saltville, Clinch Mountain, and Laurel Bed. Rhymer returned to some of these locations and also collected at Falls Church from 1959-1961, eventually depositing nearly 300 specimens in the museum under his own catalogue. L. T. Diamond also was with Handley and Rhymer near Kilmarnock, collecting his first specimen in September, 1959. Similarly, D. Peacock and Handley trapped mammals together in Fairfax, Chantilly, and Annandale in January and February 1960 and at Ewing in June 1962. From 1960-1965, Peacock made collections at many other places, eventually depositing nearly 1,200 specimens into the national collection from such places as Merrifield, Centreville, Great Falls, Warrenton, Tappahannock, Midlothian, Cedarville, Point Royal, Waverly, Williamsburg, and Hampton. Peacock collected mammals, mostly small mammals, over a large area ranging from northern Virginia to Hampton Roads. These amateur collector colleagues of Handley made important contributions to learning the distributions of mammals in Virginia, as amateurs can do today.

Another of Handley's collecting associations was with John Paradiso, who eventually wrote a book on the mammals of Maryland. For three years in the mid-1950s, Handley and Paradiso, often in company with B. F. Feinstein and D. H. Johnson, made extensive collections on Chincoteague and Assateague islands on the Eastern Shore, the Pungo region of Virginia Beach, as well as Mountain Lake and Burkes Garden. Several hundred specimens were donated by these colleagues to the national museum. Handley realized that many regions of Virginia were poorly known for their mammals (the counties of the western shore of the Chesapeake Bay and the montane southwest are notable), and I believe he encouraged many of these colleagues to make collections to fill information gaps, after taking the time to teach each one how to record useful data for specimen tags and the importance of

²George Washington, a partner in the Dismal Swamp Land Company, surveyed his eponymous ditch in 1763 during one of his five visits to the Swamp. The land company's attempts to make the land arable by ditching failed then (as did all later attempts) and his financial interests in the Swamp property passed to his heirs after his death in 1799.

taking accurate and detailed field notes to accompany the specimens when they were deposited in the national collection. Pagels (2000) summarized Handley's studies of Virginia mammals.

Another occasional collaborator of Charles Handley was John F. Pagels, who taught Mammalogy and guided graduate students at Virginia Commonwealth University for 40 years, starting in 1969. Pagels also built a significant mammal collection; the nearly 16,000 specimens from the VCU Mammal Collection are now property of the Virginia Museum of Natural History (VMNH) in Martinsville. He conducted field research and wrote numerous papers on a range of species of small mammals and bats. With his captures of rock vole (*Microtus chrotorrhinus*) and northern water shrew (*Sorex palustris*) in Bath and Highland counties, respectively, Pagels recorded two species of small mammals previously unknown in the Commonwealth (Pagels, 1990; Pagels et al., 1998). He also conducted extensive field research to learn the extent of northern flying squirrel (*Glaucomys sabrinus*) populations in western Virginia (Pagels et al., 1990). Often in association with his students and colleagues, Pagels published many papers on shrews and rodents of field and forest (e.g., Pagels et al., 1992).

Jack A. Cranford was the mammalogist in the Biology Department at Virginia Tech from 1977 until his retirement in 2008. Primarily a physiologist, Cranford and his graduate students studied mammals in Giles and Montgomery counties as well as on the Eastern Shore of Virginia. His papers were often on nutrition and digestibility of foods related to body growth and behavior, and on the habitat associations of field and forest rodents (e.g., Cranford & Maly, 1990). Besides teaching Mammalogy classes on campus, Cranford taught the course for several summers at the nearby Mountain Lake Biological Station.

Robert K. Rose taught Mammalogy at Old Dominion University from 1979 until his retirement in 2003, but he also conducted field and lab research with mammals at the University of Virginia from 1974-1976. Most of his papers are on Virginia mammals, primarily oldfield species such as meadow voles (Longtin & Rose, 2012), hispid cotton rats (Rose & Mitchell, 1990; Green & Rose, 2009), marsh rice rats, and eastern harvest mice, but also some on forest mammals in the Dismal Swamp (Rose, 2000). Many studies, often with graduate students, focused on ecology, behavior, or reproduction. Several students studied shrews in the southeastern Virginia region and rodents in tidal marshes on the Eastern Shore (e.g., Bloch & Rose, 2005; Rose & McGurk, 2006).

Raymond D. Dueser is an ecologist who has worked extensively with Virginia mammals, first as a professor

in Environmental Sciences at the University of Virginia (1974-1990), and since then until his retirement in 2009 as an occasional researcher while a faculty member of the Department of Fisheries and Wildlife Sciences at Utah State University. Dueser's research focused on the distribution of small mammals on the barrier islands off the coast of Virginia's Eastern Shore (Dueser et al., 1979), although some of his students conducted projects near Charlottesville. Dueser sometimes collaborated with Rose, John Porter, or Nancy Moncrief. In retirement, he is continuing his studies of barrier island mammals and his associations with colleagues.

After moving to Charlottesville to earn his graduate degrees, John H. Porter has remained as a research associate in the Department of Environmental Studies at the University of Virginia. One of his jobs is data manager for the Long-term Ecological Research (LTER) site on the Eastern Shore; another is as a data expert for the National Science Foundation, serving other LTER sites. Porter also has conducted long-term research on the Eastern Shore with Dueser and sometimes in association with Nancy Moncrief. His papers on Virginia mammals often are coauthored with colleagues (e.g., Porter & Dueser, 1982).

Nancy Moncrief has been Curator of Mammals at the VMNH since 1988, where her duties include Assistant Director of Research and Collections, oversight of the collections, and working with exhibits. She has an active research program on the genetics of tree squirrels and island populations of rodents (e.g., Moncrief et al., 2012)

Donald Linzey is the author of the most recent book on *Mammals of Virginia* (1998). In addition, he has written several papers on Virginia mammals since the late 1970s. The editor of the (1979) volume on Virginia's Threatened and Endangered species, Linzey now teaches at Wytheville Community College.

Richard J. Reynolds and Michael L. Fies are wildlife biologists with the VDGIF. Reynolds's publications are mostly about small mammals and bats, whereas those of Fies deal with rabbits, hares, and flying squirrels (e.g., Reynolds et al., 2009). Those currently studying Virginia bats with Reynolds include Karen Francl (Radford University) and Christopher Hobson and William Orndorff (Virginia Department of Conservation and Recreation, Division of Natural Heritage). Importantly, Reynolds and Fies have endorsed VDGIF funding for numerous studies of Virginia mammals.

Faculty members at other Virginia institutions also have increased our knowledge of Virginia mammals. At Virginia Tech, the contributions of wildlife professors are recognized, especially those of Michael R. Vaughan. Wildlife professors have published many

papers on mammals, mostly on game or fur-bearing mammals, since the 1970s (e.g., Lee & Vaughan, 2005).

Walter Bulmer (et al., 2000) and Ralph P. Eckerlin, each of whom taught for more than 35 years at the Annandale campus of Northern Virginia Community College until their recent retirements, took class field trips to many parts of Virginia, where they frequently collected small mammals. Eckerlin was especially interested in the parasites of mammals, and authored several papers on this subject. Numerous specimens prepared on these field trips are now in the collections of the VMNH, as is Eckerlin's flea collection.

Michael T. Mengak, formerly of Ferrum College and now at the University of Georgia, studied the biology and distribution of the Allegheny woodrat in its haunts in western Virginia, among other mammals (e.g., Mengak & Castleberry, 2008). Also, William J. McShea, a long-time researcher at the Smithsonian Institution's Front Royal facility, has published numerous papers on small and large mammals in Virginia, often with colleagues (e.g., McShea et al., 2003).

Finally, the contributions of dozens of graduate students should be acknowledged. Their short-term research projects, which often led to publications, have increased the knowledge of distribution and more frequently of the ecology or biology of one or more species. One of the most noteworthy of these is the black bear study of Eric C. Hellgren, conducted in the Dismal Swamp in the early 1990s; his Ph.D. study led to the publication of at least a dozen papers on that population (e.g., Hellgren & Vaughan, 2000). Among more recent graduates, A. Scott Bellows has authored a cluster of papers since 1999, on small mammals and bats in a range of habitats at Fort A. P. Hill (Bellows et al., 2001) and other places, mostly with Pagels and Joseph C. Mitchell, before earning his Ph.D. degree at ODU in 2007. Another significant contributor is John Orrock, like Bellows an MS student with Pagels, with many papers on Virginia mammals (e.g., Orrock et al., 2000).

In conclusion, mammalian wildlife in early America was so abundant that it seemed inexhaustible. This abundance led to its exploitation, overuse, and rarity so that by the late 19th century it became clear that mammalian wildlife had to be regulated by hunting seasons and bag limits. C. Hart Merriam insisted that effective regulation required basic knowledge and thus he emphasized the need for research (Cameron, 1929). Effective management of wildlife also requires information on the distribution and abundance of wildlife species, necessitating surveys that assess abundance and annual tallies of wildlife taken by

hunters and trappers. The early 20th century was also a period of great interest in natural history in America, with many people making personal collections of mammals (e.g., Lewis, 1940), yielding even more information on distributions. Recognition that mammals were intrinsically worthy of study was formalized in 1919 when the American Society of Mammalogists was founded and began publishing its *Journal of Mammalogy*. Historically, mammals in Virginia went from being a curiosity and similar to or different from English mammals, to a resource to be exploited and later valued as American, to being regulated and given the protection of law, and finally to being intrinsically worthy of study for interesting features of their biology. Today, all mammals have the protection of law: fur-bearers and game species are regulated by seasons and bag limits, but others can be studied by investigators, including non-professionals, who have been granted the state permits needed to conduct scientific research.

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