Contributions

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History of the Ecological Sciences, Part 33: Naturalists Explore North America, mid-1780s–mid-1820s

Natural history explorations, we have seen in Parts 22, 25, 27, and 32 (Egerton 2006, 2007, 2008, 2009*b*), often led to publications that, in retrospect, contain ecological observations. Humboldt set an excellent example by measuring many environmental variables during his explorations; later explorers never measured as many variables as he, but some of them recorded temperature, precipitation, and barometric pressure. The exploration literature of the late 1700s and early 1800s increased steadily in volume. There are good introductions to naturalist-explorers in North America from mid-1780s to mid-1820s that are more comprehensive than this part of my history. They include bibliographies (Meisel 1924–1929, 1967, Wood 1931, Wagner et al. 1982, Harkányi 1990, Stanton 1991), histories of American science (Smallwood and Smallwood 1941, Struik 1948, Dupree 1957, Daniels 1968, Greene 1984, Porter 1986, Welch 1998), biographical dictionaries (Gillespie 1970–1980, Sterling et al. 1997, Garraty and Carnes 1999), a biographical history of American science (Jaffe 1958), a history of scientific societies (Oleson and Brown 1976), accounts of natural history exploration (Peattie 1936:201–260, Ewan 1950, Goetzmann 1959, 1967, 1986, Savage 1970, 1979, Hanley 1977, Ewan and Ewan 1981, Spencer 1986*a*, *b*, Viola 1987, Evans 1993, Fishman 2000, Moring 2002, Beidleman 2006:4–70), of botanical exploration (McKelvey 1955:3–280, Leroy 1957, Thomas 1979:7–10, Reveal 1992), and of ornithological exploration (Allen 1951:526–569, Welker 1955:16–58, Fischer 2001:8–14). The achievements discussed here give some idea of what was being accomplished simultaneously by other naturalists in North and South America, Africa, Asia, Australia, and various islands. Although the American War of Independence marks a transition from colonial to independent science, after independence some Americans continued to travel to Europe for some or all of their science education, and some European naturalists continued to explore in America.

André and François André Michaux

Our first two naturalists were a French father and son. André Michaux (1746–1803 [not 1802; Taylor

and Norman 2002:xiv]) was born at a royal farm managed by his father near Versailles. He attended a boarding school for four years and studied both agriculture and Latin. He was orphaned at age 20, and for a while he and a brother managed the farm. He married in 1769, and in 1770 his wife died in childbirth. François André Michaux (1770–1855) saw little of his busy father during his first 15 years. André Michaux attracted the interest of two aristocratic patrons and began studying botany in 1777. In 1779 he moved to Paris to continue his studies at the Jardin du Roi (Savage and Savage 1986:6–10, Tino 1997, MacPhail 1999*a*, Taylor and Norman 2002:10–14). In 1780 he accompanied Lamarck on a trip to the Auvergne and the Pyrenees to collect plants, birds, insects, and minerals (Ewan 1974:366). In 1782 he accompanied a French diplomat to the Turkish Empire, where he collected seeds and plants for three years, which periodically he sent to Paris. He was also interested in animals and fossils. He traveled as far east as the region south of the Caspian Sea. Two letters to his son and a travel journal remain unpublished but were available to his biographers (Coats 1969:22–25, Savage and Savage 1986:16–33).

Michaux returned to Marseilles on 23 May 1785, and on 1 September he departed on a collecting trip to America. This time he took his son François, a servant, and a gardener, Pierre Paul Saumier (1751–1818). They reached New York on 13 November, and in March 1786 Michaux bought a 29-acre farm, to use as a nursery, in New Jersey, six miles from New York City (Robbins and Howson 1958). This farm-nursery was run by Saumier, who used half of it as a farm to supplement his pay; he never returned to France. On 19 April 1887 Michaux reached Charleston, South Carolina and bought a farm of 111 acres for the same purpose (or he may have bought the farm in 1886, before he arrived [Coker 1911:66–67]). He remained in America until 13 August 1796. During those 11 years he went on numerous brief explorations and eight long expeditions, plus a trip to the Bahamas in 1789. François accompanied him on some expeditions, but possibly on 5 February 1790 François sailed back to France to study medicine. He carried many live plants and chests of seeds (Savage and Savage 1986:107, Wassong 1997, MacPhail 1999*b*). In addition to studying medicine, he studied botany at the Jardin des Plantes (Savage and Savage 1986:164).

André Michaux kept travel journals with observations made from Florida to almost Hudson's Bay and from the Atlantic to the Ohio and Mississippi rivers, during which he discovered more than 300 plant species unknown to science (True 1937:313, Coats 1969:282–283, 285–289, Fishman 2000:67–92). After he returned from near Hudson's Bay to Philadelphia in December 1792, he discovered that the French Republic had not sent funds he had anticipated, and he turned to friends in the American Philosophical Society with a proposal for them to fund his exploration of the Missouri River (Ewan and Ewan 2007:498–499). A plan was underway, with Jefferson having written detailed instructions for him (Jackson 1981:75–78), when the French ambassador, Edmond Charles Genet, hijacked the trip and sent Michaux into Kentucky instead, on a wild imperialistic scheme that could not succeed (Savage and Savage 1986:124–175). Yet Michaux still observed and collected plants on that journey. When he sailed for home in 1796, he suffered shipwreck off the coast of the Netherlands and lost his journals for the period November 1785 to August 1787 (Savage and Savage 1986:161–162). His remaining American journals would be donated in 1815 by François to the American Philosophical Society in recognition of the assistance given by that society to both father and son. Botanist Charles S. Sargent published it in French in October 1888 (for an 1889 volume). In 1904–1905 Reuben G. Thwaites published his own English translation of pages 91–101 and 114–140, from the years 1793–1796 (MacPhail 1981).

Much of André Michaux's journals describe his travels and encounters with Americans. However, he also included natural history observations on plants and animals, and some of these observations have ecological interest. He left Charleston for Florida on 14 February 1788, but before doing so, he had discussed Florida with William Bartram (Taylor and Norman 2002:26), whose own trip there had ended in early 1777, but whose *Travels* would not be published until 1789 (Egerton 2007*a*:265). Michaux father and son took a canoe from St. Augustine and were accompanied by a slave bought in Charleston and two paddlers. The canoe was a hollowed-out cypress log (Taylor and Norman 2002:67, 89–91). The journal he kept is translated into English by Walter Taylor and Eliane Norman and several assistants. Most of the journal describes their travels, plants collected, and experiences. Michaux's comments of ecological interest are few, and the most interesting is on the natural history of the alligator, written on 9 May (Taylor and Norman 2002:78–79). However, his comments on alligators were briefer than those published the next year by William Bartram in his *Travels*, and since Michaux was really a botanist, his comments on plants seen on 13 May are quoted instead (Taylor and Norman 2002:79–80).

> *...we arrived at the shore of the stream whose water was so agreeable and beautiful. It is situated only one-half a mile from the salt water river [Salt River] the water of which is just as bad as the water of the little river is good. I experienced furthermore the satisfaction of collecting at only eighty toises distant the Illicium…this shrub is found in places where the Magnolia grandiflora, the Annona grandiflora, Olea Americana, Ilex cassine etc. etc. grow but more particularly where one also finds Aralia spinosa and a Grass called "Canes" which grows to ten feet in height which always indicates a good but sandy and cool soil.*

Some of his observations are merely inventory, as eight years later, on 1 January 1796 (Michaux 1888:129, 1904:82–83):

> *Wind from the north; frost; the river rose one inch during the night. In the vicinity of Little River, the country has hills scattered here and there. Soil clayey, very rich mould, rock consisting of Silex very slightly ferruginous. Blue limestone.*
>
> *Animals: raccoons, dwarf deer, opossums, buffaloes, bears, grey squirrels, beaver, otter, musk-rats (these* [last] *three species very rare).*
>
> *Birds: Ravens, owls of the large species, cardinals, blue jays; green parroquets with yellow heads of the small species; jays with red heads and throats.*
>
> *Trees and plants:* Liriodendron; Liquidambar*; yellow chestnut oak, red oak;* Annona*; horn-bean.*

At other times he commented on a particular species, as in this discussion of *Arundinaria macrosperma* Mich., presumably the "Canes" of his Florida journal, written 29 February 1796 (Michaux 1888:135, 1904:94–95):

> *This species of grass which grows abundantly in many places which have not been settled, is destroyed when completely eaten by cattle; swine also destroy it by rooting in the earth and breaking the roots. The stalk is sometimes as thick as a goose quill, but in the rich lands bordering on the rivers and between the mountains, some stalks are as much as 2 and even 3 inches in diameter;*

the height is sometimes from 25 to 30 feet. This grass is ramose but it seldom bears fruit in the territory of Kentucky, in that of Tenesee or in that of the Carolinas. This grass begins in the southern and maritime portion of Virginia. Further South as in the Carolinas, in the Floridas and in Lower Louisiana, this grass is found in abundance.

Fig. 1. *Dalibarda violaeoides*. A. Michaux 1803: I, plate 29, 1974.

André Michaux had left a monarchial France in 1785 and returned to a turbulent republic in 1796. Although he found the political change agreeable, the Republic did not honor the financial obligations to him the monarchy had incurred, and he suffered financial hardships. Consequently, although he spent time working on both the live and dried specimens and seeds he had collected for the government, the circumstances were unfavorable for completing his history of American oaks and his two-volume *Flora Borali- Americana* (Savage and Savage 1986:167–170). Therefore, in 1799 he accepted an invitation to be a naturalist on a voyage of exploration that eventually went to Australia.

This was the same expedition that both Humboldt and Bonpland had wanted to join but had given up on because of delays (Egerton 2009). On 19 October 1800, the expedition sailed from Le Harve under Nicolas Thomas Baudin (1785–1803), not under Louis Bougainville, who had been its early planner. Its staff included 3 botanists, 5 zoologists, 2 mineralogists, 3 artists, 5 gardeners, and 2 geographers. (Horner 1988:3). Michaux left the expedition at Île de France (Mauritius), and a historian of the expedition thinks he may have intended to do so from the start (Horner 1987:73–74, 119). Nine months later Michaux sailed to Madagascar, where he died from a fever (Savage and Savage 1986:177–179).

François Michaux, a faithful son, saw to the publication of his father's books on American oaks and flora (MacPhail 1981). André Michaux's *Flora Borali-Americana* (two volumes, 1803) was the first comprehensive flora for eastern North America. The text was produced in Latin by Louis Claude-Marie Richard and was limited to descriptions, with brief comment on range, and with many species illustrated (Fig. 1). None of André Michaux's travel observations were incorporated into the accounts. The account quoted above of *Arundinaria macrosperma* would have enriched the brief unillustrated account of this species in *Flora Boreali-Americana* (1803, I:73–74, 1974). André Michaux's herbarium is in the Muséum d'Histoire Naturelle in Paris (Stafleu and Cowan 1976–1988, III:456–459), and in 1838 Asa Gray found in it a specimen representing a genus and species from the mountains of the Carolinas that had been omitted from the *Flora*. Gray named it *Shortia galacifolia*; wild specimens were rediscovered in 1877 (Sargent 1886:472). Michaux had found it in what is now Oconee County, South Carolina, and his journal entries from his two trips into that area, 1787 and 1788, are now translated into English and annotated with maps and photographs by Margaret Seaborn (1976). The Canadian botanist Ovide Brunet (1864) used Michaux's notes on herbarium sheets to determine the route he had taken toward Hudson's Bay, and Jacque Rousseau (1948) has discussed further a portion of this journey, with two maps.

On 9 October 1801, having prepared his father's books for publication, François Michaux returned to Charleston to ship home further nursery stock and to sell his father's farms-nurseries there and in New Jersey (F. Michaux 1904:117–124, 1966, Savage and Savage 1986:197–202). Later, he visited New York City and the other nursery and noted in his travel journal the kinds of trees observed (F. Michaux 1904:127–128).

> *...a variety of the red oak, the acorn of which is nearly round; the white oak,* quercus alba*; and, among the different species or varieties of nut trees, the* juglans tomentosa*, or mocker-nut, and the* juglans minima*, or pig-nut. In the low and marshy places, where it is overflowed almost all the year, we found the* juglans-hickory*, or shell-barked hickory; the* quercus prinus aquatica*, which belongs to the series of* prunus *and is not mentioned in the* History of Oaks*. The valleys are planted with ash*

Fig. 2. François André Michaux, by his friend Rembrandt Peale, at the American Philosophical Society. Copy courtesy of Hunt Institute for Botanical Documentation, Carnegie-Mellon University. An anonymous portrait painted in 1819 is at the Royal Botanic Garden, Kew, UK, and reproduced in Leroy 1957:plate 32. An 1851 daguerreotype of him is in Coker 1911: facing 65.

Fig. 3. Southern catalpa (*Catalpa bignonioides*). Michaux 1810–1813, III: Plate 6, 1817–1818.

> *trees, palms,* cornus florida*'s poplars, and* quercus tinctoria*, known in the country by the name of the black oak.*
>
> *The* quercus tinctoria *is very common in all the northern states; it is likewise found to the west of the Alleghany mountains, but is not so abundant in the low part of Georgia and the two Carolinas.*

In Philadelphia he met William Bartram, Charles W. Peale, and other naturalists. In the Pennsylvania countryside he commented on the many rattlesnakes seen killed along the road (F. Michaux 1904:146). He traveled to Pittsburgh where "the air is very salubrious," intermittent fevers were unknown, and the people were not tormented by mosquitoes in summer. People in Pittsburgh built large vessels for the Ohio River and used a variety of trees, all of which he listed. Michaux also commented on the extraction of sugar from sugar maples (F. Michaux 1904:157, 160, 163).

Michaux sailed from Charleston about 1 March 03 for Bordeaux, laden with plants and seeds. He had previously sent others to Paris (Savage and Savage 1986:257–259). During two years in Paris he prepared his travel journal for publication (1804; English, 1805) and studied how well American trees that he and his father had sent or brought from America were growing in France. The outcome of the latter study was his *Memoire sur la naturalization des arbres forestiers* (1805). He then returned to America in 1806–1808 to prepare his well-illustrated natural history of eastern North American trees (three volumes, 144 plates, 1810–1813, English, 1817–1818), the outcome of three multiple-year trips to America (Wassong 1997, MacPhail 1981, 1999*b*).

British author Alice M. Coats reports, without citations, that Michaux's treatise "has been subjected to considerable criticism" (1969:293). Yet, Rodney H. True, director of the Morris Arboretum in Philadelphia, referred to Michaux's treatise as "his great work" (1937:322), and historian of American botany and forestry, Andrew Rodgers, claimed (1951:19–20) that "Only a superficial acquaintance with the botanical literature of North America is required to comprehend the vast contribution of [André and François André Michaux] to systemize descriptively the plant life of the eastern United States." Historian Charlotte Porter observes (1986:22–23) that Michaux drew a correlation between "tertian fever" (malaria), "extreme unwholesomeness of the climate," and "squalid woods," and that he claimed that Banister's oak was "an infallible index of barren soil." Some Americans may have felt that such statements were slurs on their country. Whatever the strictly botanical judgment may be (other references in Stafleu and Cowan 1976–1988, III:459–464), his treatise certainly has ecological merit. Professor Emeritus of Botany J. R. Schramm at the University of Pennsylvania observed that "Soil and moisture requirements of forest species, growth habits and rate, succession as observed in abandoned clearings, etc., engaged his attention" (1957:337). One example Schramm quoted to illustrate Michaux's ecological observations concerned the silver maple (*Acer saccharinum*), which Michaux called a white maple (1857:338).

> *...the white maple is found on the banks of such rivers only as have limpid waters and gravelly bed, and never in forests where the soil is black and miry. These situations, on the contrary, are so well adapted to the red maple that they are frequently occupied by it exclusively. Hence the last mentioned species is common in the lower parts of the Carolinas and of Georgia, for as soon as the rivers, in descending from the mountains toward the ocean, reach the low country they begin to be bordered by miry swamps covered with cypress, black gum, large tupelo, etc.*

The Michaux, father and son, were remarkably persistent private explorers in America.

Federal expeditions

The most famous expedition ever sponsored by the United States was the well-documented first one, of Lewis and Clark. Its success owed much to its planner, President Thomas Jefferson, who had purchased a vast Louisiana Territory from France in 1803. Jefferson had a strong interest in science (Bedini 1990). He had been discussing such an expedition since 1783 (Jackson 1962:654, 1981, Quinn 1986, Ambrose 1996:68–79), but he could only launch it after he became president in 1801. He appointed his personal secretary, Meriwether Lewis (1774–1809) to lead the Corps of Discovery to explore the northwestern part of the Louisiana Territory. Lewis' training and preparation in leadership began under Jefferson at the White House on New Year's Day, 1803, and continued into March. Lewis then began

Fig. 4.(Left) Meriwether Lewis, by Charles Willson Peale, 1807. (Right) William Clark, by Charles Willson Peale, 1810. Independence National Historical Park, Philadelphia.

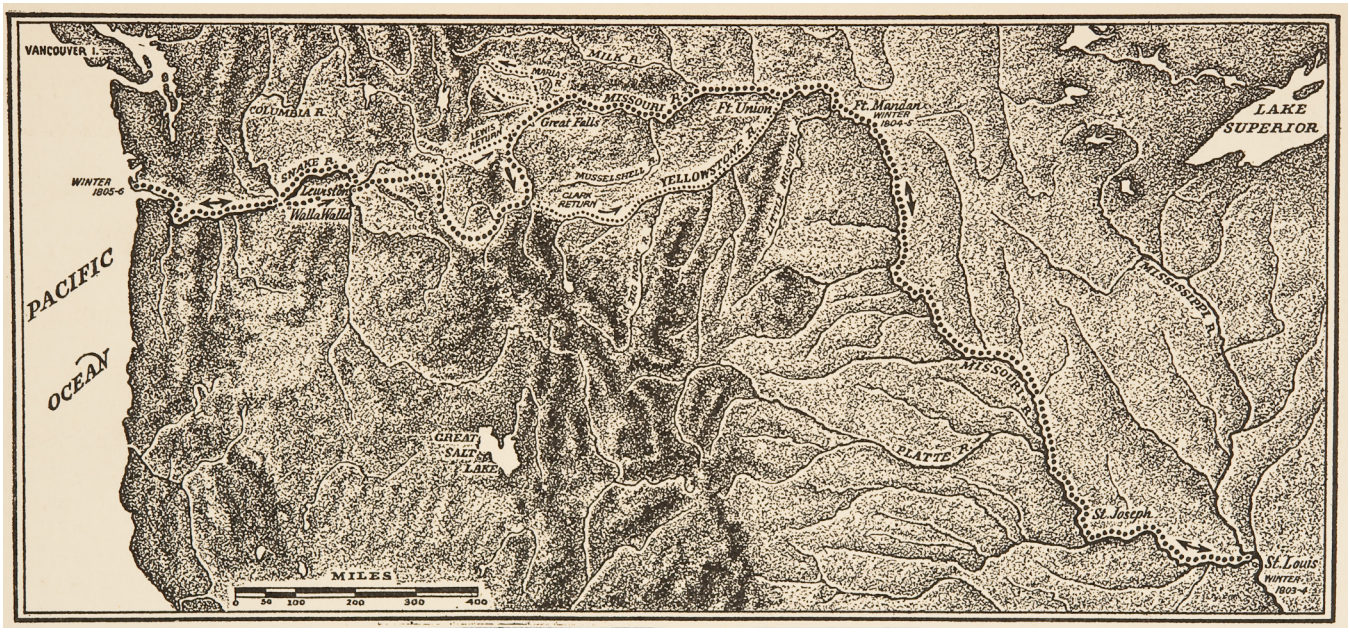

Fig. 5. Map of the Lewis and Clark Expedition's route from St. Louis to the Pacific and back.

to collect equipment and supplies. On 12 January 1803 Jefferson appointed James Madison minister to France to try to purchase New Orleans. The outcome on 2 May was purchase of all Louisiana Territory, but Jefferson had not waited that long to plan an exploring expedition. He sent a confidential message to Congress on 18 January seeking approval and funds for it, and by 27 February he was writing to several citizens for assistance (Jackson 1962:10–28). In early May Jefferson arranged for Lewis to go to Philadelphia for training as a naturalist by members of the American Philosophical Society (Ewan and Ewan 2007:541–543), and he also bought reference books there. In early June he shipped goods for the expedition from Philadelphia to Pittsburgh (Ambrose 1996:80–92, Sterling 1997*b*, Horsman 1999). On June 19 he wrote to invite his former superior in the Army, William Clark (1770–1838) to be co-leader of the expedition (Jackson 1962:57–60). The next day Jefferson wrote detailed instructions to Lewis, including the need to make reports on the geography, soils, plants, animals, and (Jackson 1962:63)

> *Climate, as characterized by the thermometer, by the proportion of rainy, cloudy, & clear days, by lightning, hail, snow, ice, by the access & recess of frost, by the winds prevailing at different seasons, the dates at which particular plants put forth or lose their flower, or leaf, times of appearance of particular birds, reptiles or insects.*

On July 5 Lewis left for Pittsburgh, where he had a special boat built and began to recruit men for the expedition. Clark received Lewis' letter on 18 July, and the next day wrote back his acceptance (Jackson 1962:110–111).

Clark also began recruiting men for the expedition. In early September, Lewis and his men sailed and rowed down the Ohio and on October 15 collected Clark along the way. They continued on to the Mississippi, and then traveled upriver to St. Louis.

They spent the winter of 1803–1804 across the river from the city. The two leaders worked well together, and Clark proved to be a skilled map maker (Allen 1975, Sterling 1997*a*, Steffen 1999, Foley 2004, Jones 2004). Spanish and French explorers had previously explored the Missouri (Nesatir 1952), but little, if any, of their findings were known to the Americans. In the spring they struggled up the Missouri and spent the winter of 1804–1805 beside the Mandan Indians (now in North Dakota). On 7 April 1805, Lewis and Clark sent their writings and collections of specimens made thus far downriver to St. Louis, New Orleans, and on to Washington. Included were four live magpies, a sharp-tailed grouse, and a live prairie dog; one magpie and the prairie dog survived the trip, and Jefferson sent them to Charles Willson Peale for his museum (Cutright 1969:375–376, Sellers 1980:186). Then the explorers crossed the Rocky and Cascade mountains and descended the Columbia River to the Pacific. They spent the winter of 1805–1806 at the mouth of the Columbia River at their Fort Clatsop. On 23 March 1806 they departed Clatsop and reached St. Louis on September 23 (Moulton 2003).

There is an impressive literature on the natural history of the Lewis and Clark Expedition (Johnsgaard 2003*b*, Tubbs and Jenkinson 2003). Raymond Burroughs' *The Natural History of the Lewis and Clark Expedition* (1961) is limited to their records on vertebrates. Excepting a lengthy introduction, the book is a collection of quotations from their journals arranged into chapters on the different groups of vertebrates, with brief editorial comments. Paul Cutright's *Lewis and Clark: Pioneering Naturalists* (1969, 2003) is very different. Its chapters follow the expedition from St. Louis to the Pacific and back. It is a history

that discusses plants as well as vertebrates, has some contemporary illustrations, and appendixes on the discoveries of plants, animals, locations, and maps. Paul Johnsgard's well-illustrated *Lewis and Clark on the Great Plains* (2003*a*) is more restricted geographically than the previous two and is correspondingly briefer, but it does cite literature that appeared after Cutright wrote. Daniel Botkin (1995) used the expedition's natural history observations as a basis for his own comments on American environmental history. David Dalton's *The Natural World of Lewis and Clark* (2008) describes the natural environment they encountered and tells how it has changed since then. The bicentennial volume edited by Kris Fresonne and Mark Spence, *Lewis and Clark: Legacies, Memories, and New Perspectives* (2004) provides an historical perspective on the expedition, though none of the essays focus specifically on natural history. The National Geographic Society has published two books on the expedition, a very nice one by Snyder (1970) and a more spectacular one by Ambrose and Abell (1998).

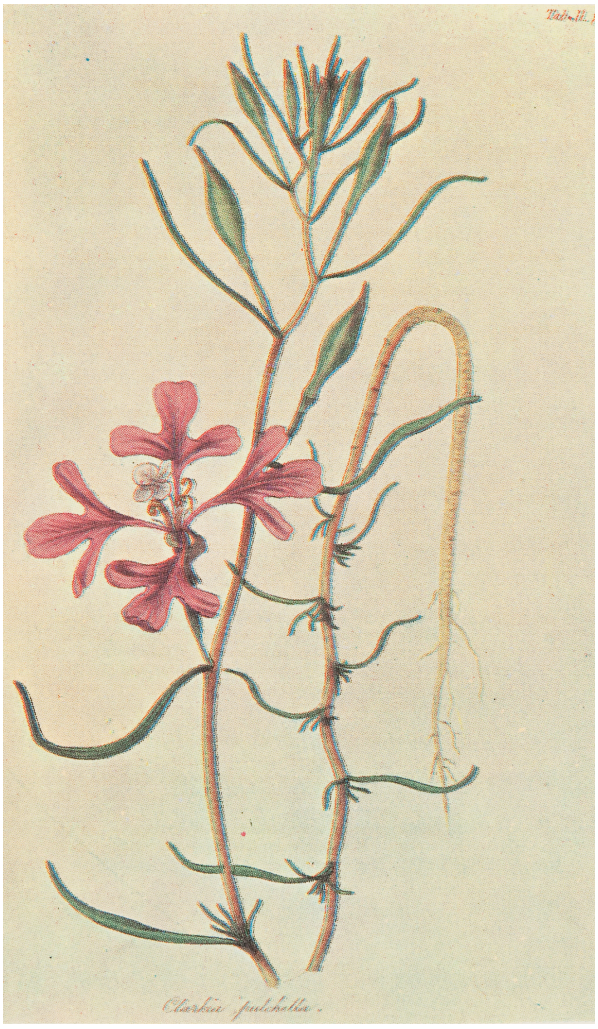

Fig. 6. Ragged robin *Clarkia pulchella* Pursh. Pursh 1814:I, plate 11, facing 261.

The history of the plants that Lewis and Clark collected is interesting but complex. Two collections of Lewis and Clark's plant specimens were lost to floods, but there are now 226 specimens in the Lewis and Clark Herbarium at the Academy of Natural Science in Philadelphia, and a good place to begin their study is the *Herbarium of the Lewis and Clark Expedition* (Moulton 1986–2001:XII). The list of species in Cutright's appendix (1969:399–423) is restricted to 178 plants previously unknown to science. After the expedition, Lewis arranged for Frederick Pursh (1774–1820) to describe their plant specimens (Jackson 1962:462–463, 485, Cutright 1969:359–356, Ewan and Ewan 2007:544). Pursh was employed by University of Pennsylvania Botany Professor Benjamin Smith Barton (1766–1815) to collect plants for an American flora that Barton never wrote (Ewan and Ewan 2007). According to Cutright on page 263, Pursh "described 124 plants collected by Lewis and Clark," but on page 423 Cutright states that Pursh described 77 of the 178 new plants. Pursh (born Friedrich Traugott Pursch) was a capable German botanist who had come to America from England and returned to England to publish his *Flora Americanae septentrionalis* in 1814 (Ewan 1952, 1975*a*, 1979, Thomas 1997*b*, Ewan and Ewan 2007:501–520). To honor the explorers, Pursh named ragged robin *Clarkia pulchella* (collected on Clearwater River, Idaho 1 June 1806) and named bitterroot *Lewisia reviviva* (collected on Bitterroot River, Montana 1 July 1806). Pursh's *Flora* had only 24 species illustrated, 13 of which

Fig. 7. Bitterroot *Lewisia revivia* Pursh. Pursh gave its specific name, because an apparently dead root was planted in Philadelphia and produced a live plant. (See Curtis' *Botanical Magazine*, series 3, volume 19, 1863.)

Fig. 8. First illustration of a pronghorn (*Antilocarpa americana* Ord). Charles Willson Peale mounted it for his museum and Alexander Lawson drew it. Academy of Natural Sciences of Philadelphia.

were from Lewis and Clark, including *Clarkia* (Fig. 6), but an illustration of *Lewisia* was not published until 1863 (Fig. 7). Pursh also named three new species after Lewis: wild flax (*Linum lewisii*), monkey flower (*Mimulus lewisii*), and syringe (*Philadelphus lewisii*). There are several books to help one sort through the botanical tangles. A good place to start is with *Herbarium of the Lewis and Clark Expedition*, volume 12 (1999) of *The Journals of the Lewis & Clark Expedition* (Moulton 1986–2001), which has an annotated list and photographs of 177 specimens. It also has a list of 176 species from Lewis' herbarium published by Pursh (1814) and photographs of Pursh's drawings of Lewis' plants, both published and unpublished. Johnsgaard's book commemorated the centennial of the expedition, as did three excellent books on the plants of the expedition that also appeared in 2003. Both Wayne Phillips' *Plants of the Lewis and Clark Expedition* and Scott Earle and James Reveal's *Lewis and Clark's Green World* are well illustrated with color photographs. Susan H. Mungar's *Common to This Country: Botanical Discoveries of Lewis and Clark* only discusses 25 species, but she does so in detail, and all are well illustrated in color by Charlotte S. Thomas. These books are indebted to Susan McKelvey's *Botanical Exploration of the Trans-Mississippi West, 1790–1850* (1955:67–85), which still retains its usefulness. Two histories of

botanical exploration discuss Lewis and Clark (McKelvey 1955:67–85, Coats 1969:293–295).

Clark discovered the pronghorn on 6 September 1804, above the mouth of the Niobrara River, and on 14 September he killed a male near the mouth of the White River (now in South Dakota). He and Lewis later recorded numerous observations, as they frequently observed them on both sides of the Rocky Mountains (Burroughs 1961:140–146). Pronghorns were alternately shy and curious of humans. The explorers observed wolves run down one by taking turns in the chase until it tired. Pronghorns were most vulnerable when they attempted to swim across a river. Lewis and Clark sent skins and skeletons of a male and a female to Philadelphia, where George Ord (1781–1866) named and described it in 1815 and 1818.

Lewis and Clark devoted three and a half pages to prairie dogs, *Cynomys ludovicianus* (Ord), with good descriptions by both. I quote Clark's account because he wrote almost two years earlier (7 September 1804), and it is only a third the length of Lewis' (Burroughs 1961:103).

> *...discovered a Village of Small animals that burrow in the grown (those animals are called by the French, Petite Chien) Killed one and Caught one alive by putting a great quantity of Water in his hole. we attempted to dig to the beds of one of those animals, after diging 6 feet found by running a pole down that we were not half way to his Lodge, we found two frogs in the hole, and Killed a Dark rattle Snake near with a Ground rat (or prarie dog) in him, (those rats are numerous) the Village of those Covered about 4 acres of Ground on a gradual decent of a hill and Contains great numbers of holes on the top of which those little animals Set erect, making a Whistling noise and when alarmed Step into their hole. we por'd into one of the holes 5 barrels of Water without filling it. Those Animals are about the Size of a Small Squirel Shorter (or longer) and thicker; the head much resembling a Squirel in every respect, except the ears which is Shorter, his tail like a ground squirrel which they shake & whistle when alarm'd. the toe nails long, they have fine fur and the longer hairs is gray, it is Said that a kind of Lizard also a Snake reside with those animals (did not find this correct.)*

Lewis first saw the woodpecker later named for him on 20 July 1805 in Montana, and he described its appearance in detail on 27 May 1806 and observed it eating worms and a variety of insects (Burroughs 1961:239–241, Moulton 2003:319–320). The next day he also described in detail the bird later named Clark's Nutcracker and noted that it "feeds on the seed of pine and also on insects" (Burroughs 1961:251–252). On 6 June 1806 he also gave a detailed description of the Western Tanager, but did not observe what it ate (Burroughs 1961:256–257). Lewis later gave the remains of these three birds to Alexander Wilson to describe and illustrate (Fig. 9), and a grateful Wilson named two of them after Lewis and Clark (Mearns and Mearns 1992:143–146, 281–285). Afterwards, Wilson deposited them in Peale's Museum in Philadelphia (Cantwell 1961:141–142), where Lewis also deposited items he had collected (Sellers 1980:187–188). Both Lewis and Clark described the Sage Grouse in detail and saw it eat both grasshoppers and seeds (Burroughs 1961:213–215); Clark also drew it (reproduced in Thwaites 1904–1905, IV, facing 126, Cutright 1969:132).

Two of the fish they caught are illustrated in Lewis and Clark's journals. The sketch of the eulachon (Fig. 10) appears in both journals (Thwaites 1904–05, IV:Frontispiece), but since it is in Lewis' journal a day before it is in Clark's, it may be originally by Lewis. It shows the head pointing to the upper right

Fig. 9. First illustration of Louisiana (= western) Tanager (*Piranga ludoviciana* [Wilson]), Clark's crow (= Nutcracker *Nucifraga columbiana* [Wilson]), and Lewis' Woodpecker (*Melanerpes lewis* [Wilson]). Wilson 1808–14: III, plate 20. Wilson's sketch for this plate was completed by his engraver, Alexander Lawson.

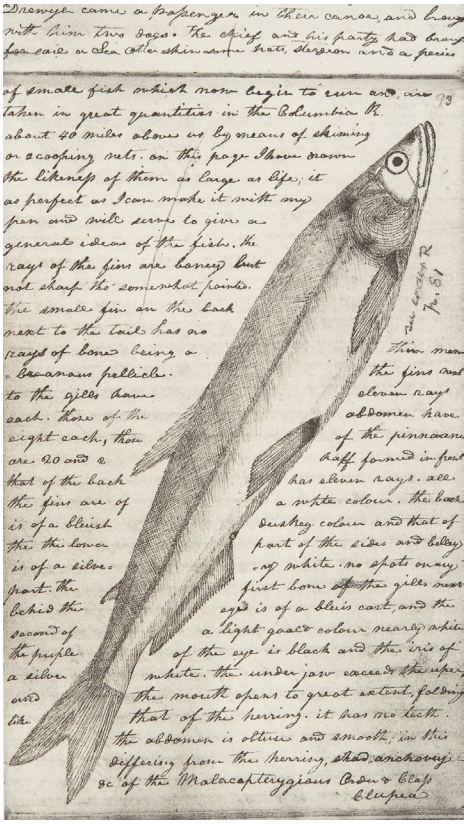

Fig. 10. Eulachon *Thaleicthys pacificus* (Richardson). Page from Lewis' journal for 24 February 1806. The same illustration from Clark's journal for 25 February 1806 is reproduced in Cutright 1969: following 240.

corner of the page. Clark's illustration of the salmon trout (= steelhead trout *Salmo gairdneri* [Richardson]) is similar, but the head points to the top left corner of the page (reproduced in Thwaites 1904–1905, IV, facing 176, Andrist 1967:110). Their detailed accounts of these species includes descriptions, but otherwise concern Indian methods of catching them and their taste when cooked (Burroughs 1961:266–271, 263–264).

Cutright's appendix on vertebrates (1969:424–447) is also limited to those previously unknown to science; it includes 17 mammals, 37 birds, 15 reptiles and amphibians, and 12 fish. Burroughs compiled Lewis and Clark's journal accounts on animals (Burroughs 1961); the lengths of these accounts are not in proportion to the number of new species discovered; there are 124 pages on mammals, 82 on birds, 9 on reptiles and amphibians, and 11 on fish.

Jefferson rewarded the leaders of this successful expedition by making Lewis governor of Louisiana and Clark head of Indian affairs for Louisiana Territory in St. Louis. The consequence of their assuming

these responsibilities was to delay publication of their journals; after Lewis' suicide Clark entrusted publication to a capable Philadelphia lawyer, Nicholas Biddle (Ambrose 1996:469–470, Jones 2004:185–200), who edited a two-volume abridgement of Lewis and Clark's journals (1814). Reuben Thwaites edited the first critical edition of the journals in 1904–1905, and Gary Moulton has edited a modern critical edition (1986–2001), including the *Herbarium* volume mentioned above.

Other early expeditions

Jefferson also sponsored an expedition to explore the southern boundary of the Louisiana Purchase. In August or September 1805 he asked veteran government surveyor Thomas Freeman (d. 1821) to lead an expedition up the Red River (Flores 1984*a*:49, 2001:29–49, 2002, Stout 1999). In November Freeman went to Washington to discuss the expedition with Jefferson and to buy equipment. Then he went to Philadelphia to be tutored by the same scholars who had tutored Lewis in 1803, and to buy scientific equipment. Jefferson's letter of instructions for Freeman was similar to the one for Lewis (Flores 1984*a*:320–325). Jefferson then invited William Bartram to be the naturalist for this expedition. He declined because of his age, but on 6 February 1806 sent Jefferson a letter from Alexander Wilson volunteering for the position (Hunter 1983:249–251, Flores 1984*a*:57–58). However, Freeman had already chosen the naturalist in the first week of January 1806. Professor Barton had recommended to Freeman one of his medical students, Peter Custis (1781–1842), and both Custis and Freeman agreed (on Custis: Jackson 1981:228, 239, Flores 1997). Jefferson chose Captain Richard Sparks to lead the expedition's soldiers.

In 1804 Jefferson had informed Spanish Boundary Commissioner, Caso Calvo, of the planned scientific expedition and had asked for a passport, which Calvo had granted. However, General James Wilkinson, a secret Spanish agent, advised the Spanish government in Mexico that the expedition would seek a route to Santa Fe and should be stopped, since Spain opposed Americans trading there (Flores 1984*a*:82–83). On 5 February 1806, U.S. Army Captain Edward D. Turner, with 150 soldiers, forced a Spanish garrison at Los Ades to withdraw to the Sabine River because Turner judged they were within Louisiana Territory (Flores 1984:86). The Red River Expedition left Fort Adams on the Mississippi on 19 April 06 and reached the Red River by 3 May, and Natchitoches on 19 May (Flores 1984*a*:101–103), where they learned that Spanish troops knew of their expedition and might stop them.

Both Freeman and Custis kept daily journals. Custis also was given the responsibility of keeping daily meteorological records, and he was often pressed into surveying for a map (Flores 1984*a*:213). According to Freeman's estimate, considered accurate, they ascended the Red River for 615 miles, about half its length (map: Jackson 1981:232), before being confronted by a large Spanish army and forced to retreat downriver on 30 July. They were back in Natichitoches within a week (Flores 1984:206, 281). Custis seldom had as much time to observe and collect specimens as he wanted, but he did identify 22 mammals, 36 birds, 17 reptiles, fish, and amphibians, 4 insects, 58 trees, and 130 herbaceous plants (Flores 1984*a*:213). He discovered and named 22 species of plants and animals new to science, though he did not adequately publish his names and descriptions and received no recognition for them (Flores 1984*b*:41–42). His lists of plants observed on the expedition were annotated by C. V. Morton (1967), and Flores (1984*a*) incorporated Morton's information in his edition of Custis' journal.

Although a number of Custis's observations are ecologically interesting, the most significant ecological observation was by Freeman, who first published an explanation for the existence of prairies (Flores 1984*a*:208–210).

> *The extensive prairies which are found in this rich and level country, appear to be owing to the custom which these nations of* [native] *hunters have, of burning the grass at certain seasons. It destroys the bushes and underwood, and in some instances the timber, preventing the future growth where once the timber is destroyed. The small spots of wood with which these prairies are interspersed, are found in the poorest spots, and on the margin of the water courses, where the undergrowth is less luxuriant, or the water stops the progress of the flames. It is observed, that where these prairies are enclosed, or otherwise protected from fire, they soon become covered with bushes and timber trees, a circumstance which proves, that neither the nature of the soil, nor any other natural cause, gives rise to these extensive and rich pastures, with which Western America abounds.*

Custis wrote a letter to Barton summarizing his observations from 19 April to 1 June, which was an adequate start, and Barton published it as an article in a journal he edited (Custis 1806). Custis himself never published his journal entries beyond 1 June after he returned. Afterwards Custis gave Barton the 26 plant specimens that he brought back to Philadelphia, and Barton may have made them available to Pursh for his *Flora* (Flores 1984:300). Both the Freeman and Custis journals and data were given to Jefferson, who perused them and then entrusted them to Nicholas King, a Washington surveyor, mapmaker, and architect, who produced a single narrative version, with some omissions, but including Custis' lists of trees and shrubs, herbaceous plants, and animals, along with King's very accurate map based on Freeman's data, that was published in 1807, mainly for Congress (reprinted 1985). A 20-page summary of expedition findings is in the 1823 report of a later expedition (James 1904, XVII:61–80). Unfortunately, the Red River Expedition and its report were overshadowed by the more extensive and successful Lewis and Clark Expedition and by the Burr Conspiracy, in which the expedition leaders were suspected (wrongly) of having participated (Flores 1984:51).

Zebulon Montgomery Pike (1779–1813) was the son of an army officer and became one himself (Hollon 1949, Sterling 1997*d*, Nelson 1999*a*). He led two U.S. Army exploring expeditions at about the same time as the Lewis and Clark and the Freeman and Custis expeditions, but his were sponsored by the traitorous General James Wilkinson (Jackson 1965, 1981:242–246, Nelson 1999*b*), who became governor of Louisiana in the spring of 1805, and, by then was already a Spanish agent who had initiated the Burr Conspiracy. Wilkinson requested that Pike provide information on geography, furs, minerals, and Indian populations. Pike was not a trained naturalist but included some natural history observations in his journals, which he published in 1810.

His first expedition was to the headwaters of the Mississippi River, that left St. Louis on 9 August 1805. On 10 October they passed a cluster of more than 20 islands within a four-mile stretch, which he called Beaver Islands because of numerous beaver dams on them (now, Thousand Islands). He stated that he "would here attempt a description of this wonderful animal, and its admirable system of architecture, were not the subject already exhausted by the numerous travelers who have written on the subject" (Pike 1895, I:100, 1966, I:45–46). In contrast, Lewis and Clark took 8 pages of notes on beaver (Burroughs

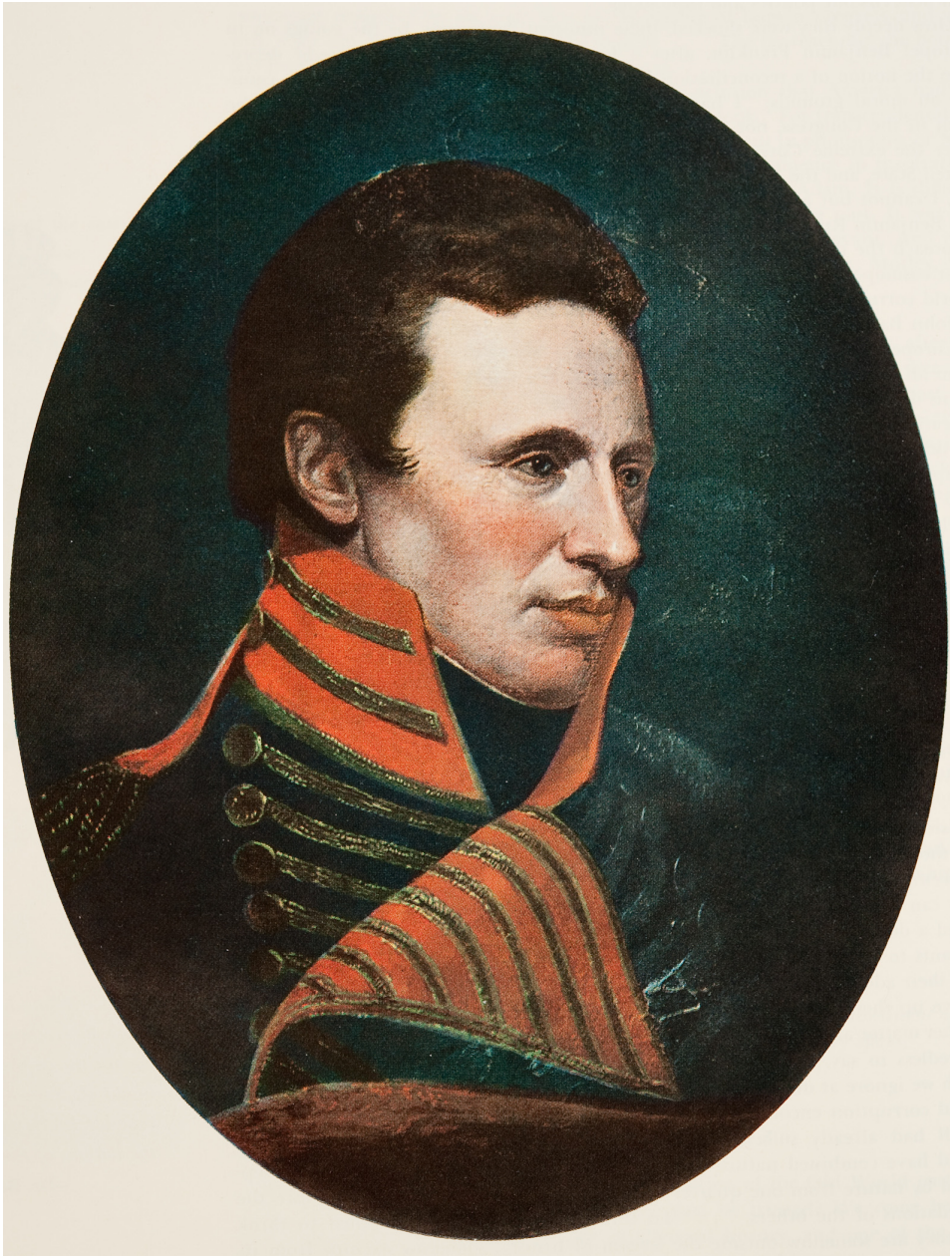

Fig. 11. Zebulon Montgomery Pike, soon after his second expedition, by Charles Willson Peale. Independence National Historical Park, Philadelphia.

1961:108–115). Pike and his men were very interested in the deer, elk, and buffalo they encountered, primarily as meat for the expedition, and secondarily to report on them as resources of the area. On 13 January 1806 Pike determined the latitude of Lake de Sable as 46°9′ N [modern = 46°46′ N]. They reached Leech Lake, a source of the Mississippi, on 1 February 1806, and they returned to St. Louis on 30 April 1806. Pike carried a Réaumur thermometer and a barometer, and his published journal includes a full weather report, including latitude, for every day from 6 August 1805 to 29 April 1806, though the

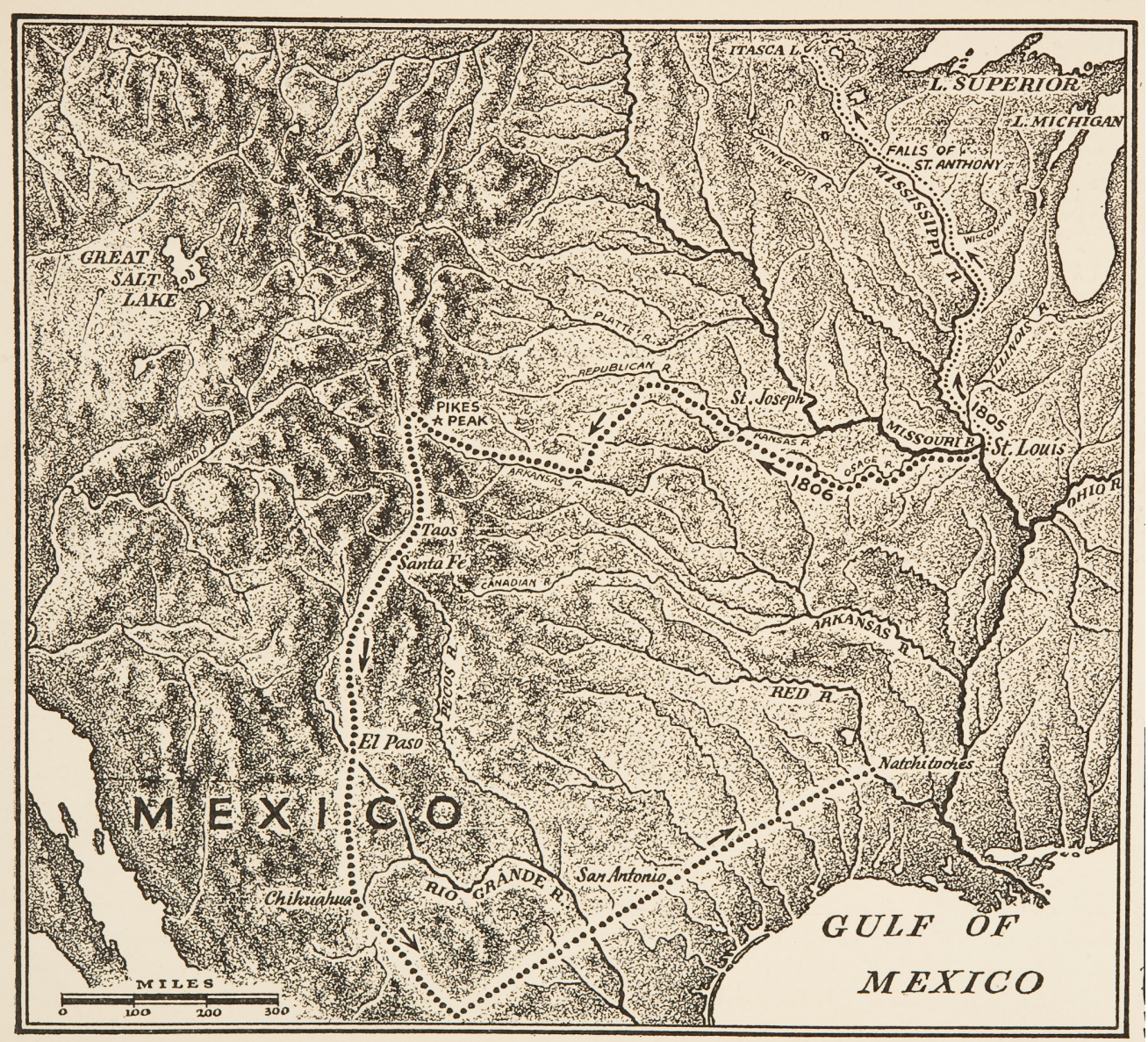

Fig. 12. Pike's two expeditions. His first, up the Mississippi, reached Leech Lake, not Itasca Lake (both are sources of the Mississippi), as this map indicates.

barometric data ends on 13 November (1895, I:216–220). His journal and field maps went to President Jefferson, who entrusted them to Nicholas King to produce a publishable version for Congress (Jackson 1981:246–248).

After Pike rested for a few months, General Wilkinson had a much more ambitious expedition for him to lead. It would be the first American expedition across the prairie to the Rocky Mountains. They left St. Louis on 15 July, and like Lewis and Clark, ascended the Missouri River, but only until they

reached the Osage River, which they followed due west. On 29 July, they killed 5 deer, 1 turkey, and a raccoon, for meat. On 5 August they saw a large rattlesnake, which did not attempt to bite, so they left it alone. On 7 August they passed many beautiful cliffs on both sides of the river and saw both a bear and a wolf swimming in the river. On 24 August Pike spent a half day adjusting the line of collimation in the telescopic sights of his theodolite. On 9 October they watched 50 to 60 young Pawnees on horseback hunt elk with bows and arrows. On October 24 he recorded two pages of observations on the prairie dogs, which he accurately called prairie-squirrels, and he also gave the Indian name for them, wishtonwishes, which was based on the sound of their call. They reside, he states (1895, II:430, 1966, I:338)

> *...on the prairies of Louisiana in towns or villages, having an evident police established in their communities. The sites of their towns are generally on the brow of a hill, near some creek or pond, in order to be convenient to water, and that the high ground which they inhabit may not be subject to inundation. Their residence, being under ground, is burrowed out, and the earth, which answers the double purpose of keeping out the water and affording an elevated place in wet seasons to repose on, and to give them a further and more distinct view of the country. Their holes descend in a spiral form; therefore I could never ascertain their depth; but I once had 140 kettles of water poured into one of them in order to drive out the occupant, without effect. In the circuit of the villages they clear off all the grass, and leave the earth bare of vegetation; but whether it is from an instinct they possess inducing them to keep the ground thus cleared, or whether they make use of the herbage as food, I cannot pretend to determine. The latter opinion I think entitled to a preference, as their teeth designate them to be of the graminivorous species, and I know of no other substance which is produced in the vicinity of their positions on which they could subsist; and they never extend their excursions more than half a mile from the burrows.*

After describing their anatomy and noting that their largest villages extend two or three miles square, he warned (1895, II:431, 1966, I:339)

> *It is extremely dangerous to pass through their towns, as they abound with rattlesnakes, both of the yellow and black species; and strange as it may appear, I have seen the wishtonwish, the rattlesnake, the horned frog, with which the prairie abounds…and a land-tortoise, all take refuge in the same hole. I do not pretend to assert that it was their common place of resort; but I have witnessed the above facts more than in one instance.*

Pike published some natural history observations that are comparable to those of Lewis and Clark, but that was not part of his mandate, as it had been of theirs, and so his are less frequent, and he did not collect plant and animal specimens for science. Except that he did bring back two grizzly bear cubs which he presented to President Jefferson. Jefferson gave them to Peale for his Museum. They were kept on display in a cage until one escaped, and then both were killed and mounted in an exhibit (Sellers 1980:206–209).

On November 15 Pike first saw—from the southeast plains, 100 miles away—the peak that was later named for him (Pike 1966, I:345–346). At the latitude of their route, it is the first seen Rocky Mountain. On the 23rd, he thought they were near its base and prepared to climb it. He measured its elevation, erroneously as 18,581 feet, whereas it is only 14,110 (Pike 1966:353–354). They left the next day for the

Fig. 13. Grizzly bear cubs from Pike's second expedition. Illustration by Titian Ramsay Peale II at his father's museum after the cubs were mounted in an exhibit. Lithograph from *Cabinet of Natural History and American Rural Sports* (1830).

climb, but only got closer to its true base, which they reached on the 25th. They began the ascent on the 26th and expected to reach the top and return the same day. They spent the night in a cave, without food, water, or blankets. On the 27th the temperature before they began to climb was 9° above 0, and when they reached the summit, it was 4° below 0. However, they were not at the top of Pike's Peak after all, but on a neighboring lower mountain. It appeared to be 15 or 16 miles away, was covered with snow, and Pike believed that "no human being could have ascended to its pinical" (1895, II:458, 1966:I, 351).

They suffered through a long, grueling search for a way through the mountains in winter, passing by Royal Gorge. They found a pass that led through the Sangre de Cristo Mountains into the San Luis Valley of the Rio Grande, which Pike believed was the Red River. They crossed an arid region that is now the Great Sand Dunes National Park, and soon afterwards they were arrested by Spanish soldiers and taken first to Santa Fe and later to Chihuahua, before being finally released at Natchitoches on the border of the Louisiana Territory on 1 July 1807. Pike expected that he and his men would be greeted as heroes the way Lewis, Clark, and their men had been, but instead he was met with the suspicion that he had been involved in the Burr-Wilkinson conspiracy. He vigorously denied it and published (1810) an account of his three trips to the northern Mississippi, Louisiana Territory, and New Spain (Mexico).

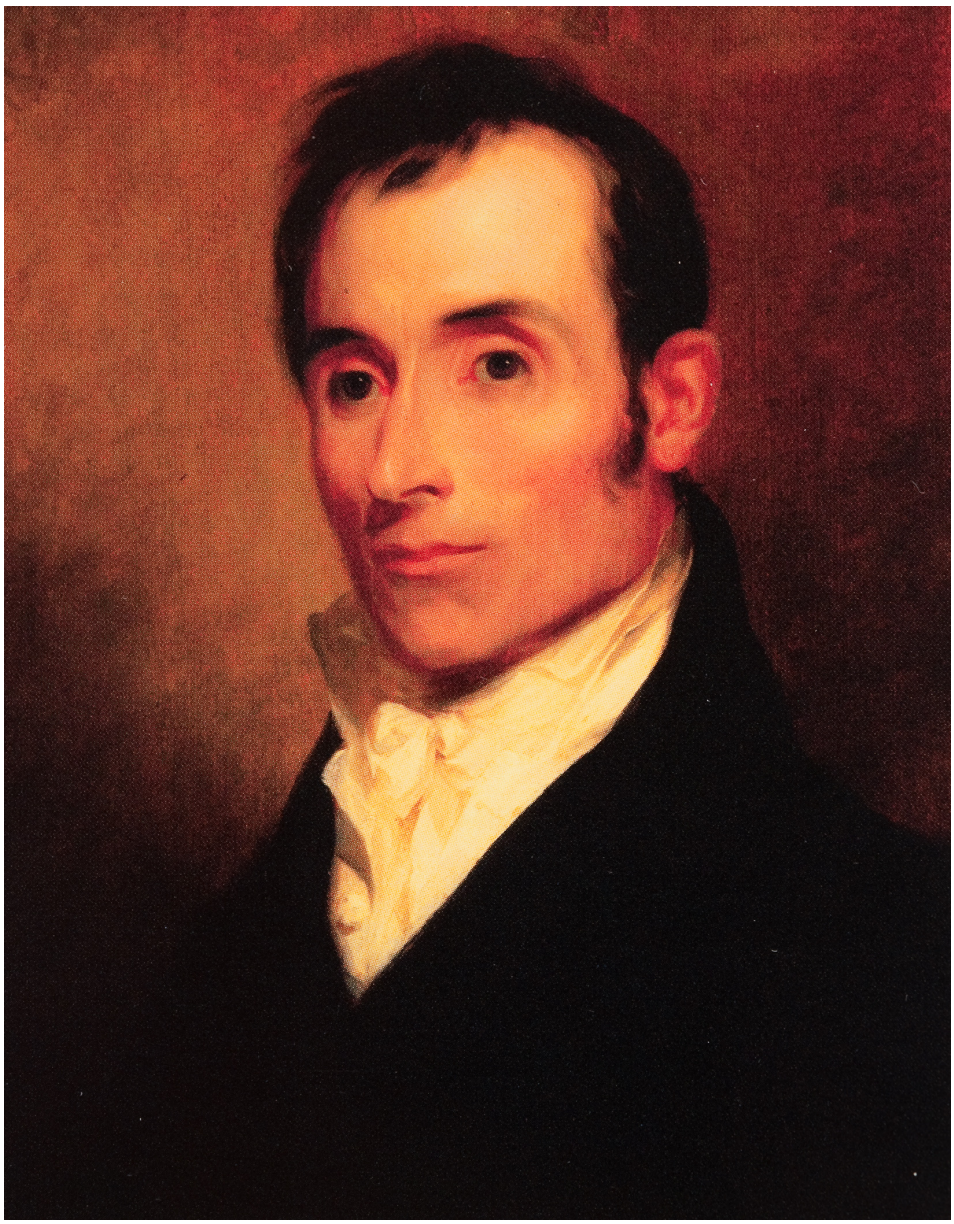

Fig. 14. Alexander Wilson, by Rembrandt Peale. American Philosophical Society.

Pike's only guide in his western exploration had been Humboldt's map, lent during his visit to Washington in 1804 to Secretary of State Albert Gallatin. The note on this map by Pike's editor, Donald Jackson (Pike 1966, II:370), seems to indicate that Humboldt did not authorize the copy of it that Gallatin had made. Humboldt was offended that Pike published it in 1810 without acknowledgment, with the maps that Pike himself had drawn, and Humboldt only published it in 1811. When Humboldt discovered it in Pike's book, he wrote a letter of complaint to Jefferson, who replied on 6 December 1813 (Pike 1966, II:388)

> *I am sorry he omitted even to acknowledge the source of his information. It has been an oversight, and not at all in the spirit of his generous nature. Let me solicit your forgiveness then of a declared hero, of an honest and zealous patriot, who lived and died for his country* [in the War of 1812].

Editor Jackson asks why Pike would have allowed Humboldt's map to be published with Humboldt's erroneous location of the Red River when Pike was the one who discovered the error? That situation led Jackson to speculate (Pike 1966, I:460)

> *Is it not possible that he turned his own data over to* [Antoine] *Nau and left to others the task of researching the areas he did not personally traverse? It may well be that the responsibility for plagiarizing the Humboldt map lies with Nau, with publisher John Conrad and others, and not with Pike—who was absent during the final preparation and publication of his book.*

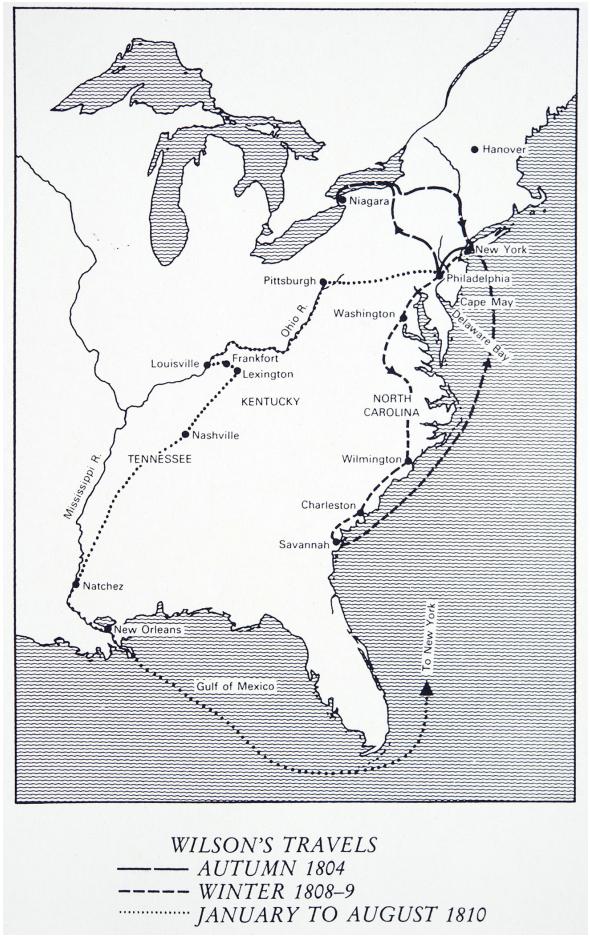

Fig. 15. Alexander Wilson's travels to find birds and sell books. Mearns and Mearns 1992:487.

Pike's book was widely read for information on the West, and his message was that, except for a few river valleys, most of the western lands he had explored were too arid for Americans and should be left to the Indians (1895, II:520–525, 1966, II:25–28). This was an early source of the idea of the "great American desert" that exerted an inhibition on western expansion during the early-to-mid 1800s (Hollon 1966:63–64).

Individual explorations

The advent of U.S. government expeditions did not mean the end of private exploration in America. Alexander Wilson (1766–1813) was a Scottish immigrant who settled near the Bartram farm outside Philadelphia and became friends with William Bartram, who encouraged him to study and draw American birds (Cantwell 1961:120, Hunter 1983:71–73, Egerton 1963, 2004, 2007:265, Slatkin 1999). In Scotland Wilson had been inspired by Robert Burns to write poetry, and he had worked for a while as a peddler and had offered customers his poems along with household goods. In America, he taught school, but Bartram's *Travels* may have inspired him to undertake a 1200-mile round trip to Niagara Falls with a nephew in 1804 (Fishman 2000:118–121).

Fig. 16. John Abbot about 1804. By George Willis, but based on Abbot's self-portrait. Allen 1951:543.

Afterwards he wrote an epic poem, *The Foresters*, that was well received but did not make him America's Virgil (Wilson 1930:153–161, Hamilton 1970:40–54, Rothman 1973). His poem described birds he observed and collected, and he developed the ambition to write a treatise on American birds. His Scottish experience of peddling goods and poetry influenced his strategy for collecting information on American birds while selling subscriptions for his *American Ornithology* (9 volumes, 1808–1814). After publishing the first volume in September 1808, he traveled through New England, lining up subscriptions for his volumes and collecting birds and information on them. He returned to Philadelphia in mid-November. From December until March 1809 he traveled south along or near the coast to St. Augustine, with stops along the way to watch and collect birds and sell books (Stringham and Egerton 1960, Simpson and McAllister 1986, Fishman 2000:123–130).

From late January 1810 until 2 August, he took his longest trip, traveling west to Pittsburgh and then going down the Ohio River, Natchez Trace, and Mississippi River to New Orleans and Florida before sailing back to New York (Fishman 2000:130–133). He also made several later trips of shorter distances (Fig. 15 and Hunter 1983: maps after 212, 356).

On his travels Wilson met two apparently provincial naturalists, though one was from England and the other from France. About the beginning of March 1809 in Savannah, Georgia, he met John Abbot (1751–1840; Fig. 16), who was primarily interested in selling both insects and his drawings of them (Egerton 2009: Fig. 6), but who also sold both his bird specimens and some 1400 illustrations of birds, often with annotations (Stresemann 1953, Allen 1957, Simpson 1984, 1993, Largen and Rogers-Price 1985, 1997, 1999, Evans 1993:18–21, Gilbert 1998, Fishman 2000:93–110). Abbot took Wilson on field trips, showed him his illustrations, and later became a valuable correspondent whose assistance Wilson acknowledged in *American Ornithology* (Cantwell 1961:183–185, Hunter 1983:86–88). The other naturalist was John James Audubon (1785–1851), whom Wilson met in Audubon's store in Louisville on 19 March 1810. Wilson wrote vaguely about their meeting and a field trip (Ord 1828:clxvi–clxvii, Herrick 1917, I:202–232, Welker 1955:48–58, Cantwell 1961:200–201, Hunter 1983:92–97), but no correspondence developed between Wilson and Audubon comparable to Wilson's with Abbot. After Wilson's death, Audubon published his version of their meeting in response to George Ord's remarks about the meeting in his biography of Wilson; that aspect of the story will be discussed in Part 38 of this history.

Fig. 17. Mississippi Kite (*Ictinia mississippiensis* [Wilson]), Tennessee Warbler (*Vermivora perigrina* [Wilson]), Kentucky Warbler (*Vermivora peregrina* [Wilson]), Prairie Warbler (*Dendroica discolor* [Vieillot]). Wilson 1808–1814:III, plate 25, engraved by Alexander Lawson.

Wilson's accounts of species include information on where he observed and collected them, and his accounts appear in the volume that appeared after the trip during which he had encountered them. For example, Plate 25 (Fig. 17) in volume III illustrates four species he described from his trip from Pittsburgh to New Orleans—all new to science, he thought (one, the Prairie Warbler, was not). He first encountered the Mississippi Kite a few miles south of Natchez (Bolen and Flores 1993:21–24).

He slightly wounded it and was able to draw it while still alive, though he later dissected it to learn what it ate. It and two others he also dissected contained beetles, locusts, and grasshoppers, though he suspected that this species could also eat mice, lizards, snakes, and small birds (it does, occasionally:

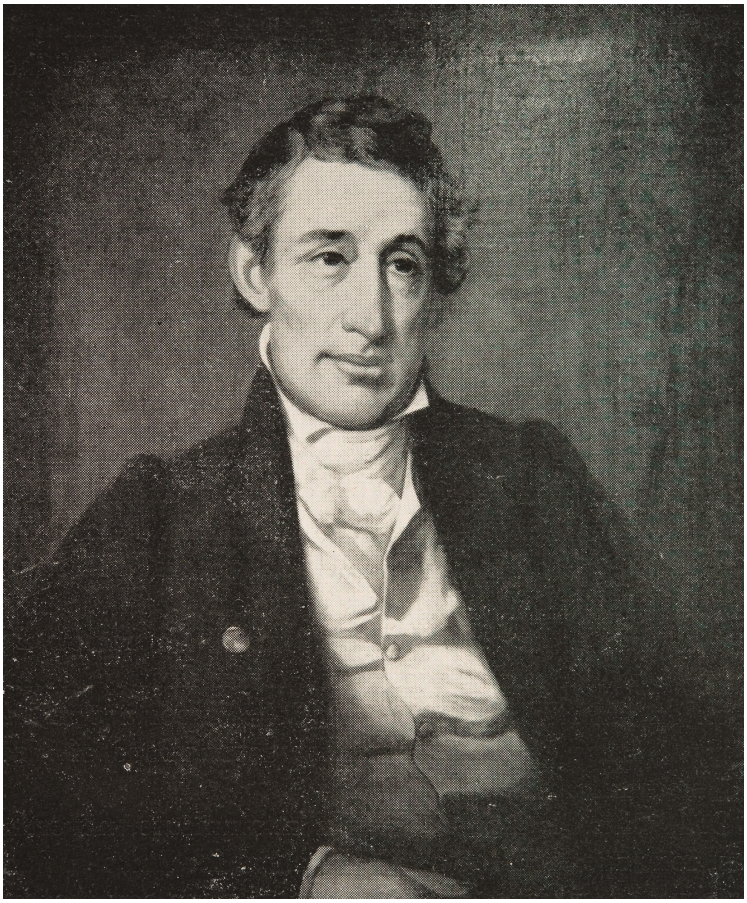

Fig. 18. George Ord. By T. Henry Smith after John Nagle. American Philosophical Society.

Bolen and Flores 1993:61–66). He discovered the Tennessee Warbler on the banks of the Cumberland River, hunting worms (caterpillars). Its name is misleading, since it only stops over in Tennessee between its breeding grounds in Canada and its wintering grounds in South America. He found the Kentucky Warbler common in that state and south to the mouth of the Mississippi in damp woods or cane swamps, and it built its nest "in the middle of a thick tuft of rank grass, sometimes in the fork of a low bush, and sometimes on the ground" (1808–1814, III:85) Females laid 4–6 eggs by early May. His Prairie Warbler is also misnamed, since it lives in bushes, but he first saw it in the Kentucky Barrens, though he acknowledged that he "shot several afterwards in the open woods of the Choctaw nation, where they were more numerous." It was unusual in its lack of alarm at him approaching near to it, and it ate caterpillars and winged insects. Its nest is (Wilson 1808–14:III, 87)

> *pensile, and generally hung on the fork of a low bush or thicket; it is formed outwardly of green moss, intermixed with rotten bits of wood and caterpillar's silk; the inside is lined with extremely fine fibres of grape-vine bark; and the whole would scarcely weigh a quarter of an ounce. The eggs are white, with a few brown spots at the great end. These birds are migratory, departing for the south in October.*

Wilson's thoughts sometimes went beyond accounts of the natural history of each species.

For example, in 1811 he estimated the numbers of birds migrating into Pennsylvania in the spring and the number nesting in an eight-acre area (Wilson 1808–14, IV:v–x, Burns 1907). Unfortunately, he did not live to finish his great work, *American Ornithology*; volume 8 was finished by his friend and colleague, George Ord (1781–1866), who also wrote volume 9 from Wilson's notes and from his own researches (Burns 1909*a*, 1917, Allen 1951:565–566, Barbuto 1997, Peck 1999).

Even so, Wilson's achievement, including 320 bird illustrations on 76 plates of 264 species, has won him recognition as the "father of American ornithology" (Burns 1909*b*, Peattie 1936:218–233, Allen 1951:552–569, Welker 1955:18–52, Stringham 1958, Savage 1970:237–284, Stresemann 1975:154–156, Elman 1977:48–79, Hanley 1977:47–64, Kastner 1977:159–194, Porter 1986:41–49, Gibbons and Strom 1988:40–57, Blum 1993:26–46, Peck 1999, Walters 2003:98–100). In recognition of his achievements, The Wilson Ornithological Society was founded in 1888 and still flourishes. There were eight birds named for Wilson, more than for any other American naturalist (six names are still in use: Mearns and Mearns 1988:419–429, 1992:484–493).

Unknown to Wilson, the Prairie Warbler had already been described by the French ornithologist Louis Jean Pierre Vieillot (1748–1831), who immigrated to Santo Domingo (Haiti). After its slave revolt in 1792, he fled to the United States, where he remained until 23 August 1798, when he sailed back to France (his wife and three daughters died on the voyage). He seems to have had little, if any contact with American naturalists, and his *Histoire naturelle des oiseaux de l'Amerique septentrionale* (1807–1808) was apparently unknown to Wilson and other American naturalists while Wilson lived (Allen 1951:549–555, Stresemann 1975:122–124, Farber 1982:83–84, Mearns and Mearns 1998:133–134, Walters 2003:90–91). It included scientific descriptions of 26 genera and 32 species that are now accepted (listed in Oehser 1948). His capable work was undervalued in France, but Charles Lucien Bonaparte, who continued Wilson's work after Wilson died, considered Vieillot to be "one of the best ornithologists who ever lived" (Stroud 2000:117).

One of the most widely traveled naturalist explorers in North America during the 1800s was Englishman Thomas Nuttall (1786–1859), who settled in Philadelphia in 1808 (Beidleman 1960, Coats 1969:295-304, Thomas 1974, Hanley 1977:103–108, Kastner 1977:254–283, Stuckey 1997, 1999, Ewan and Ewan 2007:521–540). Two maps of his travels, 1810–1836, by Pennell (1936:between pages 26 and 27), were expanded by Graustein, in her definitive biography, into two double-page maps (1967:46–47, 134–135). Nuttall's main interest was in botany (Stafleu and Cowan 1976–1988, III: 781–787), and an important outcome of his studies was *The Genera of North American Plants, and a Catalogue of the Species, to the year 1817* (two volumes, 1818, 1971). Since he published it only four years after Pursh's *Flora*, he gave only a brief characterization of any familiar genus and merely listed its already-known species, as with *Viburnum* L., listing 15 species (1818, I:202–203, 1971). But for unfamiliar species he commented on the environment in which it grew, as with *Iris verna*: "Habitat. On the gravelly shores of the calcareous islands of Lake Huron near Michilmakinak" (1818, I: 23, 1971). This is one of the early uses of "habitat" as we use the term, instead of the then commoner "habitation" or "station."

Nuttall wrote two travel journals, the first of which was only published in 1951. He wrote it on a

Fig. 19. Thomas Nuttall in 1824, published in London in 1825. Nuttall 1951:2.

western trip begun on 12 April 1810, with a stagecoach journey to Pittsburgh, which he reached on 19 April. He continued from there on foot to Lake Erie, and then by boat to Detroit and through Lakes Huron and Michigan to Green Bay, up the Fox and down the Wisconsin rivers to the Mississippi, down to St. Louis, which he reached in mid-September, though his travel journal had ended when he reached New Madrid, Missouri. Aside from telling of his travel experiences, much of his diary is taken up with detailed botanical descriptions of the new plants he found. However, when he found an interesting insect, as he did on that first day, he described its anatomy with just as technical a vocabulary as he applied to the plants (Nuttall 1951:22–23). He also commented on the birds, mammals, reptiles, and geology he observed. When he first saw a prairie at Sandusky Bay in western Lake Erie, he was quite impressed when he was told that it stretched for 150 miles, "like an ocean of land to an immeasurable

distance up the lake's N.W.!" (1951:53). He described both its characteristic plants and birds. He left St. Louis on 13 March 1811 and traveled up the Missouri to the Yellowstone River with fur traders, and back down the Missouri and Mississippi to New Orleans, which he reached in December, 1811 (McKelvey 1955:143–149).

On the same boat that Nuttall took up the Missouri was Scottish naturalist John Leigh Bradbury (1768–1823), who was collecting plants for the Liverpool Botanic Garden (Graustein 1967:56–76, Coats 1969:296–299, Ewan and Ewan 1981:25, 2007:548–551, Boewe 1997*a*). They never became friends. Bradbury published a book on his American travels (1817, 1904, 1966), describing his adventures and the Indians he met. His discussion of animals focused mainly on hunting them for food, and he mentioned plants only briefly and in passing. McKelvey (1955:107–138) nicely summarized his life and his book. Bradbury had planned to write in another publication about the plants he had collected, but Pursh had access to them and described them in his own *Flora* (1814) before Bradbury could. Bradbury protested in print (1904:26, 1966) that he had not authorized Pursh's action.

With the War of 1812 on the horizon, Nuttall prudently sailed from New Orleans back to England. He returned to America in May 1815 and resumed his botanical studies. On 17 October 1817 he was elected a member of the American Philosophical Society, and in 1818 four other members donated $50 each to defray his expenses for a trip up the Arkansas River that lasted 18 months. He left Philadelphia on 2 October and reached smoky Pittsburgh on the 15th. He then descended the Ohio and Mississippi rivers. His *A Journal of Travels into the Arkansa Territory, during the year 1819* includes a map of the Arkansas River based on his data, five landscape drawings (without captions), and a.m. and p.m. temperatures from 20 January to 28 September 1819. Much of the book is devoted to travel narration, geological observations, and discussions of Indians, but there are also observations of ecological interest (McKelvey 1955:164–187, Beidleman 1956, Graustein 1967:141–145), such as these on 7 January , on the Mississippi, still 95 miles above the Arkansas River (Nuttall 1821:57–58, 1966)

> *I was greatly disappointed to meet with such a similarity in the vegetation, to that of the middle and northern states. The higher lands produce black ash, elm (*Ulmus americana*), hickory, walnut, maple, hackberry (*Celtis integrifolia*, no other species), honey-locust, coffee-bean, &c. On the river lands, as usual, grows platanus or buttonwood, upon the seeds of which flocks of screaming parrots were greedily feeding* [footnote: *Their most favourite food in the autumn is the seeds of the cuckold bur (*Xanthium strumarium*).*], *also enormous cotton-wood trees (*Populus angulisans*), commonly called yellow popular, some of them more than six feet in diameter, and occasionally festooned with the largest vines which I had ever beheld. Here grew also the holly (*Ilex opaca*),* Aplectrum hiemale*, (*Ophrys hyemale*, Lin.),* Botrychium obliquum*, and* Fumaria aurea*. Nearly all the trees throughout this country possessing a smooth bark, are loaded with mistletoe (*Viscum verticillatum*).*

Nuttall had hoped to reach the southern Rocky Mountains, but he suffered from periodic malarial fevers and had to end his trip. He reached New Orleans on 18 February 1820 and Philadelphia by April. He brought back specimens of about 300 new plant species, which he described in a series of published papers (Graustein 1967:157, 161, MacPhail 1983*b*:17), and animal specimens, which he turned over to zoologists to describe (Graustein 1967:154). In 1823 Nuttall became Curator of the Botanic Garden and lecturer in botany at Harvard College.

Fig. 20. (Left) Thomas Say, by Charles Willson Peale, 1819. The Academy of Natural Sciences of Philadelphia. (Right) Titian Ramsay Peale II, by Charles Willson Peale, 1819. Private collection.

One of Nuttall's Philadelphia friends was Thomas Say (1787–1834), a descendant of John Bartram and son of a prominent physician (Weiss and Ziegler 1931, Jaffe 1958:130–153, Shor 1975, Hanley 1977:112–118, Stroud 1992, 1999, Schwarz 1997). Thomas and his younger brother Benjamin were childhood friends with the Peale children, and it may have been Titian Ramsay Peale I (1780–1799) who interested Thomas in insects (Stroud 1992:22). Thomas for a while was a partner in a drugstore, and he took courses at the University of Pennsylvania Medical School. On January 25, 1812, six science-oriented friends met and founded the Academy of Natural Science of Philadelphia. Say was absent but sent a resolution of support. At their next meeting on 17 March, Say joined and became one of its most active members.

In June a wealthy Scottish businessman-geologist, William Maclure (1763–1840), was elected a member of the Academy (Moore 1947, White 1973, Stroud 1992:33–34, Doskey 1997, Baatz 1999), and he became a patron of both the Academy and of Say. Maclure and Say helped make the Academy the center of natural history in Philadelphia and also the foremost natural history society in America for decades (Meisel 1924–1929, II:130–154, 1967, Gerstner 1976, Porter 1979, Bennett 1983). The Academy, in turn, helped make Say a leading American naturalist.

Say was inspired by the success of his friend Alexander Wilson's *American Ornithology* to achieve the same for American insects—a much larger task than Wilson's. Say began reading to the Academy

Fig. 21. Thomas Say's travels. Weiss and Ziegler 1931:189. Map by H. S. Barber. It was uncertain in 1931 if Say's trip to Mexico was in 1828 (it was).

essays on entomology in summer 1813 and, despite grumblings from some members, continued doing so through the winter of 1813–1814. He also contributed insects, shells, and other specimens to the Academy's scientific collections, then arranged and studied them. Wilson's *Ornithology* had appeared over a period of seven years, and in 1817 Say published the first part of his *American Entomology*, with

illustrations. However, the situation became unfavorable for him to continue it at the time.

One diversion was the *Journal,* which the Academy began publishing in May, with Say playing a major role both as author and as participant in production. For example, in volume 1, 1817–1818, he published five papers in 12 parts describing 94 species of crustaceans and 7 new genera (a few of which are not now accepted; details are in Holthius 1969). These papers are now collected and reprinted (Say 1969). Another diversion came in late 1817 when Maclure decided to lead a small natural history excursion to islands off Georgia and to northern Florida (fig. 23), and he invited Say, Ord, and Titian Ramsay Peale II (Jensen 1955:42). Titian Ramsay Peale II (1799–1885) was born to Charles W. Peale in the same year that his older brother of that name died. In 1817 he was already drawing illustrations for Say's *Entomology*, and he served as Say's assistant on this trip (Poesch 1961:20-22, 1974, Porter 1983, 1985, Harmond 1997, Thomas 1999). Later, Say regretted that they had gone in winter rather than spring, when they would have seen more insects. Nevertheless, they collected specimens of species new to science, which Say would describe in the Academy's *Journal*. The most important result of the trip was that Say and Peale worked well together and became receptive to joining a more ambitious expedition.

Stephen Long army expeditions

In 1819 the U.S. Army sponsored an ambitious expedition led by Major Stephen H. Long (1784–1864), a capable officer who had graduated from Dartmouth College, taught at West Point, and had led two previous expeditions (Dupree 1957:35–36, Wood 1966, Nichols and Halley 1980, Sterling 1997*c*, Nichols 1999). This was the first Army expedition to include professional naturalists, and both Long and Secretary of War John C. Calhoun wanted to choose outstanding ones. Long chose Say as zoologist and Peale as assistant naturalist and artist, and he chose William Baldwin (1779–1819), a capable botanist, who had to leave the expedition, due to declining health, in Franklin, Missouri. On 31 August he died of tuberculosis (Ewan and Ewan 1981:10, Stroud 1992:73 and portrait 75, Evans 1997:20–21, 52–53).

The expedition had left Franklin on 19 July and continued up the Missouri until they reached a location for their winter camp five miles south of Council Bluffs, named Engineer Cantonment. Long returned to Washington for the winter, and when he rejoined the expedition in June, he brought along Edwin James (1797–1861), who served as botanist, geologist, and surgeon (Ewan 1950:13–20, Evans 1993:113–114, Thomas 1997). James had graduated from Middlebury College, Vermont, in 1816. He then studied medicine under his brother and botany and geology under John Torrey and Amos Eaton. All the naturalists and Long kept journals, and after the expedition James compiled from these journals an *Account of an Expedition from Pittsburgh to the Rocky Mountains, Performed in the Years 1819, 1820* (three volumes, 1823) which included maps and landscape illustrations by the expedition artist, Samuel Seymour, and two engravings "after Peale."

James did not, however, indicate authors of journal entries which he included in a single narrative. Howard Evans, in *The Natural History of the Long Expedition to the Rocky Mountains, 1819–1820* (Evans 1997), identifies each author of passages from their journals, which he quotes. Reuben Thwaites published an annotated edition of James' *Account* (1904, 1966) that includes illustrations and a foldout map. Maxine Benson has published (1988) a condensed edition of James' text with a valuable introduction, bibliography, and both black and white and color illustrations, but only her name appears

Fig. 22. Edwin James. Ewan 1950: facing 13.

on the title page. In an account of Titian Peale's experiences on this expedition, Jessie Poesch (1961:23–35) quoted extensively from his journal and also published nine of his illustrations of animals, Indians, and scenery.

James' *Account* discusses geography, geology, plants (McKelvy 1955:211–249), animals, travel

experiences, and observations on Indian tribes and their habits. It includes details from the entire trip, and many details from their travels on the Ohio, Mississippi, and Missouri rivers and surrounding lands are quite interesting ecologically. However, those regions had already been discussed by earlier naturalists. For quotation here, it is more interesting to focus on passages about "desert" life. A number of passages discussed cactuses. For example, half-way between Sterling and Fort Morgan in northeast Colorado (Evans 1997:113)

> *June 29. The country…is as uniformly plain as that on any part of the Platte. It differs from that further to the east only in being of a coarser sand, and in aspect of more unvaried sterility. The cactus ferox* [Opuntia polyacantha] *reigns sole monarch, the sole possessor, of thousands of acres of this dreary plain. It forms patches which neither horse nor any other animal will attempt to pass over….In depressed and moist situations, where the soil is not so entirely unproductive, the variegated spurge (euphorbia variegata)* [E. maraginata]*, with its painted involucrum and parti-coloured leaves, is a conspicuous and beautiful ornament.*

On 4 August, James reported further on cactus (Benson 1988:267).

> *Two shrubby species of Cactus, smaller than the great cylindric prickly pear, noticed near the Rocky Mountains, occur in the sandy plains, we were now traversing. One of these which is about four feet high, and very much branched, has long and solitary spines, a small yellow flower, and its fruit, which is about as large as the garden cherry, is very pleasant to taste. The fruit of the* C. ferox*, which is also found here, was now ripe, being nearly as large as an egg, and of a deep purple colour.*

These quotations indicate that Long, like Pike, did cross semi-arid desert-like lands. Several historians have blamed the reports from the Pike and Long expeditions for misleading Americans into thinking that little land between the Mississippi and the Rockies could be settled by Americans (Hollon 1966:64–66, Bowden 1976, Benson 1988:xiii–xvi, xxv–xxvi, 400–401). Long carefully subdivided his assessment of lands surveyed into five geographic discussions, the fifth of which is at issue, on the lands between Council Bluffs and the Rocky Mountains (James 1904:XVII:147).

> *...it is almost wholly unfit for cultivation, and of course uninhabitable by a people depending upon agriculture for their subsistence. Although tracts of fertile land considerably extensive are occasionally to be met with, yet the scarcity of wood and water, almost uniformly prevalent, will prove an insuperable obstacle in the way of settling the country.*

What later critics overlooked is that, except for the Mormons, American farmers were tied to markets, and the lands between the Mississippi and the Rockies had hardly any navigable rivers, and farmers could not have gotten produce to market before railroads were built west of the Mississippi and before barbed wire became available.

The *Account*'s reports on Burrowing Owls (Benson 1988:228–229, 269), which lived in prairie dog holes, were by Say, and Peale made a drawing of one with young on 7 August that is reproduced by Benson (1988:270) and by Evans (1997:194). Peale also drew the Cliff Swallow on 17 July (in Benson 1988:236). These two drawings were the basis for Peale's plate on the Burrowing Owl and Cliff Swallow

Fig. 23. Burrowing Owl and Cliff Swallow. Collected and drawn by Titian Ramsay Peale II. Bonaparte 1825–1833, I: Plate 7.

in Bonaparte's *American Ornithology* (Fig. 23). Bonaparte named a new species from the expedition for his friend Thomas Say—Say's flycatcher (*Muscicapa saya* = Say's Phoebe, *Sayornis saya*)—though Peale shot it on 17 July near the Arkansas River, and drew it for Bonaparte (1825–1833, I, Plate 2, Fig. 3). Peale also drew pictures of plants (Benson 1988:266, Evans 1997:100, 105, 119, 137, 215) but did not find a publisher for them comparable to those of animals published in Say's *American Entomology*

(three volumes, 1824–1828) or Bonaparte's *American Ornithology* (four volumes, 1825–1833).

In their fine book on the botany of the Long Expedition, George Goodman and Cheryl Lawson chose as illustrations not Peale's drawings but photographs of three herbarium sheets (1995:235, 261, 285). They survey about 700 plants James collected and give fairly detailed maps of the expedition's route through Nebraska, Colorado, New Mexico, Texas, and Oklahoma—the westernmost states visited. Complete but less detailed maps of the route are in Nichols and Halley (1980:83) and in Evans (1997:xi). When the expedition split in Colorado, Say went on the northern route and so did not go through Texas (Fig. 21). Long's expedition chose a more northern route than Pike's, and the first mountain they sighted, on 30 June, they initially assumed was Pike's Peak, but it was at the wrong latitude. It is now called Long's Peak and is in Rocky Mountain National Park. Instead of attempting to climb it, they turned south when about fifty miles away. However, when they approached Pike's Peak, Long sent James and four soldiers on 13 July to climb it. James and two soldiers ascended on 14 July and at high elevations, James became first to collect alpine plants in North America. He found that plants became less abundant as they ascended, and at the top there were hardly even any lichens. The weather was clear, the temperature was 42° (vs. 96° at base camp), and they observed "the air in every direction filled with such clouds of grasshoppers, as partially to obscure the day. They had been seen in vast numbers about all the higher parts of the mountain, and many had fallen upon the snow and perished" (Benson 1988:225). These probably were Rocky Mountain locusts (*Melanoplus spretus*), that would plague prairie farmers during the last three decades of the 1800s and then disappear—though a few were dug out of a Rocky Mountain glacier in 1995 (Lockwood 2004:xix–xxiii). The expedition artist, Samuel Seymour, drew a picture of Pike's Peak that Evans reproduced (Evans 1997:139 and on the book's cover). Among the many new species that James discovered was a hydrangea that John Torrey and Asa Gray named *Jamesia americana* (Goodman and Lawson 1995:212–213, Evans 1997:112–114).

In 1823 Long led another expedition, around the southern end of Lake Michigan to Lake Winnipeg, and then home along the northern shore of Lake Superior, through Lakes Huron, Erie, and Ontario to Rochester to the new Erie Canal, to Albany and New York City (see Fig. 21 and these maps: Kane et al. 1978: endpapers, Stroud 1992:134–135). They had left Philadelphia on 30 April and returned there on 26 October. Say and Samuel Seymour, the artist, were the only civilian professionals from the previous expedition also on this one. Say agreed to collect plants as well as animals, and William H. Keating (1799–1841), from Philadelphia (Goldwhite 1999), served as geologist and author of the published report (1825). Since the route was through areas that had a flora and fauna already fairly well known, there were fewer novelties to discover than on a western expedition (McKelvey 1955:266–283). Almost all of Say's specimens, except for insects, were shipped back to Philadelphia but never arrived. The habits of the Indian tribes and the scenery encountered seemed more important than the species observed and collected. Say (1825*b*) did add an appendix to Keating's book on the insects collected.

Father of American entomology and an iconoclast

When Say returned to Philadelphia, he resumed his work on entomology. The American wheat crop was seriously damaged by *Cecidomya* [now *Mayetiola*] *destructor*, called Hessian fly, because it first attracted attention during America's War of Independence. One of Say's first articles (1817) was on the fact that this species had been unknown in Europe, and therefore, Say argued, hay brought over here

Fig. 24. Tiger Swallowtail (*Papilo turnus* [= *P. glaucus*]) on *Aquilegia canadensis*. Drawn by T. R. Peale. Say 1824–1828, III: Plate 40, 1859, I: Plate 20.

by British ships for its Hessian troops' horses was not the source of America's infestation. In the same article he pointed out that the female ichneumon fly *Cerapheron* deposits its eggs in the bodies of larval *C. destructor* and therefore provided hope for limiting the populations of this wheat pest. The modern view is that the Hessian fly did come to New York from southern Europe in 1777 with imported forage

for Hessian troops' horses (Pauly 2002:500, Shukle 2004). In 1906, Professor F. M. Webster found that a hymenopterous fly *Polygnotus hiemalis* was an important parasite on Hessian fly larvae (Howard and Fisk 1911:21).

Another example Say addressed: Pallas had described a fly that lays its eggs under the human epidermis *Oestrus hominis*. However, Clarke and Fabricius were skeptical that this species existed. Clarke suggested that instances of human victimization were "perhaps, merely an accidental deposit of *Oestrus bovis*, in the human body" (1822:33, 1859,II:355). Say had obtained the pickled larva of an *Oestrus* which a Dr. Brick had extracted from his own leg, and Say determined that it was a different species from *O. bovis*. Say quoted a letter from Brick describing the painful sting of the fly laying its egg and the development of the larva until he figured out how to extract it. Modern parasitologists side with Pallas and Say in judging this to be a distinct species, though it is now in a different genus: *Dermatobia hominis* (Chandler 1949:724–726).

Most of Say's entomology writings were precise, detailed accounts of species. This descriptive focus was more important for him than for his friend, Alexander Wilson, because there were many more species of insects than of birds in America, and further progress depended upon a common understanding of the identity of particular specimens. According to John Goodlove Morris (1803–1895), Say described 1575 species (Weiss 1936:87–88). Say's *American Entomology, or Descriptions of the Insects of North America* appeared in three volumes (1824–1828), with 54 colored plates; 21 of the plates illustrate just one species, and the 33 plates illustrating multiple species are all limited to a single genus per plate.

Say verbally described, according to John Goodlove Morris (1803–1895), 1500 species of Coleoptera, 225 species of Diptera, 100 species of Hemiptera, and 100 other species (Weiss 1936:87–88). Titian Peale drew 27 of the plates. In *The Complete Writings of Thomas Say on the Entomology of North America* (two volumes, 1859) the 54 illustrations in color and the three volumes of text are compressed into 123 pages. Say's account of the tiger swallowtail (Fig. 24) includes this observation which he thought shows that insects feel no pain (1859, I:87).

> *I caught an insect belonging to the present genus, and having impaled it by passing a pin vertically through its body, it escaped from my hand. The pin being light and no injurious pressure having been exerted on its body, the insect flew, apparently with its usual facility, to a flower, and unrolling its elongated proboscis, proceeded to extract the sweet fluid from the nectary, as if no mortal wound had been inflicted.*

Apparently he did not use a killing jar. Say's achievements have earned him the title "The father of American entomology, and the first great systematic entomologist in this country" (Essig 1931:750–756, 1965; also Mallis 1971:16, Lindroth 1973:121, Summers 1982:69, Stroud 1992:279). There are 770 insects that survive from Say's insect collection, including 71 specimens of 56 species he first described (Mawdsley 1993).

Another solo explorer-naturalist like Wilson and Nuttall was Constantine Samuel Rafinesque (1783–1840), but with a difference: Wilson and Nuttall were highly respected because they published their important discoveries within the traditions that had developed among naturalists. Rafinesque flouted

Fig. 25. Constantine Samuel Rafinesque by Mathew Jouett, in Lexington, Kentucky. Peattie 1936: facing 245.

those traditions and suffered the consequence that his work was not respected or taken seriously (Call 1895, Jaffe 1958:104–129, Ewan 1975, Hanley 1977:126–140, Kastner 1977:240–253, Sterling 1978, Boewe 1982, 1997, 1999, 2003, Warren 2004). He was born in Istanbul to a French father, who was a

merchant, and a German mother, and raised in Greece. He was tutored in geography, geometry, history, and English, but was otherwise self-educated (Rafinesque 1836:8, 1944:299).

He first landed in America on 18 April 1802, and in 1803–1804 he took walking field trips and discovered that his favorite activity was searching for new plants in the wilderness (Rafinesque 1836:18, 1944:303,Warren 2004:6–17). Not that he limited his searches to plants; he seemed to take all of nature as his domain, and much of human endeavor as well. On 1 January 1805, he sailed to Italy, and after a decade in Sicily, he returned permanently to America. He claimed to discover and name 2700 plant genera, 320 subgenera, 6700 species, and 900 varieties, but in 1950 only 18 of his genera, 84 species, and 13 varieties were recognized (Warren 2004:159–160). Rafinesque had two qualities that undermined his credibility: he was hypercritical of the published work of others while being careless about evidence in his own published work. His *Florula Ludoviciana* (1817, 1967) was "translated, revised, and improved from the French" *Flore Louisianaise* by Claude Cesar Robin (b. 1750), and might have won approval had Rafinesque ever been to Louisiana (Warren 2004:61)! In 1818 he traveled down the Ohio River, collecting fish as he went, and this collection became the basis for his *Ichthyologia Ohioensis, or Natural history of the Fishes Inhabiting the Ohio River* (1820*b*, 1970), one of his best publications. He stopped off at Henderson, Kentucky in late summer of 1818 and spent three weeks with Audubon, whom he took to be a friend. Audubon showed him pictures he had drawn of 11 fish, and Rafinesque added them on the basis of the drawings and Audubon's descriptions to his book, citing Audubon as his authority. But those 11 fish were a hoax, perhaps inspired by Rafinesque's eccentricity (Jordan 1877, Herrick 1917:I, 285–300, Markle 1997, Warren 2004:72–75). It apparently never occurred to Audubon that this deception would hurt his own reputation in science. Rafinesque named 63 fish genera, more than anyone else in the period 1800–1877, of which 34% were still valid in 1990 (Jackson and Kimler 1999:529). Rafinesque was Professor of Natural History at Transylvania University, in Lexington, Kentucky, 1819–1826.

In 1819 he published "Botany of Kentucky" (reprinted with annotations in Stuckey and Pringle 1997) in which he divided the state into four botanical regions and suggested a possible fifth region for the eastern mountains he had not seen. He knew the region around Lexington best. His *Annals of Nature or Annual Synopsis of New Genera and Species of Animals, Plants, &c. Discovered in North America* (1820*a*, 1974) is typical of his writings: a record of species he collected, named, and briefly described, without concern about whether other naturalists had already published their names and descriptions. His "On the botany of the Western Limestone Region" (1822) may have published the first observations on plant succession in America (Bryant 1997), though in a nonscientific publication: "There is therefore a kind of natural perennial change of vegetation; when a species has exhausted the soil of a peculiar nutrition that it requires, it gives way to another for a series of years" (Rafinesque, *Kentucky Gazette*, 4 April 1822; quoted from Stuckey 1998:139). Rafinesque also published in obscure publications descriptions of birds (Richmond 1909, Rhodes 1912). Rafinesque corresponded with European botanists and zoologists, including seven letters to Augustin-Pyramus de Candolle, 1817–1821 (Baehni 1957). He published articles in French scientific journals, but complained to de Candolle that some editors did not respond to let him know if articles he sent were published (July 1830, partly translated in Boewe 2003:357).

Although Say and Rafinesque published some of their writings on freshwater bivalves before 1825, all their writings on them will be discussed in Part 38.

Conclusions

Thomas Jefferson had begun dreaming in 1783 about government exploration of the West. In 1785, French naturalist André Michaux began his explorations and briefly planned to implement Jefferson's dream, only to be subverted by the French ambassador. Not until 1804 could Jefferson initiate government explorations, under Lewis and Clark. Federal expeditions usually produced published reports that included observations on plants, animals, and environments encountered. The ecological value of these reports varied, depending on the training and diligence of the observers and authors of reports. Simultaneously, individual naturalists continued to explore North America without government support, and they often published ecologically interesting memoirs. Exploration from mid 1780 to the mid 1820s was somewhat unpredictable and even risky—if not to life or limb, at least to the survival of collections and records. The cumulative publications from these explorations were substantial, and they remain valuable to anyone interested in North American natural history. However, that literature was diffuse and uneven in quality, and thus not as "user-friendly" as Humboldt's simultaneous exploration publications for Latin America (Egerton 2009).

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