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ENGINEER CANTONMENT, MISSOURI TERRITORY, 1819-1820: AMERICA'S FIRST BIODIVERSITY INVENTORY

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ABSTRACT—It is our thesis that members of the Stephen Long Expedition of 1819-20 completed the first biodiversity inventory undertaken in the United States at their winter quarters, Engineer Cantonment, Missouri Territory, in the modern state of Nebraska. 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 allow us to evaluate the environmental, faunal, and floral changes along the Missouri River in the intervening nearly 190 years. The historical records form a visual image of a dynamic riverine system in which a highly meandering river flows through a wide valley filled with oxbows, palustrine wetlands, and scattered groves of trees. This system has now been modified to a channelized river with the surrounding wetlands drained and converted to agricultural and municipal purposes. The suppression of prairie fires and the adoption of irrigation practices have 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. At least three taxa recorded at the site have become extinct—*Ectopistes migratorius* (passenger pigeon), *Conuropsis carolinensis* (Carolina parakeet), and *Canis lupus nubilus* (plains subspecies of the gray wolf)—and several more have been extirpated from the region. For mammals, the data indicate that nine species of the 1819-20 fauna have been lost, and two species have been added, thus resulting in a net loss of seven species. These changes represent a net loss of 15% of the mammalian biodiversity originally present in the Engineer Cantonment area. The species richness estimator for Engineer Cantonment in 1819-20 is 403 for vertebrates, insects, snails, and plants, but it is clear that this number is extremely low, because plants were not thoroughly surveyed by the expedition and only a small fraction of the insects were collected.

Key Words: biodiversity inventory, Engineer Cantonment, fauna, flora, Stephen Long, Nebraska, Titian Peale, Thomas Say

INTRODUCTION

The Yellowstone Expedition of 1819-20 was part of a larger scheme by the U.S. War Department to extend American influence along the frontier 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 Maj. Stephen H. Long and military units commanded by Col. 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 at that place. The scientific expedition was to proceed from there to explore the upper Missouri River and along the Rocky Mountains. 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, NE, 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 (not to be confused with the modern city of Council Bluffs, IA, but a site just to the east of Fort Calhoun, Washington County, NE).

On October 11, 1819, Long returned to the East for personal reasons as well as to fill open positions in the expedition and to obtain additional funds for the expedition. These efforts were only partially successful. He did

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secure the services of Edwin James to serve as botanist, mineralogist, and surgeon for the expedition, replacing Dr. William Baldwin (who had become ill and died in Franklin, MO) and Augustus Jessup, who had returned East with Long. Capt. John R. Bell requested the opportunity to replace Maj. Thomas Biddle, with whom Long had quarreled, as the official journal keeper, and he was so assigned.

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. A fort was to be established at the site of Lewis and Clark's Council Bluff (Fort Atkinson), and the scientific expedition was to explore along the path of the Platte River to discover its headwaters, to proceed along the Rocky Mountain Front, and to locate the headwaters of the Arkansas and Red rivers and to follow these rivers eastward to Fort Smith, AK, and finally to Cape Girardeau, MO.

Remaining at Engineer Cantonment during the winter of 1819-1820 were zoologist Thomas Say, assistant naturalist Titian Ramsay Peale, landscape painter Samuel Seymour, and hunter H. Dougherty. They were aided in their work, especially with the American Indians, 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 1823:165).

Long's expedition was the first party with trained scientists to explore the American West in the name of the U.S. 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). 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 (Weese 1947a, 1947b; Porter 1983, 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, NY. He was tutored in botany by John Torrey and in geology by Amos Eaton during the period that he received his medical training (Wood 1955). Samuel Seymour was an experienced landscape artist who also accompanied Long on his 1823 expedition (McDermott 1949, 1951; Ewan and Ewan 1981).

Long, Bell, and James returned to Engineer Cantonment on May 27, 1820. Preparations were quickly made, and the expedition departed for the Rocky Mountains on June 6 (Fuller and Hafen 1957). The expedition followed the general route outlined in their new orders and arrived at Fort Smith by September 9 and reassembled at Cape Girardeau by October 12. Thus, the party had covered nearly 1,600 miles [≈2,575 km] in just over three months (Goodman and Lawson 1995:117). This haste was implicit in the orders received from Secretary Calhoun, whose department was under political and fiscal pressure to show positive results from its expeditions. It was clear that "distance and speed became more important than quality or thoroughness of investigation" (Nichols and Halley 1980:110-11). The need for speed in movements of the expedition was reinforced by the limited food, supplies, and equipment that they carried, because no new funds had been received from the War Department.

The expedition of the summer of 1820 is the portion of the Long Expedition that has received the most attention from biologists and historians (Chittenden 1902; Osterhout 1920a, 1920b; Dillon 1967; Goetzmann 1967, 1979; Nichols and Halley 1980; Beidleman 1986; Benson 1988; Goodman and Lawson 1995; Evans 1997). Historians have not been particularly kind to the expedition. Noted historian William Goetzmann (1967:60) described the party as "[a] curious cavalcade of disgruntled career officers, eccentric scientists, and artist-playboys." Hiram Chittenden (1902, 2:574-75) 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." The expedition has been criticized for forwarding the idea of the "Great American Desert" (Dillon 1967) and for not finding and exploring the headwaters of the South Platte, Arkansas, and Red rivers. They in fact missed the Red River entirely and instead followed the Canadian River east (Nichols and Halley 1980). Some specimens and journals were lost late in the expedition, and the locality data used by the scientists were not as precise as they could have been (Beidleman 1986; Nichols and Halley 1980).

On the other hand, biologists have had a much more positive view of the expedition's results (Osterhout 1920a, 1920b; Nichols and Halley 1980; Beidleman 1986; Goodman and Lawson 1995). However, biologists

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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 the 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, it is our thesis that for the most part both biologists and historians have missed the most important scientific work of the Long Expedition, which was accomplished during the winter of 1819-20 at Engineer Cantonment. Here the scientific and ethnographic work was concentrated over a nearly nine-month period. Only Nichols and Halley (1980:103) have noted that "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."

The evaluation of the scientific work at Engineer Cantonment has been hampered by the fact that the site of the cantonment was not known until recently. In 2003 archeologists from the Nebraska State Historical Society discovered the site and began excavating it during that summer and subsequent summers (Carlson et al. 2004). The excavation has allowed biological and landscape information to be placed into context and evaluated. Certainly many new taxa of plants and animals were discovered in the vicinity of the cantonment; however, 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 represent what would be called in modern scientific terminology a biodiversity inventory. To our knowledge, it is the first place in America where 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 20 miles, primarily to west and north, of the cantonment on the Nebraska side of the Missouri River, although one trip was taken to explore along Boyer River [see Goodman and Lawson 1995:3] on the Iowa side.) This work provides us with a baseline for modern environmental studies of changes in the fauna, flora, and landscape of this area over time. We have more than a snapshot—in fact nearly a fully painted picture—of this area along the Missouri River at the ecotone of the extensive deciduous forest to the east and the rolling Great Plains to the west from almost 200 years ago. In this study we use these data to evaluate the biodiversity and landscape changes that have occurred over time.

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 (overexploitation and introduction of invasive species, predators, and parasites) (Wilson 1992; Pimm et al. 1995; Vitousek et al.

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1996; Mooney and Cleland 2001). Examples 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 190 years ago. Habitat fragmentation and destruction result in a net loss of biodiversity when plants and animals lose their homes and are extirpated or when invasive species replace native species. We know that human population growth is eliminating biodiversity, which in turn is altering biosphere-level processes that we depend on for $3 trillion to $33 trillion of environmental services annually (Constanza et al. 1997; Pimental et al. 1997). This loss of biodiversity has broad implications for conservation and, ultimately, for our own survival.

At a National Academy of Sciences colloquium entitled "The Future of Evolution," held in March 2000, panel discussants agreed that current extinction rates are 50 to 500 times background (former rate of extinction) 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% of the planet's species in the next 1,000 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 1,000 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)

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 is 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 typically have specific goals of discovery and documentation and so are organized, systematic, and sustained (Wilson 2005; Kohler 2006). Since the late 1700s, biotic surveys have generated vast scientific collections of specimens that became the foundation for many natural history museums and the descriptive science of taxonomy. In turn, taxonomy is the foundational discipline for all biological sciences because it documents and organizes all life on Earth 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 one was 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 U.S. Pacific Northwest 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 the *HMS Beagle* (1830s), the U.S. Biological Survey and the Nebraska Botanical Survey (both in the late 1800s), Henry Walter Bates in Amazonia (1850s), Alfred Russel Wallace in Malaysia and Indonesia (in the 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. 2006), our own 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

Engineer Cantonment is located in the extreme southeastern corner of modern Washington County, NE, at a place three miles south and four miles east of the town of Fort Calhoun (41°24′43″N latitude, 95°57′00.6″W

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longitude, SE1/4 NW1/4 SE1/4, Section 28, Township 17N, Range 13E). The site is 305 m in elevation. The buildings 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 the main channel of the river at the time the site was occupied in 1819-20.

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 present-day site 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 1823:144)

Assessing the landscape changes along the Missouri River Valley since 1820 can be aided by viewing the aerial photographs of the area taken in July-August 2003 (Fig. 1). The dominant vegetative feature now in the valley is trees, and only areas under cultivation and urban development are not covered by trees. 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 that only a few 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 44th in population among American cities with just over 400,000 residents. In the area, on the east side of river from which James (1823) described the valley, is the city of Council Bluffs, IA, with 60,000 residents.

Stephen Long carefully chose the site of Engineer Cantonment within about a mile 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 1823:153)

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 (Fig. 2). In the watercolor, we can see the cabins near the water's edge with a few trees around them. 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* and two keelboats are anchored in an area believed to be an oxbow off the Missouri River. Peale's painting can be compared with a photograph (Fig. 3) taken from near the same viewpoint (41°24′56″N latitude, 95°57′01.5″W longitude). Peale's watercolor depicts 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, which 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 miles 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:

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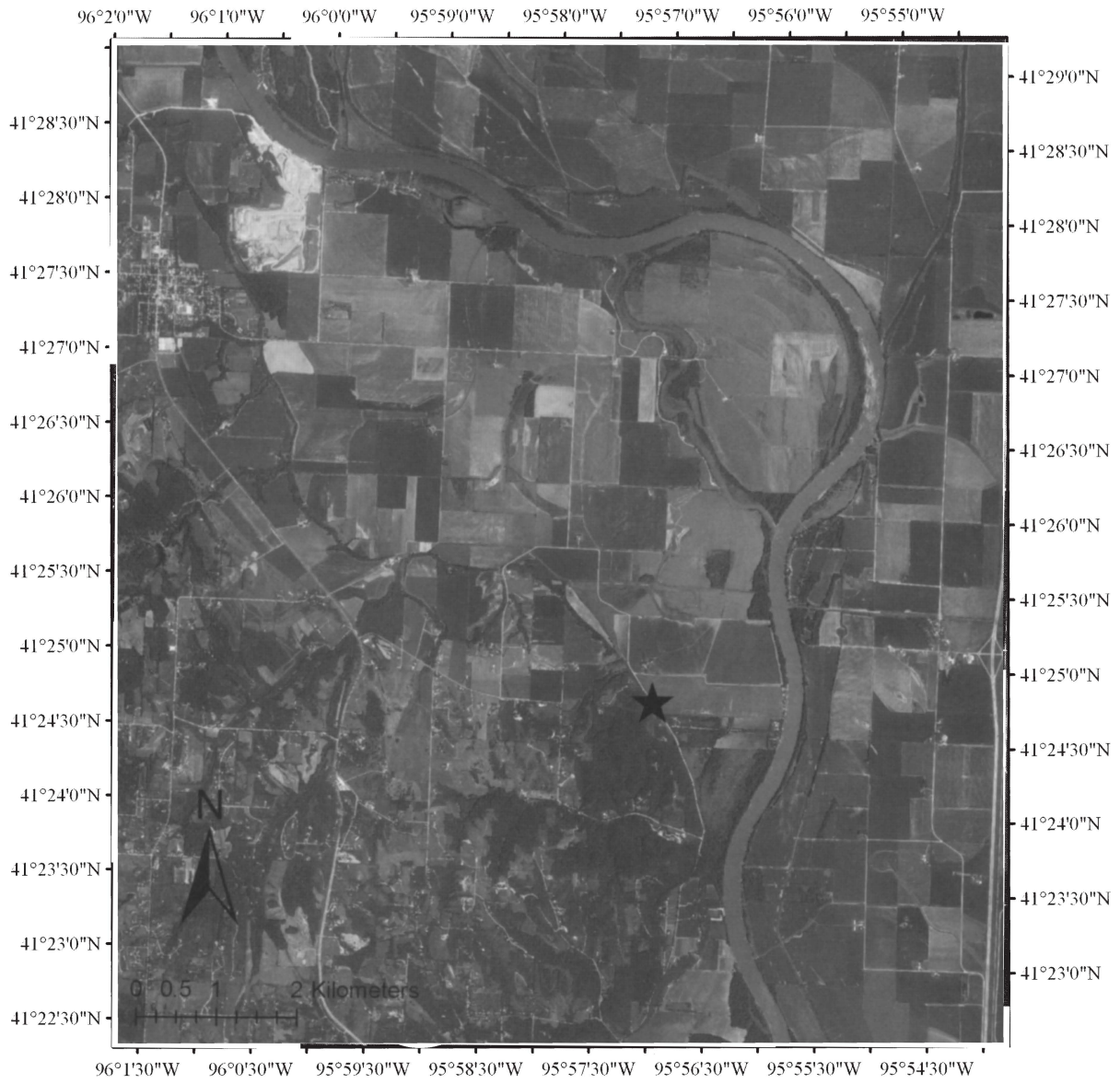

Figure 1. Aerial photographs of the Engineer Cantonment area taken in July-August 2003. The location of Engineer Cantonment is marked with a star. The modern course of the Missouri River lies to the east. The town of Fort Calhoun, Washington County, NE, is in the upper left of the image. Council Bluff, the site of Fort Atkinson, is just to the east of the town on top of the bluff above the old course of the Missouri River.

> 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 1823:152-53)

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Figure 2. Watercolor of Engineer Cantonment by Titian Ramsay Peale (presented courtesy of the American Philosophical Society) from February 1820. The expedition's winter cabins can be seen near the water's edge with a few trees around them. In the foreground of the painting the *Western Engineer* and two keelboats are anchored in an area believed to be an oxbow off the Missouri River.

Figure 3. 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. 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.

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This view from Cemetery Hill at the western edge of Fort Calhoun is unfortunately no longer available because it is blocked by numerous trees both 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 area of prairie at the base of the hill has been replaced by the town of Fort Calhoun with 1,000 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 one mile to the east, 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. (Fuller and Hafen 1957:105)

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

> 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 1823:178-79)

The area of prairie and the view to the east described by Bell was lost long ago, being replaced with a forested area and residential development (Fig. 1). 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 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 to 1880 so that fires were occurring every 2.5 years. The increased rate was associated with the settlement period and probably represents fires set intentionally as part of land clearing, as well as 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.

Comparing this area of the Missouri River in 1819-20 to 2007 clearly shows that the landscape has been significantly altered, primarily by human activity. A valley with a meandering river prone to seasonal flooding, especially in the spring, and a mixture of forests and open wetlands and meadows has been transformed into a suburban area dominated by non-native tree species, a narrow and nearly straight river, and agricultural fields. The river was altered by channelizing and by the building of upstream dams 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, permitting 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 ecotone with eastern deciduous forests (Ratcliffe 1990; Benedict et al. 2000; 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 evident 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. By our count at least 56 new

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species—4 plants, 1 snail, 38 insects, 3 snakes, 4 birds, and 6 mammals—can be confirmed as being described from this area (see Appendixes 1-6), 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. There is a formal method for making new plants and animal known to science, which 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 becomes valuable in science because it is the place where "typical" representatives of the species may be obtained in future studies. Topotypes are important because they help us understand variation in the new species beyond what we can learn from the single holotype.

A scientific name for a species is considered to be valid if it continues to be in use for the species. Reasons that a scientific name would not be the valid name for a species are that another authority named the same species but did so at an earlier date (law of priority), or if the most recent authority to review a group of species decides that the species is not distinct from others because another, older name refers to the same taxon (junior synonym). In the early history of the study of plants and animals, communication among scientists was poor because of national interests and limited distribution of the scientific literature. Many species were named several times by separate authorities, but the law of priority states that the oldest name for a species is the valid name. As our knowledge and scientific collections of plants and animals have grown, some species that were once thought to be distinct have actually been shown to be the same as other named species, and the oldest name is again the one that is used, while the other, newer names become junior synonyms. A good measure of how accurate or "good" a scientist has been is to determine how many of the scientific names they proposed remain current. For the new species described from Engineer Cantonment, the following remain current: 3 plants, 1 snail, 30 insects, 3 snakes, 2 birds, 4 mammals, and 43 total (Appendixes 1-6). This means that 77% of the names remain current as we approach 200 years since the work was done. This is an awesome record by any standard.

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, which is not 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 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 (Appendix 1) 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 of the time needed to devote to preparations for the summer expedition. The four new plants from Engineer Cantonment were described by John Torrey, one of Edwin James's mentors and one of the founders of American botany. The fact that insects (Appendix 3) 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 through birds (Appendix 5) comprised the largest group of vertebrates present at Engineer Cantonment, the fact that only four species of new birds were described by Say was to be expected. Birds had been studied longer and in much more depth, so that fewer new species remained to be discovered. Say described only another eight species of birds from the remainder of 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 1819-20. Say described and named six new mammals (Appendix 6), of which four names are still in use for widespread species (Hall 1981). From Engineer Cantonment, 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, 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 short-tailed shrews from Engineer Cantonment that

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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 thirty 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, but these names give a good illustration of how names become invalid. 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 (Merrill 1936; Gillispie 1992). 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 AT 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: "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 the alpha diversity, which is the number of species within a habitat, of other authors (Samson and Knopf 1993). We can calculate the simple richness estimator, or alpha diversity, for the sample from the vicinity of Engineer Cantonment in 1819-20. Species counts for the surveyed groups, based on data compiled in Appendixes 1-6, are as follows: 51 plants in 34 families; 14 snails in 7 families; 46 insects in 30 families; 2 amphibians in 2 families; 14 reptiles in 6 families; 143 birds in 44 families; 33 mammals in 20 families. These data indicate a species richness of 303 species. We are not aware of another site in North America surveyed during the remainder of the 19th century with a species richness that even approached 303 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.

We know that the simple richness estimator underestimates species richness at all samples sizes. However, we can use mammals as a case study to gain some understanding of the level of this underestimation. Mammals lend themselves well to this use because as a group they demonstrate considerable philopatry (they are not highly mobile like birds) and because a modern survey of the mammals of Nebraska just has been completed (Genoways et al. 2008). Based on our current knowledge of the mammals of Nebraska, we believe that the Long Expedition probably underestimated the number of species of mammals that occurred in the Engineer Cantonment area during their stay by a minimum of 16, giving a total of 49 species present. The majority of species that were missed during the survey were rodents and other small mammals, including another shrew and probably four species of bats. The larger species that were overlooked were the jackrabbit, long-tailed weasel, least weasel, and spotted skunk. If these numbers are correct, then the Long Expedition underestimated the number of species of mammals by 33%. When this factor is applied to all taxonomic groups that were surveyed, a figure of 403 for species richness is obtained. It is clear that even this number is extremely low because plants were not thoroughly surveyed by the expedition and only a small fraction of the insects were collected.

CHANGES IN BIODIVERSITY

The first changes noted in the biodiversity of the Engineer Cantonment area are the extinction of two species of birds (Appendix 5), *Ectopistes migratorius* (passenger pigeon) and *Conuropsis carolinensis* (Carolina parakeet), and one subspecies of mammal (Appendix 6), *Canis lupus nubilus* (plains subspecies of the gray wolf). These are irreversible changes. The whooping crane (*Grus americanus*) has teetered on the brink of extinction for nearly a century, and the American bison (*Bison bison*) is extinct in the wild, occurring only on controlled parks, reserves, and in private herds. Neither of these species will

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return to the fauna along the Missouri River (Appendixes 5 and 6).

Say and his colleagues clearly surveyed a spring migration of birds that swelled the number of species. The large number of bird species (Appendix 5) 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 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.

The ecotonal nature of the area surrounding Engineer Cantonment is reflected in the species of mammals documented by the Long Expedition (Appendix 6). 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, 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). We believe that nine species have been lost from the 1819-20 fauna, and two species have been added, thus giving a net lost of seven species. These changes have resulted in a net lost of 15% 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 6).

Three of the top herbivores—bison, pronghorn, and elk—are no longer part of the fauna, due primarily to hunting and habitat loss. As we stated previously, 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 19th 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 overhunting, predator control, pesticide use, and habitat loss. The subspecies of the gray wolf occurring in the Great Plains is now extinct because of predator control measures undertaken as a result of 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 introduced non-native populations of the otter have met with some success, but the species is not yet reestablished 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 reentered the state 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 and eastern chipmunk are the other two species (Appendix 6) that are no longer present in the Engineer Cantonment area, although they are still present in Nebraska in an area immediately along the Missouri River southward from Omaha. The absence of these two 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

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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 in recent years to include nearly the eastern third of the state. This is a common phenomenon in the Great Plains as riparian forests have spread westward along prairie rivers. 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 on the Stephen Long Expedition of 1819-20 completed 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 Euro-Americans was just beginning.

The written documents, collections, and drawings left to us form an image of a dynamic riverine system in which a highly meandering river flows through a wide valley filled with oxbows, palustrine wetlands, and scattered groves of trees. This picture has now been modified to one of a channelized river with the surrounding wetlands having been 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 that 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 shade trees not native to Nebraska.

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 bears or wolves, but without these species interacting with the plant and animal communities, no restoration will truly reestablish 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 tell us that a forest is not made of trees alone; 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 that efforts be directed toward the reconstruction of other historical biodiversity inventories. 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 in the Great Plains where this may be possible 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.

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APPENDIX 1
PLANTS COLLECTED AND OBSERVED IN THE VICINITY OF ENGINEER CANTONMENT IN 1819-20 (JAMES 1823; GOODMAN AND LAWSON 1995)

Family	Source	Scientific name	Common name	Remarks
Adoxaceae	viburnum (p. 290, 331)	*Viburnum lentago*	nannyberry	Omaha used to make arrows
Alismataceae	*Saggittaria* (p. 144)	*Saggittaria*	arrowhead	in marshes along Missouri River
Alismataceae	*Alisma* (p. 144)	probably *Alisma triviale*	water plantain	in marshes along Missouri River
Anacardiaceae	herbarium	*Rhus glabra*	smooth sumac	Goodman and Lawson 1995: 126; p. 331
Anacardiaceae	herbarium	*Toxicodendron radicans negundo*	poison ivy	Goodman and Lawson 1995: 126
Anacardiaceae	herbarium	*Toxicodendron rydbergii*	poison ivy	Goodman and Lawson 1995: 126
Apiaceae	herbarium	*Heracleum lanatum*	cow parsnip	Goodman and Lawson 1995: 321
Apocynaceae	herbarium	*Apocynum androsaemifolium*	dogbane	Goodman and Lawson 1995: 127
Araliaceae	herbarium	*Panax quinquefolius*	American ginseng	Goodman and Lawson 1995: 128; endangered (Kaul 2004)
Asteraceae	herbarium	*Echinacea augustifolia*	narrow-leaf purple coneflower	Goodman and Lawson 1995: 163
Asteraceae	leafless prenanthes (p. 422)	*Prenanthes aspera*	rattlesnake root	on loess hills bordering Missouri River
Betulaceae	hop-horn beam (p. 160)	*Ostrya virginiana*	hop-hornbeam or ironwood	along Missouri River; Omaha and Pawnees used to make bows
Caesalpiniaceae	*Gymnocladus canadensis* (p. 180)	*Gymnocladus dioica*	Kentucky coffee-tree	fruits substituted for coffee making a "palatable and wholesome beverage"
Campanulaceae	kinnecanick (p. 331)	*Lobelia inflata*	Indian tobacco	Omaha used as tobacco
Chenopodiaceae	description of ***Chenopodium hybridum* ß? *simplex***	*Chenopodium simplex* (Torrey) Rafinesque	maple-leaved goosefoot	Torrey 1827: 239; Goodman and Lawson 1995: 155
Cornaceae	red willow (*Cornus sericea*) (p. 331)	*Cornus sericea*	red willow	
Cyperaceae	carcies (p. 144)	*Carex*	sedges	numerous species occur in the area; in meadows along Missouri River
Cyperaceae	Cyperaceae (p. 144)		sedge family	13 genera occur in the area, including bulrush; in meadows along Missouri River
Fabaceae	*Apios tuberosa* (p. 144)	*Apios americana*	American potato bean or groundnut	woodlands filled with "pea vines;" excellent pasturage for horses and cattle; tubers boiled and eaten by soldiers
Fabaceae	herbarium	*Oxytropis lambertii*	purple locoweed	Goodman and Lawson 1995: 233; on loess hills bordering the Missouri River (p. 422)
Fagaceae	oak (Fuller and Hafen 1957: 84)	*Quercus*		small growth of timber in valleys between loess hills; several species in area
Hydrocharitaceae	Hydrocharidae (p. 144)		frogbit family	could include three species, *Elodea canadensis*, *E. nuttallii,* or *Najas guadalupensis*; in marshes along Missouri River
Hydrophyllaceae	herbarium	*Ellisia nyctelea*	waterpod	Goodman and Lawson 1995: 213
Juglandaceae	hickory (p. 160)	probably *Carya cordiformis*	bitternut hickory	along Missouri River; Omaha and Pawnees used to make bows
Lamiaceae	description of ***Scutellaria ambigua*** Nuttall ß ***missouriensis***	*Scutellaria parvula* Michaux var. *missouriensis* (Torrey) Goodman & Lawson	little skullcap	Torrey 1827: 232; Goodman and Lawson 1995: 217
Liliaceae	wild onions (Fuller and Hafen 1957: 84)	*Allium*		growing along the valley of the Missouri River; several species in area
Linaceae	herbarium	*Linum rigidum*	stiff flax	Goodman and Lawson 1995: 242
Moraceae	*Maclura aurantiaca* (p. 290)	*Maclura pomifera*	Osage orange	Omaha using as bow wood

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APPENDIX 1 (continued)

Family	Source	Scientific name	Common name	Remarks
Nelumonaceae	nelumbium (p. 201)	*Nelumbo lutea*	American lotus	may be disappearing from plains because of eradication by humans and habitat loss (Kaul 1986: 81)
Oleaceae	ash (p. 346)	probably *Fraxinus pennsylvanica*	green ash	along Boyer Creek
Poaceae	*Arundo* (p. 144)	possibly *Phragmites australis*	common reed	in meadows along Missouri River
Poaceae	zizania (p. 201)	*Zizania palustris*	interior wild-rice	
Ranunculaceae	herbarium	*Anemone patens*	pasque flower	Goodman and Lawson 1995: 284
Ranunculaceae	herbarium	*Thalictrum dasycarpum*	purple meadow-rue	Goodman and Lawson 1995 289
Rosaceae	fruit of the red haws (p. 189)	probably *Crataegus mollis*	downy hawthorn	fruits recovered from under snow and eaten by Omaha
Rosaceae	herbarium	*Drymocallis arguta*		Goodman and Lawson 1995:292
Rosaceae	wild plums (p. 170)	*Prunus americana*	American plums	
Rosaceae	description of ***Rubus Idaeus*** var. ***americanus***	junior synonym of *Rubus occidentalis* Linnaeus	black raspberry	Torrey 1827: 196; Goodman and Lawson 1995: 296
Rubiaceae	herbarium	*Galium circaezans*	woods bedstraw	Goodman and Lawson 1995: 298
Salicaceae	cottonwood (p. 160; Fuller and Hafen 1957: 86-88)	*Populus deltoides*	plains cottonwood	along opposite bank of Missouri River and on hills to the west of Engineer Cantonment
Salicaceae	herbarium	*Salix humilis*	prairie willow	Goodman and Lawson 1995: 301
Salicaceae	herbarium	*Salix eriocephala*	diamond willow	Goodman and Lawson 1995: 301
Salicaceae	young willow trees (p. 159, 346; Fuller and Hafen 1957: 86)	*Salix* sp.	willow	along Missouri River
Scrophulariaceae	description of ***Mimulus jamesii***	*Mimulus glabratus* von Humboldt, Bonpland, & Kunth var. *jamesii* (Torrey & Gray) Gray	roundleaf monkeyflower	Torrey and Gray 1846:371; Goodman and Lawson 1995: 309
Scrophulariaceae	great flower penstemon (p. 422)	*Penstemon grandiflorus*	large beardtongue	on loess hills bordering Missouri River
Solanaceae	herbarium	*Physalis missouriensis*	downy groundcherry	Goodman and Lawson 1995: 315
Solanaceae	herbarium	*Solanum carolinense*	horse-nettle	Goodman and Lawson 1995: 316
Ulmaceae	elm (p. 346)	probably *Ulmus americana*	American elm	along Boyer Creek
Ulmaceae	herbarium	*Ulmus thomasii*	rock elm	Goodman and Lawson 1995: 321
Violaceae	herbarium	*Viola pubescens*	smooth yellow violet	Goodman and Lawson 1995: 325
	Limnetis (p. 144)	unknown		in meadows along Missouri River
	Polypogon (p. 144)	unknown		in meadows along Missouri River; this genus is now used only for a European plant, it was probably used by James for some native species

Notes: Species names in bold type were described based on material from Engineer Cantonment. Herbarium specimens housed in collections of New York Botanical Gardens were identified by Goodman and Lawson (1995). Page numbers are in James (1823) unless otherwise indicated. Botanical taxonomy follows Goodman and Lawson (1995) and Kaul et al. (2006).

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APPENDIX 2
SNAILS (GASTROPODA) IDENTIFIED IN THE VICINITY OF ENGINEER CANTONMENT IN 1819-20 BY THOMAS SAY

Name used by Thomas Say	Current Scientific Name	Order/ Family	Common Name	Source	Comments
Physa gyrina	*Physella gyrina* (Say)	Basommatophora/ Physidae	tadpole physa	Say 1821: 171	"Of this species, I found two specimens at Bowyer creek, near Council Bluff." (Say 1821: 171)
Lymnaea heterostropha	*Physella heterostropha* (Say)	Basommatophora/ Physidae	pewter physa	Say 1817a	"Is very common in ponds of the Missouri as far as Council Bluff." (Say 1821: 172)
Planorbis bicarinatus	*Helisoma anceps* (Menke)	Basommatophora/ Planorbidae	twin-ridge rams-horn	Say 1817a; Baker 1942:78	". . . inhabits ponds of water, in vicinity of Council Bluff." (Say 1821: 164)
Planorbis trivolvis	*Helisoma trivolvis* (Say)	Basommatophora/ Planorbidae	marsh rams-horn	Say 1817a	". . . inhabits ponds of water, in vicinity of Council Bluff." (Say 1821: 164)
Planorbis parvus	*Gyraulus parvus* (Say)	Basommatophora/ Planorbidae	ash gyro	Say 1817a	". . . inhabits ponds of water, in vicinity of Council Bluff." (Say 1821: 164)
Cyclostoma tricarinata	*Valvata tricarinata* (Say)	Heterostropha/ Valvatidae	three-ridge valvata	Say 1817b: 13	". . . occurs in considerable numbers in ponds, in the vicinity of Council Bluff." (Say 1821:178)
Helix concava	*Haplotrema concavum* (Say)	Stylommatophora/ Haplotrematidae	disk cannibal snail	Say 1821: 159	"Found in moist places near the Mississippi river, on the Missouri as high as council bluff, and on the sea islands of Georgia." (Say 1821: 159)
Helix profunda	*Allogona profunda* (Say)	Stylommatophora/ Polygyridae	broad-banded forestsnail	Say 1821: 160	"Specimens occurred near Cincinnati on the Ohio, and Engineer Cantonment near Council Bluff, on the Missouri." (Say 1821:160)
Helix appressa	*Mesodon appressus* (Say)	Stylommatophora/ Polygyridae	flat bladetooth	Say 1821: 151	"This species is very common on the banks of the Ohio below Galiopolis; I also found it near Council Bluff." (Say 1821:151)
Helix hirsuta	*Stenotrema hirsutum* (Say)	Stylommatophora/ Polygyridae	hairy slitmouth	Say 1817c: 17	". . . common as far as Council Bluff." (Say 1821: 161)
Helix albolabris	*Triodopsis albolabris* (Say)	Stylommatophora/ Polygyridae	whitelip	Say 1817a	". . . common, as far as Council Bluff." (Say 1821:161)
Helix multilineata	*Webbhelix multilineata* (Say)	Stylommatophora/ Polygyridae	striped whitelip	Say 1821: 150	". . . numerous species in the moist forests on the margin of the Mississippi near Ohio, and the Missouri as far as Council Bluff." (Say 1821: 150)
Helix labyrinthica	*Strobilops labyrinthicus* (Say)	Stylommatophora/ Strobilopsidae	maze pinecone	Say 1817d:124	". . . common as far as Council Bluff." (Say 1821: 161)
Helix minuta	junior synonym of *Vallonia pulchella* (Mueller)	Stylommatophora/ Valloniidae	lovely vallonia or smooth grass snail	Say 1817d:123	". . . common as far as Council Bluff." (Say 1821: 161)

Note: Species name in bold type was described based on material from Engineer Cantonment.

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APPENDIX 3
INSECTS IDENTIFIED IN THE VICINITY OF ENGINEER CANTONMENT IN 1819-20 BY THOMAS SAY

Name used by Thomas Say	Current Scientific Name	Order	Family	Common Name	Source	Comments
Flata bivittata	*Acanalonia bivittata* (Say)	Heteroptera	Acanaloniidae	a planthopper	Say 1825c: 335	"Found near Engineer Cantonment on the Missouri river . . ."
Cercopis obtusa	*Clastoptera obtusa* (Say)	Heteroptera	Cercopidae	alder spittlebug	Say 1825c: 339	"Very common near Council Bluff, . . ."
Tettigonia limbata	junior synonym of *Cuerna septentrionalis* (Walker)	Heteroptera	Cicadellidae	a leafhopper	Say 1825c: 340	"Near Engineer Cantonment on the Missouri."
Tettigonia obliqua	*Erythroneura obliqua* (Say)	Heteroptera	Cicadellidae	a leafhopper	Say 1825c: 342	"Found at Engineer Cantonment, . . ."
Tettigonia 8-lineata	*Gyponana 8-lineata* (Say)	Heteroptera	Cicadellidae	a leafhopper	Say 1825c: 340	"Near Engineer Cantonment on the Missouri."
Flata stigmata	*Cixius stigmata* (Say)	Heteroptera	Cixiidae	a planthopper	Say 1825c: 336	"Very numerous at Engineer Cantonment on the Missouri."
Coreus lateralis	*Arhyssus lateralis* (Say)	Heteroptera	Coreidae	a leaf-footed bug	Say 1825c: 320	"Found near Engineer Cantonment, . . ."
Lygaeus trivittatus	*Boisea lateralis* (Say)	Heteroptera	Coreidae	boxelder bug	Say 1825c: 322	"Taken at Engineer Cantonment."
Cydnus spinifrons	*Amnestus spinifrons* (Say)	Heteroptera	Cydnidae	a burrower bug	Say 1825c: 316	"Found near Engineer Cantonment, common."
Lygaeus scolopax	*Ortholomus scolopax (*Say)	Heteroptera	Lygaeidae	a seed bug	Say 1831: 775	"I obtained a specimen at Council Bluff . . ."
Tridactylus apicalis	*Neotridactylus apicalis* (Say)	Heteroptera	Tridactylidae	a pygmy mole cricket	Say 1825c: 310-311	described from "Southern and Western States" but "This species is numerous on St. John's river, in East Florida and on the Missouri, as far as Council Bluff."
Buprestis pusilla	*Agrilus parvus* Saunders (replacement name for Say homonym)	Coleoptera	Buprestidae	a metallic wood-boring beetle	Say 1825b: 252	"I detected it at the cantonment of Major Long's party, on the Missouri."
Cantharis ligata	junior synonym of *Chauliognathus marginatus* (Fabr.)	Coleoptera	Cantharidae	a soldier beetle	Say 1825d: 166	"I found the specimen near the cantonment of Major Long's exploring party on the Missouri river."
Brachinus cyanipennis	*Brachinus cyanipennis* Say	Coleoptera	Carabidae	a ground beetle	Say 1823b: 143	". . . observed great numbers of them near Engineer Cantonment. These chiefly occurred during the winter, in a quarry from which building stone had been taken for the use of Camp Missouri. They were found hibernating in the fissures of the rocks."
Brachinus stygicornis	junior synonym of *Brachinus quadripennis* Dejean	Coleoptera	Carabidae	a ground beetle	Say 1834: 415	"I obtained this species in the winter of 1819, when with Major Long's party, at Engineer cantonment, near Council Bluff."
Bembidium inaequalis	*Bembidiom inaequalis* Say	Coleoptera	Carabidae	a ground beetle	Say 1823b: 151	". . . it occurred near Engineer Cantonment."
Leptura bivittata	*Acmaeops bivittatus* (Say)	Coleoptera	Cerambycidae	a long-horn beetle	Say 1824c: 416	"This insect, which is not very common in the vicinity of Council Bluff . . ."

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APPENDIX 3 (continued)

Name used by Thomas Say	Current Scientific Name	Order	Family	Common Name	Source	Comments
Donacia aequalis	*Donacia aequalis* Say	Coleoptera		a leaf beetle	Say 1824c: 428	"Found near Engineer Cantonment."
Tillus terminatus	*Monophylla terminata* (Say)	Coleoptera	Cleridae	a checkered beetle	Say 1835: 160	"I obtained two specimens of this curious insect, at the cantonment of Major Long's party, near Council Bluff on the Missouri river."
R[h]ynchaenus caudatus	*Listronotus caudatus* (Say)	Coleoptera	Curculionidae	a weevil	Say 1824b: 311	"Found near Engineer Cantonment on the Missouri river."
Colymbetes venustus	*Coptotomus venustus* (Say)	Coleoptera	Dytiscidae	a predacious diving beetle	Say 1823b: 152	"Found many specimens in a pond near Bowyer Creek, Missouri."
Hydroporus undulatus	*Hydroporus undulates* Say	Coleoptera	Dytiscidae	a predacious diving beetle	Say 1823b: 154	"Found in a pond near Bowyer Creek, Upper Missouri."
Geotrupes filicornis	*Odonteus filicornis* (Say)	Coleoptera	Geotrupidae	an earth-boring scarab beetle	Say 1823b: 211	"I obtained it near Council Bluff on the Missouri."
Geotrupes excrementi	*Geotrupes blackburnii excrementi* Say	Coleoptera	Geotrupidae	an earth-boring scarab beetle	Say 1823b: 210-211	described from the United States, but "This species is common in various parts of the United States. It is found in Pennsylvania, and I obtained specimens at Engineer Cantonment, and at Cape Gerardeau."
Spaeridium apicialis	junior synonym of *Cercyon pygmaeus* (Illiger)	Coleoptera	Hydrophilidae	a water scavenger beetle	Say 1823b: 203	"Found at Engineer Cantonment."
Helophorus lineatus	*Helophorus lineatus* Say	Coleoptera	Hydrophilidae	a water scavenger beetle	Say 1823b:200	"Found in river near Engineer Cantonment."
Latridius 8-dentatus	junior synonym of *Corticaria serrata* Paykull	Coleoptera	Latridiidae	a minute brown scavenger beetle	Say 1824b: 325-326	"Caught above the confluence of the Platte with the Missouri river."
Catops basilaris	*Choleva basilaris* (Say)	Coleoptera	Leiodidae	a round fungus beetle	Say 1823b: 194	"Found under wood at Engineer Cantonment on the Missouri."
Agathidium pallidum	junior synonym of *Hyonobis matthewsii* Crotch	Coleoptera	Leiodidae	a round fungus beetle	Say 1825a: 91	"A single specimen occurred under wood, at Engineer Cantonment."
Meloe conferta	*Epicauta conferta* (Say)	Coleoptera	Meloidae	a blister beetle	Say 1824a: 281	"Found in the vicinity of Council Bluff . . ."
Phalacrus penicillatus	*Phalacrus penicillatus* Say	Coleoptera	Phalacridae	a shining flower beetle	Say 1825a: 91	"Found near Engineer Cantonment."
Aphodius tenella	*Aphodius tenellus* Say	Coleoptera	Scarabaeidae	a scarab beetle	Say 1823b: 213	". . . obtained specimens of it in the vicinity of Engineer Cantonment on the Missouri."
Cetonia barbata	junior synonym of *Euphoria inda* (Linnaeus)	Coeloptera	Scarabaeidae	a scarab beetle	Say 1824a: 239	" . . . found at Council Bluff, on the Missouri, . . ."
Melolontha sericea	*Serica sericea* (Illiger)	Coleoptera	Scarabaeidae	a scarab beetle	Say 1824a: 245	". . . we obtained specimens near Council Bluff on the Missouri river."

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APPENDIX 3 (continued)

Name used by Thomas Say	Current Scientific Name	Order	Family	Common Name	Source	Comments
Paederus binotatus	*Astenus binotatus* (Say)	Coleoptera	Staphylinidae	a rove beetle	Say 1823b: 154	"Found near the Missouri above the confluence of the Platte"
Oxytelus armatus	*Bledius armatus* (Say)	Coleoptera	Staphylinidae	a rove beetle	Say 1823b: 156	"On the banks of the Missouri above the confluence of the Platte river"
Oxytelus fasciatus	*Bledius fasciatus* (Say)	Coleoptera	Staphylinidae	a rove beetle	Say 1823b: 157	"Found near Engineer Cantonment."
Stenus quadripunctatus	*Carpelimus quadripunctatus* (Say)	Coleoptera	Staphylinidae	a rove beetle	Say 1834: 459	"Found at Engineer Cantonment."
Omalium marginatum	*Eusphalerum marginatum* (Say)	Coleoptera	Staphylinidae	a rove beetle	Say 1834: 463	". . . it occurred at Engineer Cantonment on the Missouri."
Lathrobium cinctum	*Homaeotarsus cinctus* (Say)	Coleoptera	Staphylinidae	a rove beetle	Say 1834: 454	"Found near Engineer Cantonment on the Missouri."
Anthophagus brunneus	*Psephidonus brunneus* (Say)	Coleoptera	Staphylinidae	a rove beetle	Say 1823b: 158	"On the banks of the Missouri above the confluence of the Platte river"
Diaperis bifasciata	*Alphitophagus bifasciata* (Say)	Coleoptera	Tenebrionidae	a darkling beetle	Say 1824a: 268	"Found at Engineer Cantonment."
Dilophus stigmaterus	*Dilophus stigmaterus* Say	Diptera	Bibionidae	a march fly	Say 1823a: 78	"Taken at Engineer Cantonment."
Zodion abdominalis	a junior synonym of *Zodion fulvifrons* Say	Diptera	Conopidae	a conopid fly	Say 1823a: 84	described from near the Rocky Mountains, but "I obtained an individual at Engineer Cantonment, less than half the above mentioned size."
Gonia frontosa	*Gonia frontosa* Say	Diptera	Tachinidae	a tachina fly	Say 1830: 175	"Occurred rather common at Engineer Cantonment on the Missouri, late in March, on a wounded tree from which much sap had exuded."
Myrmosa unicolor	*Myrmosa unicolor* Say	Hymenoptera	Tiphiidae	a tiphiid wasp	Say 1824d: 331	described from North-west Territory, but . . . "also occurred on the Missouri, at Engineer Cantonment, . . ."

Notes: Species names in bold type were described based on material from the vicinity of Engineer Cantonment. Listed in traditional arrangement of orders and then alphabetically by current family and generic names.

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APPENDIX 4
AMPHIBIANS AND REPTILES IDENTIFIED IN THE VICINITY OF ENGINEER CANTONMENT IN 1819-20 (JAMES 1823)

Name in Say (in James 1823)	Current Scientific Name	Common Name	Comments
Rana (Bufo) musicus	*Bufo woodhousii* and/or *Bufo cognatus*	Woodhouse's toad and/or Great Plains toad	these two species occur across most of Nebraska and are difficult to distinguish
Rana clamata	*Rana pipiens* and/or *Rana blairi*	northern leopard frog and/or plains leopard frog	two species occur in eastern Nebraska and are very close in appearance; *R. blairi* was only recognized recently
Testudo (Emys) geographica	*Chrysemys picta* and/or *Graptemys pseudogeographica*	western painted turtle and/or false map turtle	
Testudo (Emys) serpentaria	*Chelydra serpentina*	common snapping turtle	
Testudo clausa	*Terrapene ornata*	ornate box turtle	"rarely, if ever, enters the water . . . decidedly terrestrial"
Testudo (Trionix) ferox	*Trionyx mutica/T. spinifera*	soft-shelled turtle	
Lacerta (Agama) undulata	possibly *Cnemidophorus sexlineatus*	six-lined race runner	
Lacerta (Scincus) 5-lineatus	probably *Eumeces septentrionalis*	prairie skink	
Coluber flaviventris	*Coluber constrictor flaviventris* Say	eastern yellowbelly racer	described by Say *in* James 1823:185; found hibernating in limestone quarry 100 yards from cantonment
Coluber heterodon	*Heterodon platirhinos*	eastern hognose snake	
Coluber proximus	*Thamnophis proximus proximus* (Say)	western ribbon snake	described by Say *in* James 1823:187; found hibernating in limestone quarry 100 yards from cantonment
Coluber ordinatus	probably *Thamnophis radix haydenii*	western plains garter snake	
Coluber parietalis	*Thamnophis sirtalis parietalis* (Say)	red-sided garter snake	described by Say *in* James 1823:186; found hibernating in limestone quarry 100 yards from cantonment
Coluber constrictor	unknown		
Crotalus horridus	*Crotalus horridus*	timber rattesnake	
Crotalus durissus	*Sistrurus catenatus tergeminus*	western massasauga	April 14, 1820: "We saw numbers of the smaller species of rattle snake, which had, no doubt, but lately left their winter dwelling." (James 1823: 345-34)

Notes: Species names in bold type were described based on material from Engineer Cantonment. Taxonomy follows Lynch (1985), Conant and Collins (1991), Benedict (1996), and Peyton (2000). Citations to T. Say *in* James 1823 refer to footnotes written by Say in the text of the *Account of an Expedition from Pittsburgh to the Rocky Mountains*, which give scientific descriptions for vertebrates collected by the party.

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APPENDIX 5
BIRDS COLLECTED AND OBSERVED IN THE VICINITY OF ENGINEER CANTONMENT IN 1819-20 (JAMES 1823)

Name in Say (in James 1823)	Current Scientific Name	Common Name	Arrival Dates and Comments
Colymbus glacialis	*Gavia immer*	Common Loon	
Colymbus (Podiceps) cornutus	*Podiceps nigricollis*	Eared Grebe	May 5, 1820
Pelecanus erythrorhynchos	*Pelecanus erythrorhynchos*	American White Pelican	April 8, 1820
Pelecanus fuscus	*Pelecanus occidentalis*	Brown Pelican	
Pelecanus (Phalacrocorax) carb	*Phalacrocorax auritus*	Double-crested Cormorant	April 10, 1820
Ardea herodias	*Ardea herodias*	Great Blue Heron	
Ardea virescens	*Butorides virescens*	Green Heron	
Ardea nycticorax	*Nycticorax nycticorax*	Black-crowned Night-Heron	
Vultur (Cathartes) aura	*Cathartes aura*	Turkey Vulture	April 2, 1820
Anas (Anser) albifrons	*Anser albifrons*	Greater White-fronted Goose	
Anas (Anser) hyperborea	*Chen caerulescens*	Snow Goose	
Anas (Cygnus) Canadensis	*Branta canadensis*	Canada Goose	"flying to the north February 21, 1820"
Anas (Anser) bernicla?	*Branta bernicla*	Brant	This could be an erroneous report
Anas (Cygnus) Cygnus	*Cygnus buccinator*	Trumpeter Swan	"flying to the north February 22, 1820"
Anas sponsa	*Aix sponsa*	Wood Duck	
Anas Americana	*Anas americana*	American Widgeon	"shot March 3, 1820"
Anas boschus	*Anas platyrhynchos*	Mallard	
Anas discors	*Anas discors*	Blue-winged Teal	
Anas acuta	*Anas acuta*	Northern Pintail	"shot February 28, 1820"
Anas marila	*Aythya affinis*	Lesser Scaup	
Anas glacialis	*Clangula hyemalis*	Oldsquaw [= Long-tailed Duck]	
Anas albeola	*Bucephala albeola*	Bufflehead	
Anas clangula	*Bucephala clangula*	Common Goldeye	
Mergus cucullatus	*Lophodytes cucullatus*	Hooded Merganser	
Mergus serrator	*Mergus merganser*	Common Merganser	
Falco (Pandion) haliætus	*Pandion haliaetus*	Osprey	May 17, 1820
Falco (Milvus) furcatus	*Elanoides forficatus*	Swallow-tailed Kite	May 20, 1820
Falco Mississippiensis	*Ictinia mississippiensis*	Mississippi Kite	"generally winter here"
Falco (Haliætus) leucocephalus	*Haliaeetus leucocephalus*	Bald Eagle	"generally winter here;" threatened (Lackey 2003)
Falco (Circus) uliginosus	*Circus cyaneus*	Northern Harrier	"generally winter here"
Falco velox	*Accipiter striatus*	Sharp-shinned Hawk	"generally winter here;" species described based on young female
Falco Pennsylvanicus	*Buteo platypterus*	Broad-winged Hawk	"generally winter here;" species described based on male
Falco (Accipitur) ruficaudus *Falco (Buteo) galinivorus*	*Buteo jamaicensis*	Red-tailed Hawk	"generally winter here"
Falco lagopus	*Buteo lagopus*	Rough-legged Hawk	Feb. 1820—presence documented by T. Peale watercolor
Falco (Aquila) fulvus	*Aquila chrysaetos*	Golden Eagle	"generally winter here"
Falco (Tinnunculus) sparverius	*Falco sparverius*	American Kestrel	
Tetrao umbellus	*Bonasa umbellus*	Ruffed Grouse	
Tetrao phasianellus	*Tympanuchus phasianellus*	Sharp-tailed Grouse	
Tetrao cupido	*Tympanuchus cupido*	Greater Prairie-Chicken	
Meleagris gallipavo	*Meleagris gallipavo*	Wild Turkey	extirpated and re-introduced
Tetrao (Perdix) Virginianus	*Colinus virginianus*	Northern Bobwhite	

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APPENDIX 5 (continued)

Name in Say (in James 1823)	Current Scientific Name	Common Name	Arrival Dates and Comments
Fulica Americana	*Fulica americana*	American Coot	
Ardea (Grus) Canadensis	*Grus canadensis*	Sandhill Crane	May 24, 1820—based on watercolor by T. Peale this was the Greater Sandhill Crane
Ardea (Grus) Americanus	*Grus americana*	Whooping Crane	March 19, 1820; endangered (Lackey 2003)
Charardrius pluvialis	*Pluvialis dominica*	American Golden-Plover	
Scolopax (Totanus) semipalmata	*Catopterophorus semipalmatus*	Willet	
Charardrius vociferus	*Charadrius vociferus*	Killdeer	
Recurvirostra Americana	*Recurvirostra americana*	American Avocet	
Scolopax (Totanus) melanoleucus *Scolopax (Totanus) vociferus*	*Tringa melanoleuca*	Greater Yellowlegs	March 19, 1820
Scolopax flavipes	*Tringa flavipes*	Lesser Yellowlegs	
Tringa solitaria	*Tringa solitaria*	Solitary Sandpiper	April 30, 1820
Tringa Bartramia	*Bartramia longicauda*	Upland Sandpiper	
Numenius longirostra	*Numenius americanus*	Long-billed Curlew	April 1, 1820
Scolopax fedoa	*Limosa fedoa*	Marbled Godwit	
Tringa semipalmata	*Calidris pusilla*	Semipalmated Sandpiper	
Pelidna cinclus	*Calidris fuscicollis*	White-rumped Sandpiper	"This bird was shot in November, near Engineer Cantonment"
Pelidna pectoralis	junior synonym of *Calidris melanotos* (Vieillot)	Pectoral Sandpiper	described by Say *in* James 1823:171; "Many flocks of them were seen at Engineer Cantonment, both in the Spring and Autumn"
Limosa scolopacea	*Limnodromus scolopaceus* (Say)	Long-billed Dowitcher	described by Say *in* James 1823:170; "several specimens were shot in a pond near the Bowyer creek"
Scolopax minor	*Scolopax minor*	American Woodcock	April 8, 1820
Larus ridibundus	*Larus pipixcan*	Franklin Gull	"in large flocks, flying northward, May 4, 1820;" probably this species
Sterna arenea	*Chlidonias niger*	Black Tern	
Sterna minuta	*Sterna antillarum*	Least Tern	April 2, 1820; endangered (Lackey 2003)
Columba Carolinensis	*Zenaida macroura*	Mourning Dove	April 30, 1820
Columba migratoria	*Ectopistes migratorius*	Passenger Pigeon	May 2, 1820; extinct
Psittacus Carolinensis	*Conuropsis carolinensis*	Carolina Parakeet	"seem several times during winter;" extinct
Strix (Otus) otus	*Asio otus*	Long-eared Owl	
Strix (Otus) asio	*Otus asio*	Eastern Screech-Owl	"generally winter here"
Strix (Otus) Virgiana *Strix (Bubo) bubo*	*Bubo virginianus*	Great Horned Owl	"generally winter here"
Strix (Noctna) Hudsonia	*Surnia ulula*	Northern Hawk Owl	"generally winter here"
Strix (Ulula) nebulosa	*Strix varia*	Barred Owl	"generally winter here"
Strix (Noctna) passerina *Strix (Noctna) phalœnoides*	*Aegolius acadicus*	Northern Saw-whet Owl	"generally winter here"
Caprimulgus porpetue	*Chordeiles minor*	Common Nighthawk	May 16, 1820
Caprimulgus Virginianus	*Caprimulgus vociferus*	Whip-poor-will	April 19, 1820
Hirundo pelasgia	*Chaetura pelagica*	Chimney Swift	May 1, 1820
Trochilus colubris	*Archilochus colubris*	Ruby-throated Hummingbird	May 18, 1820
Alcedo alcyon	*Ceryle alcyon*	Belted Kingfisher	March 20, 1820
Picus erythrocephala	*Melanerpes erythrocephalus*	Red-headed Woodpecker	March 20, 1820 "entirely migratory"

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APPENDIX 5 (continued)

Name in Say (in James 1823)	Current Scientific Name	Common Name	Arrival Dates and Comments
Picus Carolinus	*Melanerpes carolinus*	Red-bellied Woodpecker	
Picus pubescens	*Picoides pubescens*	Downy Woodpecker	
Picus villosus	*Picoides villosus*	Hairy Woodpecker	
Picus auratus	*Colaptes auratus*	Northern Flicker	"remain all winter"
Picus pileatus	*Dryocopus pileatus*	Pileated Woodpecker	February 28, 1820
Musicapa fusca	*Sayornis phoebe*	Eastern Phoebe	March 22, 1820
Musicapa (Tyrannus) Ludovicianus	*Myiarchus crinitus*	Great Crested Flycatcher	
Musicapa (Tyrannus) pipiri	*Tyrannus tyrannus*	Eastern Kingbird	May 7, 1820
Lanius borealis	*Lanius excubitor*	Northern Shrike	
Musicapa cantatrix Musicapa novaboracensis	*Vireo griseus*	White-eyed Vireo	April 30, 1820
Musicapa olivacea	*Vireo olivaceus*	Red-eyed Vireo	April 30, 1820
Corvus (Garrulus) cristatus	*Cyanocitta cristata*	Blue Jay	
Corvus (Pica) pica	*Pica pica*	Black-billed Magpie	"retired northward March 23, 1820"
Corvus corone	*Corvus brachyrhynchos*	American Crow	
Corvus corax	*Corvus corax*	Common Raven	"the young nearly able to fly, May 12, 1820"
Alauda alpestris	*Eremophila alpestris*	Horned lark	
Hirundo purpurea	*Progne subis*	Purple Martin	March 30, 1820
Hirundo riparia	*Riparia riparia*	Bank Swallow	
Hirundo Americanus	*Hirundo rustica*	Barn Swallow	
Parus atricapillus	*Poecile atricapillus*	Black-capped Chickadee	"all winter"
Sitta varia	*Sitta canadensis*	Red-breasted Nuthatch	
Sitta Carolinensis	*Sitta carolinensis*	White-breasted Nuthatch	"remains all winter"
Certhia Caroliniana	*Thryothorus ludovicianus*	Carolina Wren	
Sylvia (Troglodites) troglodites	*Troglodytes troglodytes*	Winter Wren	
Certhia palustris	*Cistothorus palustris*	Marsh Wren	April 15, 1820
Sylvia sialis	*Sialis sialis*	Eastern Bluebird	"a few remain all winter"
Turdus migratorius	*Turdus migratorius*	American Robin	April 11, 1820
Turdus fuscus			species undetermined; April 28, 1820
Turdus felivox	*Dumetella carolinensis*	Gray Catbird	
Turdus pollyglottus	*Mimus polyglottos*	Northern Mockingbird	
Turdus rufus	*Toxostoma rufum*	Brown Thrasher	
Alauda rubra	*Anthus rubescens*	American Pipit	
Ampelis (Bombycivora) Carolinensis	*Bombycilla cedrorum*	Cedar Waxwing	
Sylvia solitaria	*Vermivora pinus*	Blue-winged Warbler	
Sylvia celatus	*Vermivora celata* (Say)	Orange-crowned Warbler	described by Say *in* James 1823:169; "Shot at Engineer Cantonment early in May"
Sylvia Ludoviciana	*Parula americana*	Northern Parula	
Sylvia æstiva	*Dendroica petechia*	Yellow Warbler	
Sylvia striata	*Dendroica striata*	Blackpoll Warbler	April 26, 1820
Sylvia bifasciata *Sylvia azurea*	junior synonym of *Dendroica cerulea* (Wilson)	Cerulean Warbler	described by Say *in* James 1823:170; "Shot in May near Engineer Cantonment;" April 28, 1820
Musicapa (Mucipeta) ruticilla	*Setophaga ruticilla*	American Redstart	April 28, 1820
Turdus aurocapillus	*Seiurus aurocapillus*	Ovenbird	April 26, 1820
Turdus aquaticus	*Seiurus noveboracensis*	Northern Waterthrush	April 26, 1820

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APPENDIX 5 (continued)

Name in Say (in James 1823)	Current Scientific Name	Common Name	Arrival Dates and Comments
Musicapa Canadensis	*Wilsonia canadensis*	Canada Warbler	
Musicapa (Icteria) viridis	*Icteria virens*	Yellow-breasted Chat	
Tanagra rubra	*Piranga rubra*	Summer Tanager	May 1, 1820
Tanagra Ludoviciana	*Piranga olivacea*	Scarlet Tanager	
Fringilla (Ploceus) erythrocephala	*Pipilo erythrophthalmus*	Eastern Towhee	
Fringilla socialis	*Spizella passerina*	Chipping Sparrow	
Fringilla melodia	*Melospiza melodia*	Song Sparrow	
Fringilla Hudsonia	*Junco hyemalis*	Dark-eyed Junco	departing April 11, 1820
Loxia (Vidua) cardinalis	*Cardinalis cardinalis*	Northern Cardinal	
Loxia (Vidua) Ludoviciana	*Pheucticus ludovicianus*	Rose-breasted Grosbeak	
Emberiza Americana	*Spiza americana*	Dickcissel	
Fringilla oryzivora	*Dolichonyx oryzivorus*	Bobolink	May 14, 1820
Oriolus (Zanthornus) phœniceus	*Agelaius phoeniceus*	Red-winged Blackbird	March 1, 1820
Sturnus Ludovicianus	*Sturnella magna*	Eastern Meadowlark	April 5, 1820
Oriolus (Zanthornus) icterocephalus	*Xanthocephalus xanthocephalus*	Yellow-headed Blackbird	May 14, 1820
Gracula (Icterus) quiscala	*Quiscalus quiscala*	Common Grackle	
Fringilla pecora	*Molothrus ater*	Brown-headed Cowbird	
Oriolus (Zanthornus) spurius	*Icterus spurius*	Orchard Oriole	
Oriolus (Zanthornus) Baltimoreus	*Icterus galbula*	Baltimore Oriole	
Loxia (Corythus) enueleator	*Pinicola enucleator*	Pine Grosbeak	"occasionally seen during the winter"
Fringilla purpurea	*Carpodacus purpureus*	Purple Finch	February 28, 1820
Loxia Curvirostra Americana	*Loxia curvirostra*	Red Crossbill	February 21, 1820
Fringilla (Linaria) linarta	*Carduelis flammea*	Common Redpoll	February 1, 1820
Fringilla (Cardualis) tristis	*Carduelis tristis*	American Goldfinch	

Notes: Species names in bold type were described based on material from Engineer Cantonment. List developed using Ord (1815), Brewer (1840), Rhoads (1894), Evans (1997), Ducey (2000), and Sharpe et al. (2001). Species are listed in the same order as the most recent American Ornithologists' Union (1998) checklist. Arrival dates and quoted material are from James (1823). Citations to T. Say *in* James 1823 refer to footnotes written by Say in the text of the *Account of an Expedition from Pittsburgh to the Rocky Mountains*, which give scientific descriptions for vertebrates collected by the party.

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APPENDIX 6
MAMMALS IDENTIFIED IN THE VICINITY OF ENGINEER CANTONMENT IN 1819-20 (JAMES 1823)

Name in Say (in James, 1823)	Current Scientific Name	Common Name	Comments
Didelphis virginiana	*Didelphis virginiana*	opossum	
Lepus Americanius	almost certainly *Sylvilagus floridanus*	eastern cottontail	given the abundance and descriptions in text this is almost certainly the common cottontail, *S. floridanus*; "went out this morning to kill rabbits, returned, about noon, with twenty-seven"
Sorex brevicauda	*Blarina brevicauda brevicauda* (Say)	northern short-tailed shrew	described by Say *in* James 1823:164; taken near cabins; "the specimen is a male"
Sorex parvus	*Cryptotis parva parva* (Say)	least shrew	described by Say *in* James 1823:163; taken near cabins; "Mr. Peale caught this animal in a pitfall, which he had dug for the purpose of catching a wolf. It is a female."
Scalops aquaticus	*Scalopus aquaticus*	eastern mole	
Vespertilio arquatus	junior synonym of *Eptesicus fuscus fuscus* (Palisot de Beauvois)	big brown bat	described by Say *in* James 1823:167
Vespertilio Carolinus	*Eptesicus fuscus*	big brown bat	
Vespertilio novaboracensis	*Lasiurus borealis*	red bat	
Vespertilio pruinosus	junior synonym of *Lasiurus cinereus cinereus* (Palisot de Beauvois)	hoary bat	described by Say *in* James 1823:167; "common in this region"
Felis concolor	*Puma concolor*	mountain lion	extirpated; a few wanderers coming into general area
Felis rufa	*Lynx rufus*	bobcat	
Canis	*Canis familiaris*	Indian dog	
Canis latrans	*Canis latrans latrans* Say	coyote	described by Say *in* James 1823:168; apparently four individuals used in description; present "in considerable numbers;" "prairie wolves . . . killed a doe, within a short distance of our huts; this morning the remains of the carcass were found, consisting only of bones and skin"
Canis nubilus	*Canis lupus nubilus* Say	prairie gray wolf	described by Say in James 1823:169; description based on a single individual; extinct
Canis lycaon	*Canis lupus*	gray wolf	
Canis virginianus	*Vulpes vulpes*	red fox	
Canis cinereo-argenteus	*Urocyon cinereoargenteus*	gray fox	
Ursus Americanus	*Ursus americanus*	black bear	extirpated
Lutra (mustela lutra Braziliensis)	*Lontra canadensis*	otter	extirpated, but being reintroduced
Mustela minx	*Mustela vision*	mink	
Mustela vision	*Mustela vision*	mink	
Taxus labradoricus	*Taxidea taxus*	American badger	
Mephitis putorius	*Mephitis mephitis*	striped skunk	"The flesh of the skunk we had sometimes dressed for dinner, and found it a remarkably rich and delicate food."
Procyon lotor	*Procyon lotor*	raccoon	
Cervus major	*Cervus elaphus*	elk	extirpated; "saw several herds of elk"
Cervus Virginianus	*Odocoileus virginianus*	white-tailed deer	nearly extirpated, re-introduced, and now superabundant; "Mr. Peale on one occasion killed two deer at a single shot and with one ball"
Antilocapra Americana	*Antilocapra americana*	pronghorn	extirpated
Bos bison	*Bison bison*	bison	extirpated; "Messrs. Dougherty and Peale returned from a hunt, having killed twelve bisons, out of a herd of several hundred"

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APPENDIX 6 (continued)

Name in Say (in James, 1823)	Current Scientific Name	Common Name	Comments
Sciurus cinereus	*Sciurus carolinensis*	gray squirrel	
Sciurus capistratus	*Sciurus niger*	fox squirrel	
Sciurus nigra	*Sciurus niger*	fox squirrel	
Sciurus striatus	*Tamias striatus*	eastern chipmunk	not currently known from this area in Nebraska
Arctomys monax	*Marmota monax*	woodchuck	
Castor fiber	*Castor canadensis*	American beaver	extirpated and now re-invaded
Pseudostoma bursaria	*Geomys bursarius*	plains pocket gopher	
Gerbillus canadensis	*Zapus hudsonius*	meadow jumping mouse	
Mus agrestris ?	*Peromyscus leucopus*	white-footed mouse	
Mus musculus	*Mus musculus*	house mouse	"introduced by our expedition"
Ondatra zibethicus	*Ondatra zibethicus*	muskrat	

Names: Species names in bold type were described based on material from Engineer Cantonment. Mammalian taxonomy follows Jones (1964), Wilson and Reeder (2005), and Genoways et al. (2008). Citations to T. Say *in* James 1823 refer to footnotes written by Say in the text of the *Account of an Expedition from Pittsburgh to the Rocky Mountains*, which give scientific descriptions for vertebrates collected by the party.

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