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Science at Engineer Cantonment

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CHAPTER 11
NATURAL HISTORY STUDIES

11.1 Science at Engineer Cantonment

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Introduction

The Yellowstone Expedition of 1819–1820 was part of a larger scheme by the U. S. War Department to extend American influence along the frontier and to counter British activities in the years following the War of 1812 (Goodwin 1917; Wesley 1931). The expedition consisted of two contingents—a scientific party commanded by Major Stephen H. Long and military units commanded by Colonel Henry Atkinson. The expedition was to proceed using steamboats from Pittsburgh to the mouth of the Yellowstone River (in present-day North Dakota) and to occupy a position there. Because of a late start for the expedition and many troubles with the steamboats, the Long Expedition went into winter quarters on September 19, 1819, at a place just north of modern Omaha, Nebraska, designated as Engineer Cantonment (these temporary quarters for military troops were named for their steamboat, the *Western Engineer*). The military expedition experienced even more problems, finally going into winter quarters at Camp Missouri just a few miles up the Missouri River from Engineer Cantonment and just below the Council Bluff of Lewis and Clark.

Long's expedition was the first party with trained scientists to explore the American West in the name of the United States government (Beidleman 1986). Thomas Say, who was one of the leading young zoologists in America, was a founding member of the Philadelphia Academy of Natural Sciences and was to become known as the "Father of American Entomology" (Stroud 1992). Titian Ramsay Peale was the son of Charles Willson Peale, who founded America's first great museum in Philadelphia. Peale received training both from his father and members of the Academy. Say and Peale had both participated in an expedition to Georgia and Florida (Peale 1947a, 1947b; Porter 1983a, 1985). Later in the 1840s, Peale served as the zoologist on the Wilkes Expedition (Poesch 1961). Edwin James, who joined the party in May 1820, was a graduate of Middlebury College and received medical training from his brother in Albany, New York. He was tutored in botany by John Torrey and in geology by Amos Eaton (Wood 1955). James replaced Dr. William Baldwin (who had become ill and died in Franklin, Missouri) and Augustus Jessup, who had returned east with Long. Samuel Seymour was an experienced landscape artist, who also accompanied Long on his 1823 expedition (Ewan and Ewan 1981; McDermott 1949, 1951).

On October 11, 1819, Long returned to the east from Engineer Cantonment for personal reasons, and to fill open positions and obtain additional funds for the expedition. Remaining at Engineer Cantonment during the winter of 1819–1820 were Say, Peale, Seymour, and H. Dougherty, hunter. They were aided in their work, especially with the Native Americans, by the Indian agent for tribes along this part of the Missouri River, Benjamin O'Fallon, and his interpreter, John Dougherty. Although this was an extremely harsh winter, the scientists worked diligently to carry out Long's orders "to examine the country, visit the neighbouring Indians, procure animals, &c." (James 1822:I:165).

Long returned to Engineer Cantonment on May 27, 1820. Because of the financial crisis caused by the Panic of 1819 and growing opposition to military spending, Long was able to obtain only a limited commitment from the Secretary of War, John C. Calhoun, for additional funds, which ultimately were never delivered. The orders for the expedition were significantly altered during the winter of 1819–20. The revised orders for the scientific expedition were to explore along the path of the Platte River to discover its headwaters, to proceed along the Rocky Mountain Front, to locate the headwaters of the Arkansas and Red rivers, to follow these rivers eastward to Fort Smith, Arkansas, and finally arrive in Cape Girardeau, Missouri. Preparations were quickly made, and the expedition departed for the Rocky Mountains on June 6 (Bell 1957). The expedition followed the general route outlined in their new orders, arrived at Fort Smith by September 9, and reassembled at Cape Girardeau by October 12. It was clear that "distance and speed became more important than quality or thoroughness of investigation" (Nichols and Halley 1980:110-111).

The expedition of the summer of 1820 is the portion of the Long Expedition that has received the most attention from biologists and historians (Beidleman 1986; Benson 1988; Chittenden 1902; Dillon 1967; Evans 1997; Goetzmann 1966, 1979; Goodman and Lawson 1995; Nichols and Halley 1980; Osterhout 1920a, 1920b). Historians have not been particularly kind to the expedition. William Goetzmann (1966:60) described the party as "A curious cavalcade of disgruntled career officers, eccentric scientists, and artist-playboys, . . ." Hiram Chittenden (1902, vol. 2:574-575) believed that the expedition of 1819 had failed, and that "a small side show was organized for the season of 1820 in the form of an expedition to the Rocky Mountains."

On the other hand, biologists have had a much more positive view of the expedition's results (Beidleman 1986; Goodman and Lawson 1995; Nichols and Halley 1980; Osterhout 1920a, 1920b). However, biologists have concentrated their interest, not surprisingly, on the summer expedition, because members of the party were the first to study and collect in the foothills of the Rocky Mountain Front. James was the first person to collect plants from above tree-line when he and his companions scaled Pike's Peak on July 13–14. This work certainly made many new plants and animals known to the scientific community (Beidleman 1986), but no more than a few days were devoted to any one area.

However, Genoways and Ratcliffe (2008) recently concluded that both biologists and historians have missed the most important scientific work of the Long Expedition that was accomplished during the winter of 1819–1820 at Engineer Cantonment. Here the scientific and ethnographic work was conducted over a nearly nine-month period. Nichols and Halley (1980:103) made a similar observation, stating: "the rest of the explorers set to work gathering specimens, making sketches, interviewing Indians, and making notes. In fact, they probably gathered as much scientific data during the winter at Engineer Cantonment as they did on the rest of the expedition." Many new taxa of plants and animals were discovered in the vicinity of the cantonment. The specimens, drawings, and catalogs of the plants and animals prepared by the scientists are the most valuable result of the entire expedition. These materials serve as the vouchers and documentation for what would be called, in modern scientific terminology, a biodiversity inventory. This is the first place in America of which we are aware that a party of scientists attempted to produce a complete inventory of the mammals, birds, amphibians, reptiles, insects, snails, and plants occurring in a limited geographic area (our estimate is that most of these plants and animals were collected or observed within 30 km, primarily to west and north).

Genoways and Ratcliffe (2008) based their study on the historical record, scientific literature, and journals kept by members of the expedition. Studies in this volume (Nepstad-Thornberry and Bozell; Picha; and Falk et al.) have been published based on historical phytoarcheological and zooarcheological materials resulting from the excavation of Engineer Cantonment. The items forming the basis of these studies come to us as a time capsule of the plants and animals encountered and used by members of the expedition in 1819–1820. These archeological data enhance the scientific information used by Genoways and Ratcliffe (2008), allowing us to extend and update their work in this publication. The results have provided us more than a snapshot, in fact nearly a fully painted picture, of this area at the ecotone of the extensive deciduous forest to the east and the rolling prairies of the Great Plains to the west from almost 200 years ago, revealing the changes in biodiversity and landscapes that have occurred in Washington County, Nebraska, and adjacent areas along the Missouri River. Not only do these scientific results detail what has happened in the past, but they also provide the basis for predicting the future as the climate is changing.

What is Biodiversity ?

Biodiversity, or biological diversity, refers to all species of plants, animals, and microorganisms and the ecosystems and ecological processes of which they are parts (McNeely et al. 1990). Although humans have studied biological diversity since the time of Aristotle, the term biological diversity was not used until 1980, and the term biodiversity first appeared in 1986 at a National Academy of Sciences (NAS) symposium. The word first appeared in print in 1988 when E. O. Wilson used it to describe the proceedings of the NAS meeting. Since that time it has become commonplace, both in the biological sciences and with the public. Dybas (2006) observed that biodiversity has several meanings (genetic, species, ecosystem), but the definition adopted by the United Nations Convention on Biological Diversity is "the variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are a part." In short, biodiversity is the sum total of life on Earth.

Biodiversity is important to humankind practically, aesthetically, and ethically, because our very existence depends on our direct use of, and care for, the plants, animals, and ecosystem functions that comprise biodiversity (Lovejoy 1997). The presence of many different kinds of species is important because many species provide food, shelter, clothing, medicine, and enhanced spirituality to humans. Knowledge of biodiversity also serves society as an indicator of ecological change that could affect human welfare. Comparing baseline biodiversity information through time, such as that documented by the Long Expedition at Engineer Cantonment with what we see there today, illustrates changes in habitats and their inhabitants and how or why these changes may have occurred. Thus, comparisons with historical biodiversity inventories have predictive value by showing how changes in the composition of plants and animals occurring in an area can be extrapolated to other, modern events given a similar set of circumstances.

Losses in biodiversity may occur from human impacts on habitats (habitat destruction, degradation, fragmentation, restructuring) and on organisms (over-exploitation and introduction of invasive species, predators, and parasites) (Mooney and Cleland 2001; Pimm et al. 1995; Vitousek et al. 1996; Wilson 1992). This can clearly be seen at Engineer Cantonment where today's habitats consisting of urban areas and agriculture are vastly different from the broad floodplain of nearly 200 years ago. Habitat fragmentation and destruction results in a net loss of biodiversity as plants and animals lose their homes and are extirpated or when invasive species replace native species. We know that human population growth is causing the destruction of biodiversity, and that it is altering biosphere-level processes that we depend on for $3 to $33 trillion of environmental services annually (Constanza et al. 1997; Pimental et al. 1997). This has broad implications for conservation and, ultimately, for human survival.

At a National Academy of Sciences colloquium, "The Future of Evolution," held in March 2000, panel discussants agreed that current extinction rates are 50 to 500 times background rates and are increasing, and that the consequences for the future evolution of life are serious. We are now living in what will eventually be recognized as a mass extinction event. If current area-species curve-based projections are correct, we could lose up to 50 percent of the planet's species in the next 1000 years (Rosenzweig 2001; Woodruff 2001).

In response to the on-going rapid decline of biomes and homogenization of biotas, the panelists predicted changes in species geographic ranges, genetic risks of extinction, genetic assimilation, natural selection, mutation rates, the shortening of food chains, the increase in nutrient-enriched niches permitting the ascendancy of microbes, and the differential survival of ecological generalists. Action taken over the next few decades will determine how impoverished the biosphere will be in 1000 years when many species will suffer reduced evolvability and require interventionist genetic and ecological management. Whether the biota will continue to provide the dependable ecological services humans take for granted is less clear. Our inability to make clearer predictions about the future of evolution has serious consequences for both biodiversity and humanity (Woodruff 2001).

McNeely et al. (1990) observed that biological diversity is an umbrella term covering the totality of species, genes, and ecosystems, but also that biological resources can actually be managed, consumed, replenished, and can be the subject of directed conservation action. The efficient and rational use of natural resources depends on accurate ecological knowledge, but the major deterrent to ecological studies is the lack of biodiversity data that are fundamental for all subsequent studies. To arrive at a sound view of ecology, we must first identify and catalog the fauna and flora. Cataloging the fauna and flora was the prime directive for the scientific contingent of the Long Expedition.

Biodiversity inventories, in general, have specific goals of discovery and documentation and so are organized, systematic, and sustained (Kohler 2006; Wilson and Reeder 2005). Since the late 1700s, biotic surveys have generated vast scientific collections of specimens that were the foundation for many natural history museums and the descriptive science of taxonomy. In turn, taxonomy is the foundational discipline for all of the biological sciences, because it documents all of life on Earth and organizes this knowledge into a hierarchical system of data retrieval.

Kohler (2006) observed an important distinction between surveys and exploration. Exploration usually consisted of journeys into the unknown for commercial, military, or political reasons. Occasionally, a biologist might accompany such an expedition, but they were incidental to the principal goals of the journey. Examples of this kind of exploration are the Pacific voyages of James Cook (1770s), the South American travels of Alexander von Humboldt and Amié Bonpland (early 1800s), explorations of the Pacific Northwest of the U.S. by George Vancouver (1790s), and the Corps of Discovery led by Meriwether Lewis and William Clark (early 1800s).

By contrast, survey collecting expeditions were primarily scientific and their goal was to inventory the flora and fauna of a given area. Notable examples are Charles Darwin and the second voyage of *HMS Beagle* (1830s), the U.S. Biological Survey and the Nebraska Botanical Survey (both late 1800s), Henry Walter Bates in Amazonia (1850s), Alfred Russel Wallace in Malaysia and Indonesia (late 1850s), the many biotic surveys both here and abroad sponsored by natural history museums, including the recently published *Flora of Nebraska* (Kaul et al. 2011), surveys of the mammals of Nebraska (Genoways et al. 2008) and scarabs of Nebraska (Ratcliffe 1991; Ratcliffe and Paulsen 2008), and the Long Expedition's intensive and sustained inventory activities at Engineer Cantonment from the fall of 1819 to the late spring of 1820.

Landscape Changes

The expedition cabins at Engineer Cantonment were located at the eastern base of a steep ridge that is bisected by a ravine just south of the camp. This ridge and associated ridges and cliffs marked the western edge of the old Missouri River channel. The cabins were located only a few meters from the edge of the water (Carlson et al. 2004), along what is believed to have been an oxbow off of the main channel of the river.

Through word descriptions, sketches, and paintings, members of the expedition have left an excellent record of the general landscape in the vicinity of Engineer Cantonment. As the party rode along the eastern side of the Missouri River across from the modern city of Omaha, they approached the site of Engineer Cantonment from the south on September 16, 1819, and made the following initial observations of the river valley:

> Above the Platte, the scenery of the Missouri becomes much more interesting. The bluffs on each side are more elevated and abrupt, and being absolutely naked, rising into conic points, split by innumerable ravines, they have an imposing resemblance to groups of high granitic mountains,

> seen at a distance. The forests within the valley of the Missouri, are of small extent, interspersed with wide meadows covered in Carices and Cyperaceae [= sedges], . . . sometimes sinking into marshes occupied by Saggittarias [= arrowhead], Alismas [= water plantain], ...(James 1822:I:144).

The dominant vegetative feature now in the valley is trees, and the only areas not covered by them are those under cultivation and urban development. The loess hills and cliffs bordering the valley are still present, but they are difficult to observe because they are covered in trees. The Missouri River has been channelized, being confined to a much narrower and deeper channel. The associated wetlands were drained and converted to rich farmland, so only a few of the restricted meadows and marshes described by James are present. Encroaching on the site from the south and west is the rapidly growing metropolitan area of Omaha, which stands at 42nd in population among American cities with just over 408,000 residents (2010 U.S. Census). In the area, on the east side of river from which James (1823) described the valley, is the city of Council Bluffs, Iowa, with 60,000 residents.

Stephen Long carefully chose the site of Engineer Cantonment within a kilometer or so of Manuel Lisa's trading post. He obviously selected the site with the eye of an experienced explorer to take advantage of all of the local resources:

> . . . a very narrow plain or beach, closely covered with trees, intervenes between the immediate bank of the river, and the bluffs, which rise near two hundred feet, but are so gradually sloped as to be ascended without great difficulty, and are also covered with trees. . . . Here were abundant supplies of wood and stone, immediately on the spot where we wished to erect our cabins, and the situation was sheltered by the high bluffs from the northwest winds. The place was called Engineer Cantonment (James 1822:I:153).

Titian Peale left us an excellent watercolor (no. 60 in the Titian Ramsay Peale sketches at the American Philosophical Society) of a view of Engineer Cantonment, which gives a visual record of the site (see plate 1.2.1 A). In the watercolor, we can see the cabins near the water's edge with a few surrounding trees. To the north (right) along the plain there appears to be a dense growth of trees. The ridge behind camp appears to have trees as well, but they do not appear to be as dense a growth as along the plain. In the foreground of the painting the *Western Engineer,* four keelboats (based on number of masts) are anchored in an area believed to be an oxbow off of the Missouri River. Peale's painting can be compared with a photograph (plate 11.1.1) taken from near the same viewpoint. Peale's watercolor is based on the site in February 1820, and the photograph was taken in March 2004. The first feature to note in the photograph is that the ridge behind the location of the cabins is heavily forested down to the level of the cabins. The river oxbow is no longer present in the foreground where the area is now in the process of being returned to wetlands after having been farmed for many years.

After the military contingent of the expedition had arrived and settled at Camp Missouri, the scientists visited the site, which was established a few kilometers upstream along the main channel of the Missouri River. They made observations in the area of the Council Bluff of Lewis and Clark, which was on the bluff above Camp Missouri. These observations help give a fuller picture of the landscape along this segment of the Missouri River Valley:

> The Council Bluff, so called by Lewis and Clark . . . is a remarkable bank, rising abruptly from the brink of the river, to an elevation of about one hundred and fifty feet. This is a most beautiful position . . . . Its defects are a want of wood within a convenient distance, there being little within a mile above, and much farther below, also a want of stone and of water, except that of the river. From the summits of the hills, about one mile in the rear of the Bluff, is presented the view of a most extensive and beautiful landscape. The bluffs on the east side of the river, exhibit a chain of peaks stretching as far as the eye can reach. The river is here and there seen meandering in serpentine folds, along its broad valley, chequered with woodlands and prairies, while at a nearer view you look down on an extensive plain interspersed with a few scattered copses or bushes, and terminated at a distance by the Council Bluff (James 1822:I:152-153).

This view from Cemetery Hill at the western edge of Fort Calhoun, Washington County, is unfortunately no longer available, because it is blocked by numerous trees on this hill, the prairie, the Council Bluff, and in many areas of the Missouri River Valley. The Missouri River no longer meanders through the valley, because it is confined to its considerably straightened, channelized course. The

Plate 11.1.1. Photograph taken in March 2004 near Peale's viewpoint (41°24'56"N latitude, 95°57'01.5"W longitude) for the watercolor of Engineer Cantonment (plate 1.2.1 A). The expedition cabins were located about 25 m south (left, facing the photograph) of the metal grain storage bin near the center of the photograph, where a small canopy covering one of the excavations can be seen.

area of prairie at the base of the hill has been replaced by the town of Fort Calhoun with 1000 residents and shady, tree-lined streets. Beyond the city to the east at the top of Council Bluff stands the restored Fort Atkinson. It also is nearly impossible to get a view of the valley from here because the entire slope of Council Bluff is heavily forested. The valley at this point is in agricultural use, and the river, currently located about 2 km to the northeast, is extensively lined by cottonwood trees.

Leaving Engineer Cantonment on June 6, 1820, and riding to the west, Captain Bell made the following observations:

> After ascending the hill distant from the Missouri half a mile we enter the prairie which is undulating and entirely destitute of timber—from the hills of the prairie we had a beautiful view of Council Bluff and the country on the opposite side of the river—variegated with wood and meadow land. (Bell 1957:105).

The previous fall, members of the scientific party had commented on the problems that they had encountered from the smoke of prairie fires burning in the area. These fires were stopped only with two days of rain and a shift in the wind direction. They made the following observations about the smoke:

> From the 24th of October to the 10th of November, the atmosphere was generally filled with dense smoke like a fog or stratus, which proceeded from the conflagrated prairies. . . . On the morning of the 8th instant [= November 8] it occurred in greater quantity than at other time, when it was so extremely dense as to intercept a view of the opposite shore of the Missouri

from Engineer Cantonment (James 1822:I:178-179).

The area of prairie and the view to the east described by Bell was lost long ago, being replaced with an area of forest and residential development. Fires in this area and other areas of the Great Plains have been actively suppressed since the first settlements were established. Stambaugh et al. (2006) studied the fire history of trees at the extreme southern end of the loess hills that border the eastern floodplain of the Missouri River just south of the Iowa border in northwestern Missouri. In this area, the minimum fire interval from 1672 to 1820 was 6.6 years and the rate of fire occurrence increased between 1821 and 1880 so that fires were occurring every 2.5 years. This increased rate was associated with the settlement period and probably represents fires set intentionally, as part of land clearing, and accidental fires, resulting from increased human activity. From 1881 to 1980, the rate dropped significantly again so that fires occurred only every 5.8 years. Stambaugh et al. (2006) also found that fires after 1900 were smaller and burned with less intensity and that only one fire had occurred in the area after the mid-1950s.

In summary, comparing this area of the Missouri River in 1819–1820 to 2016 clearly shows that the landscape has been significantly altered, primarily by human activity. A broad valley with a meandering river prone to seasonal flooding, especially in the spring, and a mixture of forests, open wetlands, and meadows has been transformed into a suburban area dominated by cottonwoods and non-native tree species, a narrow and nearly straight river, and agricultural fields. The river was altered by channelizing and the building of upstream dams beginning in the 1940s by the Army Corps of Engineers to prevent flooding, allowing the permanent draining of wetlands for conversion to agricultural use and to maintain a constant river flow to allow barge traffic at least as far as Omaha. All of these actions have encouraged the growth of trees, especially cottonwoods, as has the suppression of fires that are necessary to maintain the prairies in these areas of the ecotone with eastern deciduous forests (Benedict et al. 2000; Ratcliffe 1990; Ratcliffe and Hammond 2002; Roehrs and Genoways 2004). Knopf (1986) also attributed the development of forests along prairie rivers to the effects of subirrigation when water is diverted from the river for agricultural purposes and then slowly allowed to work its way underground back to the river. As should be clear from this discussion, it is impossible today to get the same impressions of the landscape that greeted Long and his scientific party as they arrived at Engineer Cantonment.

New Plants and Animals

Certainly, one of the major contributions to science made by the Long Expedition lies in the number of new species of plants and animals described from the vicinity of Engineer Cantonment. Genoways and Ratcliffe (2008) counted at least 56 new species—4 plants, 1 snail, 38 insects, 3 snakes, 4 birds, and 6 mammals—that can be confirmed as being described from this area and many others may have been as well, because in a number of instances the sources of the specimens later described by Thomas Say are not noted. The formal method for making new plants and animals known to science involves a description of the new species, how it differs from related species, and the proposal of a scientific name for the new species. One individual specimen is usually designated to represent the species, and it is referred to as the holotype. The geographic place where the holotype originated becomes known as the type locality, and other specimens from this site become known as topotypes. The type locality and topotypes become valuable in science, because it is the place where 'typical' representatives of the species may be obtained in future studies. Topotypes are important for conveying variation in the new species beyond what can be learned from the single holotype.

There is no doubt that Engineer Cantonment is the most important type locality in the modern state of Nebraska, and we are comfortable with the claim that Engineer Cantonment is the most important type locality on the Great Plains. Clearly, more new plants and animals were described from this area than from any other visited by the Long Expedition. This should not be overly surprising given that the expedition spent no more than a few days at any other site from the time they left Engineer Cantonment in June 1820 until they arrived at Fort Smith in September. The pressure of short supplies and equipment only allowed the scientists to gather material while they were on the move or after the day's travel and camp had been established.

Examining the list of new species allows several observations. The number of new plants (Genoways and Ratcliffe 2008) is unusually low given the time at Engineer Cantonment. However, it must be remembered that William Baldwin, the original botanist on the expedition, became ill and never reached Engineer Cantonment. Edwin James, Baldwin's replacement, only reached the site on May 27 and departed for the Rocky Mountains on June 6. Little time was available for botanizing, because time was devoted to preparations for the summer expedition. The four new plants from Engineer Cantonment were described by John Torrey, one of Edwin James' mentors and one of the founders of American botany. The fact that insects (Genoways and Ratcliffe 2008) comprise the largest group of new species of animals described should not be surprising, because all of the new animal species were described by Thomas Say, whose specialty was insects, and he is considered by many to be the father of American entomology. Even though birds (Genoways and Ratcliffe 2008) comprised the largest group of vertebrates present at Engineer Cantonment, the fact that only four species of new birds were described by Say should not be considered an unexpected result. Birds had been studied longer and in much more depth, and so fewer new species remained to be discovered. Say described only another eight species of birds from the remainder of the expedition even though much more new territory was surveyed (Osterhout 1920a).

Mammals present an interesting counterpoint to birds, because they were poorly studied throughout North America in 1819–1820. Say described and named six new mammals (Genoways and Ratcliffe 2008) of which four names are still in use for widespread species (Hall 1981). The coyote (*Canis latrans*), which ranges throughout the western two-thirds of North America and from Alaska to Costa Rica, was first made known to science from Engineer Cantonment, as was the prairie wolf (*Canis lupus nubilus*), which occurred throughout the Great Plains east of the Rocky Mountains from southern Canada to Oklahoma and as far east as Iowa and Missouri. Say also described two species of short-tailed shrews from Engineer Cantonment that are common inhabitants of the eastern United States. The techniques for catching small mammals, such as the northern short-tailed shrew (*Blarina brevicauda*) and the least shrew (*Cryptotis parva*), were not fully developed until the invention of the cyclone trap in the 1880s. These two shrews were actually captured in large pitfalls constructed in an attempt to catch specimens of the prairie wolf. Only in the last 30 years have mammalogists regularly used pitfall traps, albeit much smaller ones, as an effective method for capturing small mammals.

The other two species of mammals described by Say were bats. Say described the big brown bat under the name *Vespertilio arquatus* and the hoary bat under the name *Vespertilio pruinosus*. However, both of these species had been described and named earlier by the French naturalist, Palisot de Beauvois (1796) in a catalog of the collection of Charles Willson Peale's museum in Philadelphia (Gillispie 1992; Merrill 1936). Undoubtedly, these species, which are now known to have geographic ranges that cover most of North America, were described by Palisot de Beauvois based on specimens from the Philadelphia area, and Say did not make the connection to these specimens from half a continent away.

Species Richness and Engineer Cantonment

The most fundamental measure of biodiversity is expressed as species richness (Peet 1974). Various methods have been devised to estimate species richness, but our data set does not fulfill the assumptions of these statistical methods. However, as Peet (1974) stated, "Direct species counts, while lacking theoretical elegance, provides one of the simplest, most practical, and most objective measures of species richness." More recently Hellman and Fowler (1999) compared four measures of species richness and concluded: "The simple richness estimator was the most precise estimator in all studied communities, but it yielded the largest underestimate of species richness at all sample sizes." The simple richness estimator used by Hellman and Fowler (1999) was "the sum total of species observed in a sample." This is similar to alpha diversity, which is the number of species within a habitat, of other authors (Samson and Knopf 1993). Genoways and Ratcliffe (2008) calculated the simple richness estimator, or alpha diversity, for the vicinity of Engineer Cantonment in 1819–1820. Using data compiled in Appendices 1–6 of Genoways and Ratcliffe (2008), the following species counts are found for the surveyed groups: 51 plants in 34 families; 14 snails in 7 families; 46 insects in 30 families; 2 amphibians in 2 families; 13 reptiles in 6 families; 143 birds in 44 families; and 33 mammals in 20 families. This gives a species richness of 302 species. We are not aware of another site in North America that was surveyed during the remainder of the nineteenth century with a species richness that even approached 302 species. Most areas during this time were surveyed for a few days and then the field parties moved along. Most were not interested in broad taxonomic representation in their surveys, but focused on plants and larger vertebrates.

Now after adding data from the phytoarcheological and zooarcheological surveys the species richness number increases by 6.5 percent. The 20 new species added by the archeological work include 6 plants, 4 mollusks, 5 fish, 2 amphibians, 1 bird, and 2 mammals. With these archeological additions and inclusions of the overlooked historical records of the killifish and stickleback, the species richness number for Engineer Cantonment in 1819–1820 becomes 324.

Changes In Biodiversity

Plants

When the Long Party occupied Engineer Cantonment for about nine months in 1819–20, they lived directly adjacent to several distinct plant communities. These are identified largely through the expedition members' scientific collecting efforts and the artwork of Titian Peale and Samuel Seymour (see figs. 2.3.4; 2.3.5; 11.2.1 and plate 1.2.1 A). Although the cabins were built in an opening or clearing, much of the narrow area between the base of the bluffs and channel or harbor was covered with dense trees. Kaul (personal communication with Bozell November 2014) was not able to positively identify the species of trees depicted in the Seymour illustrations, but suggested that they are *not* oak, willow, or walnut but could be elm, hackberry, or green ash. To the east, the floodplain appears in the illustrations to be defined more by lowland and near aquatic sedges, forbs, and grasses. The western boundary of their encampment is depicted as steep slopes, ravines, and bluffs. Much of this terrain was covered by grasses with only occasional ribbons of timber in the ravines and on the bluff crests. The bluffs in the distance to the east (now Iowa) in the Seymour painting of the Pawnee Council (fig. 2.3.5) also appear to be largely free of trees. These plant communities have changed rather dramatically over the past 195 years and have continued to change since the 2003–2005 excavation program.

Members of the Long Expedition recorded 51 plant taxa in the general vicinity of Engineer Cantonment. Of these, 13 taxa are trees (Kentucky coffee tree, oak, ironwood, cottonwood, bitter nut hickory, Osage orange, green ash, American elm, rock elm, and several species of willows). The remainder are a variety of grasses, sedges, shrubs, and woody vines. Four of these species were new to science and were formally described and named based on material collected by the party including: *Chenopodium simplex* (maple-leaved goosefoot); *Scutellaria parvula* (little skullcap); *Rubus occidentalis* (black raspberry); and *Mimulus glabratus* (monkey flower).

A discussion of the significance of the botanical material recovered during the archeological investigations must consider several factors that introduce bias in the sample. Only charred botanical material is likely to have survived for nearly two centuries in places like eastern Nebraska. So while wood used for fuel or plants that have been cooked with open flame might preserve, plants that were collected for scientific study and wooden architectural elements such as roof rafters, floor boards, wall logs, and posts (Structure 1 did not apparently burn) would have very limited survivorship. This also would hold true for plants that were collected to be boiled or eaten raw. Accordingly, our ability to gain a coherent view of how the Long Party were using trees and plants is skewed. Similarly, identified archeobotanical remains associated with the Long Party cannot be expected to add in any significant manner to formally quantifying net gain or loss of plant biodiversity.

Large samples of uncharred plants remains were discovered during the investigation although, for the reason discussed above, these can not be confidently attributed to the Long Party and probably are more recent, finding their way into the archeological deposit through bioturbation or cultural actions related to a nearby farmstead. Nevertheless these materials certainly have significance with respect to changes in plant communities following abandonment of the site.

Charred remains believed to likely be associated with the Long Expedition are limited to 603.7 gm of wood charcoal and 200 charred seeds (Section 9.1, Nepstad-Thornberry and Bozell, this volume). The seeds include: *Vitis* sp. (wild grape), *Coffea* sp. (coffee), *Juglans nigra* (black walnut), *Celtis* sp. (hackberry), and *Zea mays* (corn). Corn and coffee are introduced domestic species brought to the site through interaction with resident native tribes, local traders (Manuel Lisa in particular), or transported from the east coast. The wood charcoal is from nine types of trees although several could not be identified to a particular species. The charcoal is dominated (76 percent) by Ulmaceae/*Ulmas* sp. (elm). Other taxa represented in the collection include: *Acer* sp. (maple), *Corylus americana* (hazelnut), *Celtis* sp. (hackberry), *Juglans* sp. (black walnut), *Juniperus virginiana* (eastern red cedar), *Populus* sp. (cottonwood), *Quercus* sp. (oak), and Salicaceae (willow family).

Of the plants identified in the archeological collection, some are absent in surviving notes and journals by the Long Party in the Engineer Cantonment vicinity. Historic records, however, document several types of willow, cottonwood, oak, and elm, but not maple, hazelnut, hackberry, black walnut, cedar, or wild grape. Coffee and corn of course are introduced species and do not figure into consideration of native plant biodiversity.

All of these plant species still occur in the Engineer Cantonment area based on an inventory of plants and trees from the Neale Woods Nature Center located about 1.8 km south of Engineer Cantonment (Ratzlaff and Barth 2007; see also Johnsgard 2001:142-146; Kaul et al. 2011; Weaver 1965). In fact, the modern plant biodiversity of the Nebraska–Iowa Missouri River valley, is greatest in the area immediately to the north and south of the Omaha area. This is due in no small measure to very well-managed conservation areas such as Fontenelle Forest, Neale Woods, and the Boyer Chute and DeSoto National Wildlife Refuges. In Fontenelle Forest and Neale Woods, nearly 75 percent of Nebraska's 136 families of vascular plants occur today (Johnsgard 2001:143). The unfarmed floodplains and near-bluff Missouri River forests are dominated today by elm (although there are virtually no large trees because most were killed by Dutch elm disease since the 1960s; Kaul et al. 2011:865), hackberry, green ash, silver maple, box elder, and of course cottonwood and willow (Johnsgard 2001:145).

Four major cultural practices have resulted in changes to the local setting and plant biodiversity over the past 100 years or more.

- The Peale illustrations and those by other nineteenth century artists normally depict the Missouri River bluffs with limited stands of timber. As Euroamerican settlement expanded in the early twentieth century, fire-prevention and suppression allowed forests to expand into the draws and eventually across the slopes and tops of the bluffs in environs like the bluffs immediately behind the cantonment (Mutel 1989; National Park Service 2000; Stambaugh et al. 2006). These forests are diverse with oak, linden, ash, maple, cottonwood, and other common species and the biodiversity of this landform has certainly shifted from one dominated by tall and mixed grass to trees and woody understory.

- Secondly, the development of row crop agriculture (primarily corn and soybeans) in the late nineteenth century virtually eliminated the native floodplain plant community immediately east of the cantonment.
- Related to modern agriculture was the development of the farmstead within and immediately to the north of Engineer Cantonment. This farmstead was built sometime between 1884 and 1908 (based on Washington County atlases) and remained occupied until the 1980s. The area of the farmyard where the cantonment ruins are buried likely was used for hog and other animal containment, refuse disposal, and perhaps construction of small outbuildings (Herb and Gloria Gibreal, personal communication 2003-2004). This type of setting would have resulted in the dominance of species such as velvetleaf, pigweed, goosefoot, elderberry, and knotweed. Uncharred seeds associated with these species were recovered during the archeological excavation and are believed to be intrusive and related to the abandoned farmstead and the plant community associated with it.
- Lastly, during the archeological investigations, the U.S. Fish and Wildlife Service (Boyer Chute National Wildlife Refuge) restored the floodplain immediately to the east of the site to a native plant community. The seed mix used in this restoration included: leadplant, black-eyed Susan, Illinois bundle flower, gray-headed coneflower, butterfly milkweed, false sunflower, Maximilian sunflower, wild bergamot, New England aster, purple prairie coneflower, pale purple coneflower, purple coneflower, big bluestem, indiangrass, switchgrass, Virginia wildrye, and tall wheatgrass (Thomas Cox, U.S. Fish and Wildlife Service [Boyer Chute National Wildlife Refuge], personal communication December 2014; U.S. Fish and Wildlife Service 2001). As a result, while the now tree-covered bluffs west of the cantonment are quite different than they were in 1819–1820, the floodplain vegetation immediately to the east may now, to a certain extent, mirror conditions that existed nearly 200 years ago.

Snails and Mollusks

A minimum of 18 species of mollusks have now been identified at Engineer Cantonment, with the zooarcheological survey identifying a minimum of eight species of snails and mollusks of which four are new for the site. One of these species new for Engineer Cantonment is the first pelecypod identified from the site (Picha Section 9.2, this volume). The historical record documented 14 species for the site (Genoways and Ratcliffe 2008), whereas four species were documented by both studies (Appendix E).

Efforts at lauding the work of pioneering zoologist Thomas Say have been: “too restrictive in that his contributions to conchology … were substantial,” as has been noted by Evans (1997:229). Furthermore, bibliographic citations listing Say’s shell publications between 1816 and 1825 found in Coan et al. (2013) add support to the claim of the American scientist’s key role within the developing discipline of zoology. Say’s intervening molluscan reporting, as Leonard (1959:101) discussed, had Engineer Cantonment as one of the two type localities for the broad-banded forestsnail, *Allogona profunda* (Say, 1821) reported in Section 9.2 of this volume.

The history of scientific discovery and exploration involving mollusks of the Missouri River basin begins with the Corps of Discovery as summarized by Hoke (2011:1). Captain William Clark reported in his journal on August 15, 1804, regarding local occurrences of mussels 3 mi. northeast of the Omaha Village at the fish camp where the creek: “… is Crouded with large Mustles” (Moulton 1986:483).

The molluscan assemblage comprising snails and mussels from Engineer Cantonment also aided in responding to questions posed by Wolverton and Lyman (2012:1): “Applied zooarchaeologists investigate questions such as: What species are native and occurred in an area in the past?” The occurrence of *Tritogonia verrucosa* (Rafinesque, 1820), pistolgrip, at Engineer Cantonment mirrors Say’s identification of the same mussel for Prince Maximilian at New Harmony, Indiana, a decade later. These are but two examples of many presented in this volume on biodiversity and science, as Wolverton and Lyman (2012:214-215) have added: “The point is that multiple independent samples will often reveal an accurate (if somewhat coarse-grained) paleoecological signal precisely because they are independent of one another in terms of sampling, recovery, preservation (taphonomy), and interanalyst variation such as how materials are quantified.” Lastly, complexity in the zoological and taxomomic worlds is every bit as complicated as it was in Say’s time as evinced by the recent works of Dillon et al. (2013), Nekola and Coles (2010), and Perez and Cordeiro (2008).

Insects

Nearly all of the insects collected and described from Engineer Cantonment during 1819–1820 are typical, relatively common, and abundant for that particular locale as it existed at the time. Without the specialized collecting methods that entomologists use today that might engender hundreds of species, the relatively poor results (at least for insects) of this kind of general collecting conducted only during the fall, winter, and spring are not surprising, especially given that most insect activity would instead have been during the late spring and summer. Many insects were collected and described as new species from Engineer Cantonment simply because there were more of them to be had relative to other groups of animals and because the insect diversity of newly explored areas of the United States was just beginning to be documented with discoveries of new species. It is not surprising that there have been no zooarcheological discoveries of insects at Engineer Cantonment, because they were largely soft-bodied, small, and fragile and so did not preserve well. Modern insect surveys specific to the area of Engineer Cantonment have never been conducted, and so we have no way to compare the species collected then versus now. Due to dramatic changes in the habitat where oak-linden-hickory forests now clothe the east-facing slopes of the bluffs and the bottomlands have been converted to row crop agriculture, there are now definite changes in the composition of the insect fauna. It is probably safe to say, however, that many of the same generalist insects are present in the area today.

As a consequence of all of these anthropogenic-induced changes to the native vegetation, the distributions of insects inhabiting these biotopes have also changed, either by expanding or contracting, because most insects are closely associated with their respective plant communities where they seek food, shelter, and breeding places. The most significant changes affecting insect diversity in the vicinity of Engineer Cantonment are the loss of most bottomlands to agriculture and the introduction of trees in the gullies, draws, and slopes of the bluffs. These changes affected all the biota, because vegetation is a limiting factor for animals both as food and shelter, and animal activity in return influences patterns of plant distribution. In some cases, floristic changes have been mirrored by the loss of animals to a particular habitat, while in others it has resulted in a net gain in diversity. The interplay between plant and animal distribution is dynamic, and the human factor has substantially changed this relationship.

Temperate forest habitats generally contain more insect species than temperate grasslands, due simply to a greater number of trophic levels and niches, and so the diversity of insects in the dense forests along the east-facing slopes is now higher than in 1819–1820, when those slopes had very few trees. The increasing diversity over the last nearly 200 years in this forest biome can be attributed to mobile insects dispersing northwards from more forested habitats along the Missouri River in southeastern Nebraska via river bottom forests that provide natural pathways for forest-adapted species. Scarabaeoid beetles in southeastern Nebraska are, for example, a recent amalgam of other faunas, both eastern and western, northern and southern, that are near the limits of their respective ranges and so are mostly adventive with nearly all of the species having colonized from elsewhere. Scarabaeoid beetles associated with eastern deciduous forests comprise 25 percent of the Scarabaeoidea in Nebraska but, considering that only 3 percent of the state's land area is covered by these forests, the large number of scarabs occurring there provides an indication of the rich biotic diversity supported by woodlands (Ratcliffe and Paulsen 2008).

Conversely, monoculture row crops present today in the converted bottomlands have far fewer insect species than the meadows, wetlands, and marshes that previously existed there. This kind of modern agriculture is a homogenous habitat consisting of only one or two kinds of plants and, combined with the usual use of pesticides that eliminate most insect activity, biodiversity has been largely suppressed, indeed eliminated.

The near-shore insects with common representatives of Carabidae (ground beetles), Staphylinidae (rove beetles), and Tridactylidae (pygmy mole crickets) should still be present, but they will have kept to the changing shoreline as oxbows and ponds dried up or were drained by human activities. Similarly, the truly aquatic insects such as Dytiscidae and Hydrophilidae (water beetles) would have maintained themselves where there is water. Since the adults all fly, it is easy for individuals in these populations to follow the changes in the availability of their preferred habitats.

In terms of richness of insect biodiversity, the wooded, east-facing bluffs are now richer than in 1819–1820, while the converted bottomlands are now far poorer. This reflects human activities that have altered the original habitats to suit human needs and values.

Fish

Fish are poorly represented in accounts of the expedition's stay at Engineer Cantonment, perhaps a reflection of the difficulty of securing specimens of fish during the late fall, winter, and spring months. A field trip in mid-February 1820 yielded a collection of several small fish from holes cut in pond ice near the Boyer River. According to Thomas Say, the collection included examples of the genus "Gasterosteus" (James 1966:I:190-191 [1822]). Falk et al. (Section 9.3, this volume) suggest the collection sample probably included the brook stickleback (*Culaea inconstans*). Sticklebacks (Gasterosteidae) are a distinctive fish found throughout the upper Mississippi basin and Great Lakes region and, as a group, were almost certainly known to expedition scientists. The brook stickleback, found in scattered locations primarily in streams and ponds north of the Platte River, is the only stickleback reported from the region. A second fish species, identified as the banded killifish (*Fundulus diaphanus*) (Genoways and Labedz, Section 11.2, this volume), is recorded in a pencil drawing by Titian Peale dated February 1820 (Peale Collection, APSimage 5645). The banded killifish is not presently recorded in Nebraska waters, but is found in rivers and natural lake areas in northwest Iowa. A similar species, the plains killifish (*F. zebrinus*) is found in the Platte drainage. Finally, Peale's pencil drawing of a river otter (APS image 5395; fig. 11.2.18, this volume), also dated February 1820, shows a larger fish lying adjacent to an ice hole. Falk et al. (Section 9.3, this volume) speculated the drawing represents a member of the sucker family, but lack of details in the sketch precludes certain identification.

A minimum of five species of fish is represented by the archeological materials associated with Engineer Cantonment (Falk et al. Section 9.3, this volume), although in all but one instance, identification of recovered specimens was not carried beyond the level genus. Identified taxa include sturgeon (*Scaphirhynchus* sp.), gar (*Lepisosteus* sp.), bullhead (*Ameiurus* sp.), channel catfish (*Ictalurus punctatus*), and black bass (*Micropterus* sp.). Specimens with metal tool marks (channel catfish) and burning (channel catfish and gar), as well as archeological context, suggest that at least some, if not all, of the identified remains are from fish that may have provided minor sustenance. Each of these taxa are presently found within the Missouri River drainage along the Nebraska–Iowa border, despite major changes to the river system itself, including channel straightening and upstream dam construction.

Amphibians and Reptiles

Genoways and Ratcliffe (2008:25, Appendix 4) list a minimum of two amphibian genera observed in the vicinity of Engineer Cantonment: *Bufo,* either Woodhouse's toad *(B. woodhousii*) and/or Great Plains toad (*B. cognatus*), and *Rana*, representing northern leopard frog (*R. pipiens*) and/or plains leopard frog (*R. blairi*). Zooarcheological remains associated with Engineer Cantonment match the historical record with identified specimens referred to both genera. In addition, the archeological sample includes single elements for American bullfrog (*R. catesbeiana*) and treefrog, either Cope's gray treefrog (*Hyla chrysoscelis*) or the near identical gray treefrog (*H. versicolor*). Falk et al. (Section 9.3, this volume) suggest that the association of the bullfrog element is uncertain. With the exception of Cope's gray treefrog, which is limited to the southeastern corner of the state, identified amphibian taxa are widely distributed in central and eastern Nebraska and associated with a variety of habitats.

Regarding reptiles, historic records summarized by Genoways and Ratcliffe (2008, 25, Appendix 4; see also, Appendix E, this volume) suggest a minimum of four turtle species, seven species of snake, and perhaps two lizard species were observed by expedition scientists. Documented forms include common snapping turtle (*Chelydra serpentina*), painted turtle (*Chrysemys picta*) and/or false map turtle (*Graptemys pseudogeographica*), ornate box turtle (*Terrapene ornata*), and soft-shelled turtle (*Apalone* sp.). Common snapping turtle and painted turtle are confirmed in the archeological sample with the remains of both species found in the floor deposits of Structure 1 (Falk et al. Section 9.3, this volume). Blanding's turtle (*Emydoidea blandingii*), a species that might be expected in the area of the Cantonment, is absent from both the historical and archeological records.

The historic inventory of snakes includes as many as five colubrid species and two pit vipers (Appendix E, this volume). Technical descriptions for three colubrids, the eastern yellowbelly racer (*Coluber constrictor flaviventris*), western ribbon snake (*Thamnophis proximus proximus*), and red-sided garter snake (*T. sirtalis parietalis*) were new to science. These species, as well as two additional colubrids observed by the expedition, the eastern hognose snake (*Heterodon platirhinos*) and western plains garter snake (*T. radix haydeni*), are found in the general project area today. The two pit vipers, timber rattlesnake (*Crotalus horridus*) and western massasauga (*Sistrurus catenatus tergeminus*), recorded by expedition scientists are not represented in modern records for the area, a reflection of habitat destruction resulting from intensive agriculture and urbanization (e.g., Ballinger et al. 2010:304-305). Seventeen snake vertebrae are included in the archeological sample from Engineer Cantonment deposits: 15 referred to the family Colubridae and the remaining two identified simply as snake. Cultural associations of these remains are uncertain. Pit vipers and lizards (skinks) are not represented in the collection.

Birds[1]

Engineer Cantonment was occupied for nearly nine months during the late fall, winter, spring, and early summer, 1819–1820. Location of the encampment on the eastern periphery of the Central Flyway, and the overlapping western limits of the Mississippian flyway (Johnsgard 2012), is strongly reflected in the large numbers and dominance of birds among recorded vertebrate species, both historically and archeologically. A minimum of 143 bird species was recorded in the vicinity of Engineer Cantonment by the Long Expedition (Genoways and Ratcliffe 2008:12, 26-29, Appendix 5). Thirteen of these species are represented in the archeological collections from the Cantonment (Falk et al. Section 9.3, this volume). One additional species, Pied-billed grebe (*Podilymbus podiceps*), is identified archeologically, but not found in the historical record, bringing the combined number of bird species represented at Engineer Cantonment to 144. A minimum of five additional species is represented by archeological specimens referred to higher taxonomic levels (i.e., Family, Genus), but these identifications duplicate taxa in the historical record and do not increase total species count. Analysis of burning, metal tool marks, and patterns of skeletal element representation for identified archeological specimens—combined with information from expedition journals—reveals that many birds, including geese, ducks, Prairie Grouse, Northern Bobwhite, Wild Turkey, crane, shorebirds, and passerines, were taken for food, and/or preparation of study specimens (Falk et al. Section 9.3, this volume).

The avian fauna described for the early years of the nineteenth century is remarkably similar to that observed today, but there are notable and significant changes. The most dramatic and irreversible of these changes is the extinction of two species, the Passenger Pigeon (*Ectopistes migratorius*) and the Carolina Parakeet (*Conuropsis carolinensis)*. The Whooping Crane (*Grus americanus*), teetering on the brink of extinction for nearly a century, is no longer found along the Missouri River in the area of the Cantonment as it was in 1820. Several species recorded in 1819–1820 were extirpated, or nearly so, in eastern Nebraska (and bordering areas of western Iowa) by the end of the nineteenth century. These local extinctions follow marked changes in biotic communities resulting from increased expansion of human settlement in the region and the impact of agricultural and hunting practices discussed earlier in this chapter. Examples here include the Swallow-tailed Kite (*Elanoides forficatus*), Ruffed Grouse (*Bonasa umbellus*), Wild Turkey (*Meleagris gallopavo*), Pileated Woodpecker (*Dryocopus pileatus*), and, perhaps, the Common Raven (*Corvus corax*). The Wild Turkey has been successfully reinstated in the state, but attempts to reintroduce the Ruffed Grouse have met with little or no success (Sharpe et al. 2001:136, 142).

Say and his colleagues clearly surveyed a spring migration of birds that swelled the number of species. The large number of bird species (Appendix E) is a testament to the importance of the migratory routes of the Central and Mississippi flyways, which tend to narrow considerably and merge, in part, along the Platte River and Missouri River valleys of central and eastern Nebraska. The value of this flyway for waterfowl and shorebirds has been significantly reduced because of the loss of habitat along the Missouri River, such as the meandering course of the river with many oxbow lakes, marshes, and wet open meadows. To compensate for this loss of habitat, a series of National Wildlife Refuges, such as Boyer Chute, Desoto, and Squaw Creek, have been established along the Missouri River, but these cannot match the size and complexity of the area lost to migratory species.

Mammals

Thirty-five mammal species were recorded by Say and others in the general vicinity of Engineer Cantonment. This number includes domestic dog (*Canis familiaris*), associated with nearby Native American villages, and house mouse (*Mus musculus*), an invasive Old World species that may have been introduced by the Long Expedition (James 1966:I:370 [1822]). The archeological assemblage from cantonment deposits includes eight of the historically identified species as well as at least five additional native species represented by specimens referred to higher taxonomic levels, the latter group also documented in expedition records (Falk et al. Section 9.3, this volume). However, two native rodents, not listed in historical inventories, meadow vole (*Microtus pennsylvanicus*) and woodland vole *(M. pinetorum*), are included in the archeological sample. A third microtine, the prairie vole (*M. ochrogaster*), is identified from mixed Engineer Cantonment/farmstead deposits. The excavated sample also includes the remains of at least two domestic animals, horse and/or mule (*Equus* sp.) and domestic pig (*Sus scrofa*). Both animals were closely associated with the expedition, one critical for transportation, the other a basic subsistence item when native game animals were scarce or unattainable. Although the house mouse is absent in the archeological material, a second Old World rodent, the Norway rat (*Rattus norvegicus*), is present in the archeological collection and these remains are the earliest documented presence of this species in Nebraska. The origins of insectivore and small rodent bones from the cantonment deposits are uncertain. However, analysis of both archeological and historical data show that many of the identified mammal species (eastern cottontail, tree squirrel, beaver, raccoon, elk, and especially, deer and bison) played a critical role in diet of expedition members (Falk et al. Section 9.3, this volume).

Important changes in mammal communities recorded by the expedition and represented in the archeological collection can be considered. One mammal subspecies, the plains gray wolf (*Canis lupus nubilus)* is now extinct, as is the American bison (*Bison bison*), in its wild state now found only on controlled parks and reserves and in private herds. As noted for the birds, a number of species recorded by the expedition were extirpated, or nearly so, in eastern Nebraska by the end of the nineteenth century. These include the mountain lion (*Puma concolor*), black bear *(Ursus americanus*), North American river otter (*Lontra canadensis*), white-tailed deer (*Odocoileus virginianus*), pronghorn (*Antilocapra americana*), American bison (*Bison bison*), and American beaver (*Castor canadensis*). Populations for many of these species, including river otter, white-tailed deer, and beaver, have since recovered, a result of natural re-invasion or purposeful re-introduction.

The ecotonal nature of the area surrounding Engineer Cantonment is reflected in the species of mammals documented by the Long Expedition (Appendix E, this volume). Present in this area were species typical of the oak-hickory deciduous forests of the eastern United States, such as opossum, gray squirrel, eastern chipmunk, woodland vole, and white-footed mouse. At the same time, the field party recorded species typical of the grasslands of the Great Plains, such as the bison, pronghorn, and American badger. Species that were typical inhabitants of forest edge habits, such as fox squirrel, woodchuck, and white-tailed deer, were also well represented. Most species of mammals with aquatic or semi-aquatic habitat requirements, such as the American beaver, muskrat, meadow jumping mouse, mink, and otter, were recorded by the expedition. One of the values of historical biodiversity inventories is that these data can be compared with modern survey results to gain insight into the changes in biodiversity and the environment. Based on the recently completed survey of the mammals of Nebraska, 42 species of mammals currently occur in the area of Engineer Cantonment (Genoways et al. 2008). It is believed that nine species have been lost from the 1819–1820 fauna, and two species have been added, thus giving a net loss of seven species. These changes have resulted in a net loss of 15 percent of the mammalian biodiversity originally present in the Engineer Cantonment area. Looking at the species that have been lost and the reasons for their disappearance is very informative (Appendix E, this volume).

Three of the top herbivores—bison, pronghorn, and elk—are no longer part of the fauna, due primarily to hunting and habitat loss. The bison is extinct in the wild and the nearest populations of pronghorns are in the Nebraska Sandhills. Elk were extirpated from Nebraska but have since staged a reappearance in the state, first in the Pine Ridge area and now along the Niobrara River and in the loess hills south of the Platte River in Lincoln County. Wolcott and Shoemaker (1919) made the point that large herds of free-ranging herbivores were incompatible with the agricultural interests that developed in Nebraska in the latter part of the nineteenth century. Accordingly, they were actively removed, both as sources of food and hide, but also to protect crops. The only large herbivores that reach significant numbers in Nebraska are the white-tailed deer and mule deer, and even these species were nearly extirpated from the state; only in the last half of the twentieth century did they become abundant once more.

Four of the top carnivores—black bear, gray wolf, eastern spotted skunk, and North American river otter—have been removed from the fauna as the result of over hunting, predator control, pesticide use, and habitat loss. The subspecies of the gray wolf occurring on the Great Plains is now extinct because of predator control measures undertaken due to their perceived threats to humans and livestock. Black bear populations were never large in the state, and the first wave of settlers removed them, probably as a supplemental food source. Landholt and Genoways (2000) presented compelling evidence that spotted skunks and other small species of mustelid carnivores were severely reduced by increasing pesticide use in the 1940s and 1950s. Sightings of the eastern spotted skunk are now extremely rare anywhere in Nebraska. The North American river otter was the top aquatic carnivore before it was extirpated from the state. Recent effort to introduce non-native populations of the otter have met with some success, but the species is not yet re-established along the Missouri River. A fifth species of top carnivore, the mountain lion, would have been listed among the species lost in the Engineer Cantonment area just a few years ago. However, the mountain lion has re-entered the area and quickly spread across the state, with several individuals having been sighted in the Omaha area in Douglas and Sarpy counties (Hoffman and Genoways 2006).

The gray squirrel, woodland vole, and eastern chipmunk are the other three species (Appendix E, this volume) that are no longer present in the Engineer Cantonment area, although they are still present in Nebraska in an area along the Missouri River immediately southward from Omaha. The absence of these eastern forest species is more difficult to understand than the other missing species. There is more forest today in the Engineer Cantonment area than in the past, which would seem to favor these species. The explanation, however, may lie in the shifting composition of the forest itself. Today the forest along the Missouri River is dominated by riparian cottonwoods, whereas the gray squirrel and eastern chipmunk seem to prefer areas of mature oak-hickory forest with a more diverse variety of trees that provide both food and shelter.

The two species that have been added to the fauna of the Engineer Cantonment area are the American pipistrelle (*Perimyotis subflavus*) and the evening bat (*Nycticeius humeralis*). These two species roost and forage in areas of forest and forest edge. These species were originally confined to extreme southeastern Nebraska but have expanded their geographic ranges to include nearly the eastern third of the state in recent years. This is a common phenomenon in the Great Plains as riparian forests have spread westward along prairie river systems. Species of birds (Knopf 1986), mammals (Benedict et al. 2000), and insects (Ratcliffe 1991) adapted to the eastern forest are moving westward along these forested corridors.

Conclusions

It is our contention that Thomas Say, Titian Peale, Edwin James, and their colleagues of the Stephen Long Expedition of 1819–1820 were heavily engaged in scientific research, which took the form of the first biodiversity inventory undertaken in the United States. This accomplishment has been overlooked both by biologists and historians, but it should rank among the most significant accomplishments of the expedition. The results of this inventory continue to inform us today about environmental, faunal, and floral changes along the Missouri River in an area that is known to be an ecotone between the deciduous forests of the eastern United States and the prairies of the Great Plains. This inventory was completed at a time when the impact of Euroamericans was just beginning.

A modern archeological excavation of the Engineer Cantonment dwellings has added significantly to our knowledge of the environment and species present at the site in 1819–1820. The archeological investigation has added 7 percent more species for the species richness estimate for Engineer Cantonment. These additions to the biota of Engineer Cantonment were not made uniformly across the groups surveyed. The species added to the inventory are primarily plants, mollusks, and fish. The flora at Engineer Cantonment was not heavily surveyed by James because he was at the site only a little over two weeks. The survey party's interest in fish appears to have been only as food items, so we learn the most about them from their skeletal remains in the camp's trash. The mollusks are difficult to survey because they are small, secretive animals.

The written documents, collections, and drawings left to us, along with the archeological inventory, form an image of a dynamic riverine system with a highly meandering river having a wide valley filled with oxbows, palustrine wetlands, and scattered groves of trees. This has now been modified to an area that has a channelized river with the surrounding wetlands being drained and converted to agricultural and municipal purposes. Construction of upriver dams has controlled flooding, especially in the spring, so that the river valley is not renewed and changed. Irrigation of farmlands has promoted the growth of riparian forests composed primarily of cottonwood. Suppression of prairie fires, which were prevalent during the fall of 1819, also has promoted the growth of trees and other woody vegetation. The city of Omaha and its suburbs are expanding and encroaching on the site from the south and west, converting once open grasslands and scattered trees to housing tracts with well-manicured lawns and non-native Nebraska shade trees.

The impacts of these landscape and environmental changes are clearly reflected in the plants and animals of the area. Although the U.S. Fish and Wildlife Service has done some habitat restoration in the Boyer Chute National Wildlife Refuge and continues fish and wildlife habitat restoration in associated upland and wetland areas along the Missouri River, their efforts will never be totally successful, because many of the plants and animals no longer occur in the area. Among mammals, three of the top herbivores are gone as are four of the top carnivores. We are not advocating reintroduction of bison or wolves, but without these species interacting with the plant and animal communities, no restoration will truly re-establish what once was. Secondary herbivores and carnivores have now filled these top niches and make a vastly different impact. The gray squirrel and eastern chipmunk appear to indicate that it is not just trees that make a forest, because the forest established along the Missouri River and its former floodplain is dominated by cottonwoods that do not provide the necessary habitat for these species.

We believe our examination of the Engineer Cantonment area in eastern Nebraska demonstrates the value of biodiversity inventories, both historical and modern. Although it is beyond our power to undertake historical inventories, we urge efforts be directed toward the reconstruction of other historical biodiversity inventories, including phytoarcheological and zooarcheological surveys. This may be feasible in areas such as historical forts, which were visited by traveling biologists on a recurring basis. The results of these explorations, especially when combining the work of a number of parties and scientists, may result in useful historical biodiversity inventories. Other places on the Great Plains where this may be possible would include Fort Union in North Dakota, Fort Sisseton in South Dakota, Fort Hays in Kansas, and Fort Sill in Oklahoma. Today's modern inventory is tomorrow's historical inventory, and so there is still an ongoing need for biodiversity inventories. They provide the baseline information for dynamic biological systems that will change over time and with environmental shifts.

Bozell, Carlson, and Pepperl

ENGINEER CANTONMENT

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ARCHEOLOGICAL INVESTIGATIONS AT ENGINEER CANTONMENT:

WINTER QUARTERS OF THE 1819–1820 LONG EXPEDITION, EASTERN NEBRASKA

Edited by

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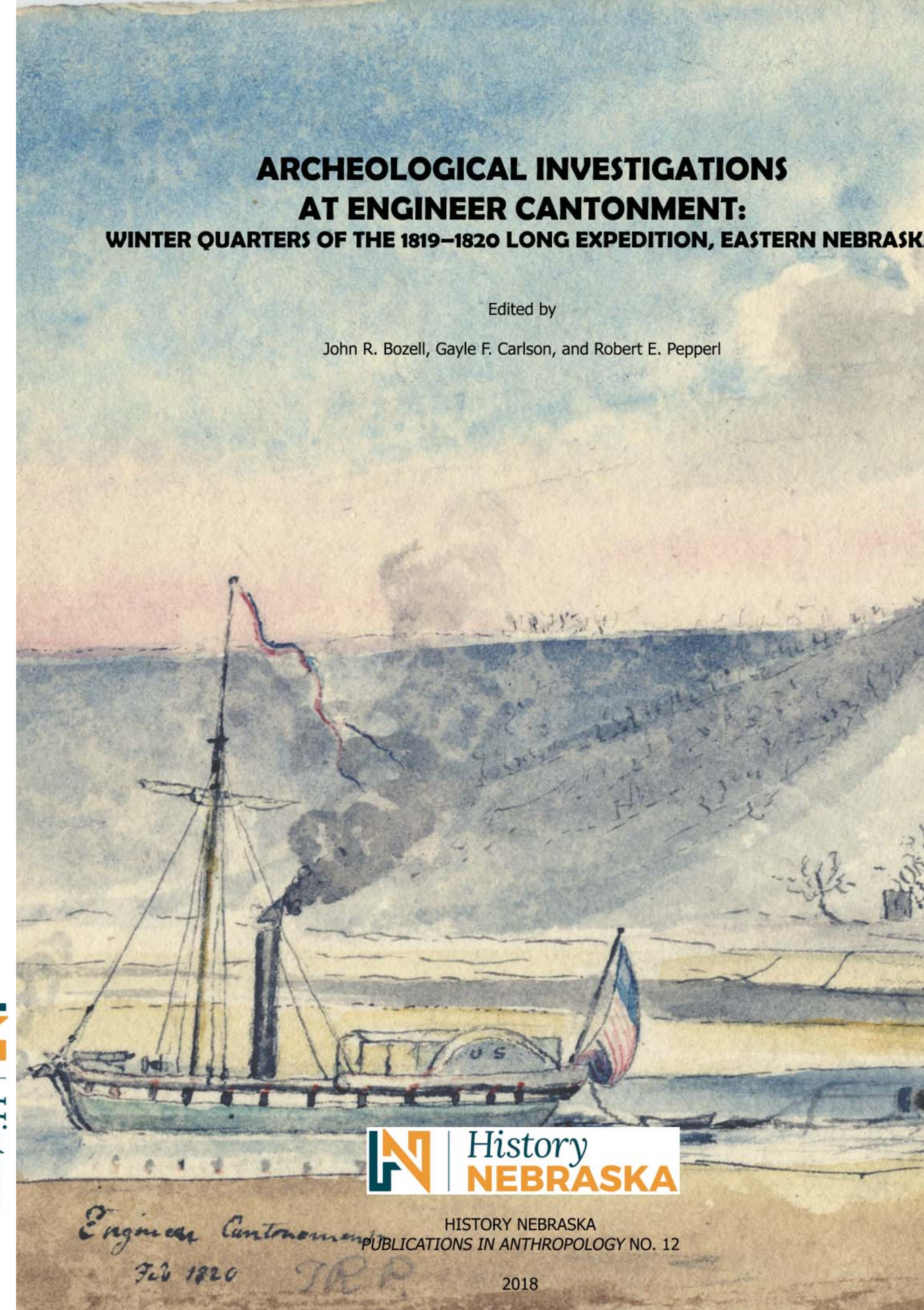

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