CONTRIBUTIONS

Commentary

A History of the Ecological Sciences, Part 24: Buffon and Environmental Influences on Animals

The two leading naturalists during the 1700s were Linnaeus and Buffon, both born in 1707. Although Réaumur was a better scientist than Buffon, and although insects were important subjects to study, they lacked the popular appeal and diversity of Buffon's subjects—the history of the earth, mammals, birds, and minerals.

Georges-Louis Leclerc, Comte de Buffon (1707–1788) was eldest of five children of a conseiller to the Burgundian parliament. Three of his siblings entered the church, and although he attended a Jesuit college in Dijon, he subsequently went to Paris and became infected with Enlightenment skepticism. His memoir on probability gained him admission to the Académie Royale des Sciences. He next wrote several papers on botany and forestry and translated into French (1735) Stephen Hales' *Vegetable Statiks* and (1740) Isaac Newton's *Method of Fluxions and Infinite Series*. In 1739 he became intendant (head) of the Jardin du Roi, and he was to broaden its scope from a national botanic garden to a national center for Buffonian science (François 1952, Hanks 1966, Roger 1970, 1997*a*, Gillispie 1980:146–151, Laissus 1986*a*, 1988*a*, Spary 2000:15–39).

The French Enlightenment was a movement to increase middle-class political power and freedom at the expense of church and state (Reill and Wilson 1996, Delon 2001, Kors 2002). Science was used as a battering ram to weaken these establishments. Two notable encyclopedias came from this movement: *Encyclopédie, ou Dictionnaire raisonné des Sciences, des Arts et des Métiers* (28 volumes, 1751–1772), by Denis Diderot and associates (Bloom 2004), and *Histoire naturelle, générale et particulière* (15 volumes, 1749–1767 + 7 volumes of supplements, 1774–1789; English version: 9 volumes, 1780–1785) by Buffon and associates, followed by *Histoire naturelle des oiseaux* (9 volumes, 1770–1783; English version: 9 volumes, 1792–1793) and *Histoire naturelle des minéraux* (5 volumes, 1783–1788), by Buffon and some other associates (Laissus 1988*b*). The *Encyclopédie* was much broader in scope than Buffon's works, but it also borrowed information and ideas from Buffon's works (Ehrard 1992, Vartanian 1992, Hoqet 2005). Both sets of encyclopedias offended the church, and Diderot was harassed by state censors, but Buffon was a state employee, and he avoided offending the government. He was willing, however, to engage in a verbal feud at home with fellow academician René-Antoine Ferchault de Réaumur (Heilbron 1979:346–349) and abroad with Carl Linnaeus (next paragraph).

The first three volumes of *Histoire naturelle* appeared in 1749, containing his "Initial Discourse" on methods, history of the earth, and natural history of man. In the "Initial Discourse" he attacked Linnaeus' botanical system without naming him, but he did name him when he attacked his zoological classification (Buffon 1954:8–14, 18–19, Lyon and Sloan 1981:100–108, 115–116; see also Le Guyander 1992, Sloan 1976). Although the Jesuits praised the *Histoire naturelle* (Lyon and Sloan 1981:213–230), their hostile rivals, the Jansenists, attacked it in their *Nouvelles ecclésiastiques* on 6 and 13 February 1750 (Lyon and Sloan 1981:231–252), and this forced the Theology Faculty at the Sorbonne to react. It condemned 14 "reprehensible statements," primarily because Buffon's history of the earth ignored the Book of Genesis (Lyon and Sloan 1981:283–288). Buffon (1860, I:47) wrote to his friend abbé Le Blanc on 23 June 1750 that he hoped to prevent his volumes being placed on the Index of Forbidden Books, and to the relief of both himself and the Faculty, a satisfactory resolution to the problem was achieved (Stengers 1974, Roger 1997*a*:186–189). He appeased the theologians in volume IV (1753) by publishing their censure with his apology (Lyon and Sloan 1981:289–293). Later editions of *Histoire naturelle* contained his history of the earth unaltered, followed by the censure and apology; readers could therefore decide for themselves how valid his history was and how sincere his apology was. In 1778, after his reputation and prestige were well established, he returned to earth history in "Des époques de la nature," in his fifth supplementary volume. His "Époques" both defied the censors by estimating that the earth was 70,000 years old (privately, he though it much older) and appeased them by dividing his history of the earth into six epochs, which could be viewed as the six days of creation mentioned in Genesis. He saw people as living in a seventh epoch in which the power of humans is affecting the earth (Buffon 1962). This time, as he commented to Gueneau de Montbeillard on 15 November 1779 (Buffon 1860, II:68), he did not worry about the reactions of the theologians.

Fig. 1. Buffon at age 54 (Buffon 1780–1785, I: frontispiece), an engraving by C. Baron based on a portrait by F. H. Drouais.

Buffon's personality was very strong, and his writings are characterized mainly by pronouncements rather than tentative statements. As he gained new information, he could change his mind (Roger 1997*b*:458), but he would make new pronouncements that contradicted the old, rather than explicitly correcting his old pronouncements. This led to confusion about what he really thought. One scholar (Eddy 1994) has argued that Buffon did not, in fact, change his mind over time, and that his science is ahistorical, but this interpretation has won little, if any, support. Yet there are aspects of Buffon's thought that did not change. Understanding reproduction and heredity were difficult problems, and Buffon adopted and adapted, without acknowledgments, some ideas either from about 1700 (Roger 1997*b*:289) that became his concepts of *moules intérieurs* (internal molds) and *molécules organiques* (organic molecules), or he got these ideas from Pierre Louis Moreau de Maupertuis (1698–1759, on whom see Glass 1959, 1974) according to Gillispie (1980:149). (Roger [1997*a*, *b*] discusses both Buffon and Maupertuis without mentioning this connection.) These vague and unsubstantiated notions did for him what our gene–chromosome theory does for modern biology. There are inanimate substances, but also living organic molecules, and the latter are organized by internal molds into living beings (Buffon 1749–1789, II:20, 39, 1780–1785, II:18, 36, Sloan 1992, Roger 1997*b*:469). He did, indeed, imagine that he had substantiated these ideas in 1748 by collaborating with a British Catholic priest, John Turberville Needham (1713–1781), in experiments on spontaneous generation (Westbrook 1974, Sloane 1992). However, another priest, Lazzaro Spallanzani (1765) showed that they had not heated their organic infusion long enough and sealed its container tightly enough, and that the life forms they later found were from contamination, not spontaneous generation (Dolman 1975, Farley 1977:22–27). Buffon's theory of interior molds and organic molecules later provided a convenient way to explain the origin of internal parasites (Buffon 1828, XII:373 [cited from Farley 1977:23–24 and note 59:195].

> *…when there are several malfunctions in the organization of the body, which prevent the absorption and assimilation of all the organic molecules in the food by the interior mould. These excess molecules, unable to penetrate the interior mould of the animal, reunite several particles of brute matter in the food and form organized bodies…This is the origin of tapeworms, ascarides, flukes and all the other worms which are born in the liver, stomach and intestines.*
>
> [since Farley 1977:195 says edited by M. Lamouroux, this is the 1824–1832 edition]

There are two aspects of Buffon's natural history that involved environmental influences on animals—animal populations and degenerations—and since his concern for both subjects persisted over time, his ideas changed somewhat as he gained new knowledge from his own and other naturalists' investigations. His discussions of populations began before his discussions of degeneration, and the former are discussed here first.

Buffon's interior mold–organic molecule theory led him to: (1) revive belief in spontaneous generation; (2) argue that spontaneous generation prevents modern-day species from becoming extinct (he thought species that lived when the earth was hotter became extinct when it cooled); and (3) view reproduction in terms of the organization of matter. He illustrated the latter perspective with a hypothetical example of the rate at which an elm tree could reproduce in order to cover the earth with its descendants if unimpeded: 150 years. This reminds us of a similar calculation by Denis Dodart in 1700 (Egerton 2006*a*:122), but Buffon's perspective was closer to the modern concept of biomass production than was Dodart's (Buffon 1749–1789, II:38, 1780–1785, II:35).

Since antiquity, there had been two ways to explain differences in species fertility: the ecological explanation of Herodotos and Plato, that predator species were created with less ability to reproduce than their prey, so that they would not eat all their prey (Egerton 2001*a*); and the physiological necessity explanation of Aristotle, that large species have fewer offspring than small species because it takes longer to organize a large embryo than a small one (Egerton 2001*b*). Linnaeus recognized that neither explanation explained all the facts, and he used both principles (Egerton 2007:83). Buffon (1749–1789, II:306–307, 1780–1785, II:255–256) emphasized the physiological necessity principle: "In general, large animals are less prolific than small ones." One consequence of this principle was: "Animals which produce but one at birth acquire nearly their full growth before they are fit for generation. But those which produce many, generate before they are half grown" (Buffon 1749–1789, II:308, 1780–1785, II:40). He thought that wild animals breed in the spring because during the winter they lack sufficient food to produce organic molecules for reproduction (Buffon 1749–1789, VI:92, 1780–1785, IV:99–100).

He also provided relevant data for various species. For example (Buffon 1749–1789, VII:328, 1780–1785, IV:289):

> *The rat is very prolific; but the long-tailed field-mouse is more so. The latter brings forth more than once a year, and the litters often consist of nine or ten, while those of the rat never exceed five or six. In one hole I have found two mothers and twenty young.*

In 1776 he organized (Buffon 1749–1789, supplement III:25–28, 1780–1785, VIII:26–29) tabular data on the ages of sexual maturity, gestation length, number of young per pregnancy, and the ages at which fertility ceases for 53 "mammals" (a Linnean term Buffon never used), a small-scale anticipation of the *Biology Data Book* (Altman and Dittmer 1964:57–65). Buffon's motive for collecting the data was to clarify interspecific hybrids.

He had data indicating that hybrids are sometimes fertile, though the fertility rate was lower than either species breeding true, and that a very large percentage of the hybrid's offspring were males (Buffon 1749–1789, supplement

TABLE of the Relative Fecundity of ANIMALS.

Names.	Age at which males can engender, and females produce. MALE. Years.	FEMALE. Years.	Times of geftation.	Number of young produced at a litter.	Age at which males ceafe to engender, and females to produce. MALE. Years.	FEMALE. Years.
Elephant	30	30	2 years	1 in 3 or 4 years	lives 200	
Rhinoceros	15 or 20	15 or 20	. . . .	1	lives 70 or 80	
Hippopotamus	. . . .	. . . .	. . . .	1	. . . .	
Walrus	. . . .	. . . .	9 months	1	. . . .	
Camel	4	4	1 year nearly	1	lives 40 or 50	
Dromedary	4	4	idem	1	lives 40 or 50	
Horfe	2½	2	11 months	1, fometimes 2	at 25 or 30	at 18 or 20
Zebra	2	2	11 ditto	1, rarely 2	at 25 or 30	at 18 or 20
Afs	2	2	11 do. & more	1, rarely 2	at 25 or 30	at 25 or 30
Buffalo	3	3	9 months	1	lives 15 or 18	
Ox	2	1½	9 ditto	1, rarely 2	at 9	at 9
Stag	1½	1½	8 do. & more	1, rarely 2	lives 30 or 35	
Rain-deer	2	2	8 months	1	lives 16	
Lama	3	3	. . . .	1, rarely 2	at 12	at 12
Man	14	12	9 months	1, fometimes 2		
Large apes	3	3	. . . .	1, fometimes 2		
Mouflon	1½	1	5 ditto	1, fometimes 2, twice a year in hot climates	at 8	at 10 or 12

Fig. 2. The first of four pages of data in a Table of the Relative Fecundity of Animals (Buffon 1780–1785, VIII:29). The French version appeared in 1776.

III:2, 1780–1785, VIII:3). His tabular data provided norms for comparison in future hybrid experiments, though the data were also relevant for investigations in population biology.

Buffon had a theory of aging for animals and humans that I have discussed previously (Egerton 1967:194). Despite demonstrations of the utility of human demographic data (Egerton 2005), governments had not begun to publish regular data on births, marriages, and deaths, and therefore Buffon published data collected by a fellow member of the French Academy in 12 rural and 3 Parisian parishes. For each parish, he gave mortality data, and he discussed reasons why longevity was less in cities than in rural areas. His main use of the data was to construct a table "showing the probabilities of the duration of human life." His table indicated (Buffon 1749–1789, II:602–603, 1780–1785, II:516–517)

> *...a new born infant, or a child of 0 age, has an equal chance of living 8 years; that a child of 1 year will live 33 more; that a child of 2 years will live 38 more; that a man of 20 years will live 33 and 5 months more; and that a man of 30 years will live 28 more, &c.*

Fréchet (1954:436) suggests that Buffon's importance for the development of statistics in France was as great as that of Graunt and Petty for England, which slights the earlier contributions of Antoine Deparcieux and Sebastien le Prestre de Vauban, but does indicate Buffon's significance.

Buffon did not analyze animal populations mathematically; there were no statistical data. However, he did discuss animal population fluctuations several times, under the headings of various species that multiply rapidly. His explanations of population outbreaks were mainly physiological, though he recognized ecological factors to a lesser extent. His essay on the hare in 1756 opened with a reminder of numerous plagues of locusts, ants, rats, and even barbarians (Normans, Huns, Goths), but he pointed out that such plagues were inevitably followed by the destruction of these individuals, leading to restoration of the usual numbers of the species. Buffon's coauthor of the *Histoire naturelle, générale et particulière, avec la description du cabinet du Roy* was a physician, Louis-Jean-Marie Daubenton (1716–1800), who was in charge of the cabinet (museum) at the Jardin du Roi, and who undertook detailed anatomical studies of most mammals which they described (Limoges 1978, Laissus 1986*b*), and he was the likely source of these observations (Buffon 1749–1789, VI:251–252, 1780–1785, IV:143):

> *The multiplication of these [hares] is very rapid. From the first year of their existence, they are always in a condition for propagating. The females go with young only thirty or thirty-one days. They bring forth three or four at a litter, and, immediately afterwards, they receive the male. They likewise admit him during the time of gestation; and from a peculiar conformation of their organs, they have frequent superfoetations: For the uterus is only a continuation of the vagina, and has neither neck nor orifice, as in other animals; but, in each horn, there is an orifice opening into the vagina, which dilates during the time of bringing forth. Thus the horns are two distinct uteri, which can act independent of each other; so that the females of this species are capable of conceiving and bringing forth, at different times, by each uterus; and, consequently, superfoetations must be as frequent among these animals as they are rare in those which have not a double organ.*

The account continues with other anatomical and physiological details that contribute to the hare's ability to increase rapidly: the young suckle for about 20 days; they eat a variety of vegetation; they mature in a year and can live seven years, but rarely live that long because of their many predators (Buffon 1749–1789, VI:263, 1780–1785, IV:153): "A perpetual war is carried on against them by owls, buzzards, eagles, foxes, wolves, and men." In 1776 he reported (Buffon 1749–1789, supplement III:145, 1780–1785, V:153) that hares and rabbits are not usually numerous in the same places, but he did not speculate on whether this was due to competition or differences in their needs.

Buffon distinguished between long-tailed and short-tailed field mice, the latter now called voles. He also had a long-standing interest in forestry (Brosselin 1992), and these two interests converged because field mice eat acorns. When he was trying to grow trees, he had traps set out for the mice to prevent them from eating all the planted seeds and acorns, and he had all the trapped mice brought to him. He was astonished that more than 100 were trapped daily from an area of 40 French arpents (arpent probably = 1/2 hectare), for a total of over 2000 from 15 November to 8 December, after which the numbers declined as they retreated from the cold into their holes.

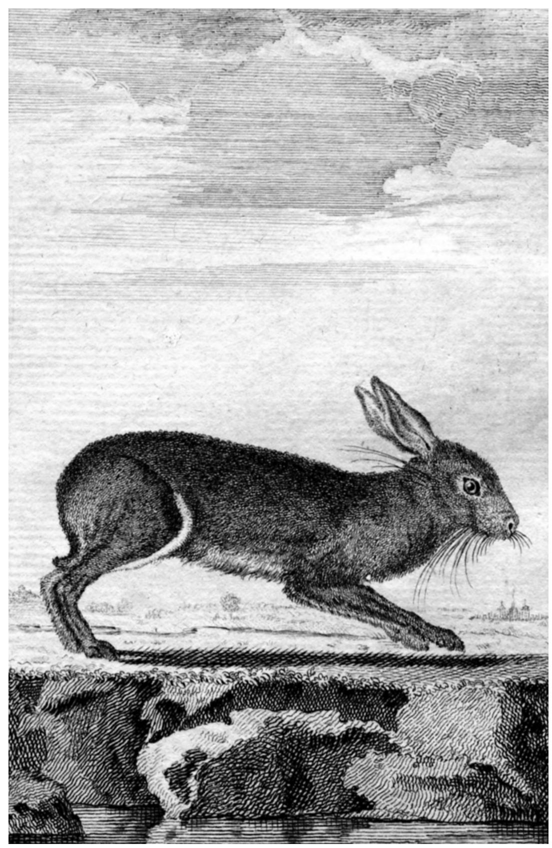

Fig. 3. Hare (Buffon 1780–1785, IV: facing page 152).

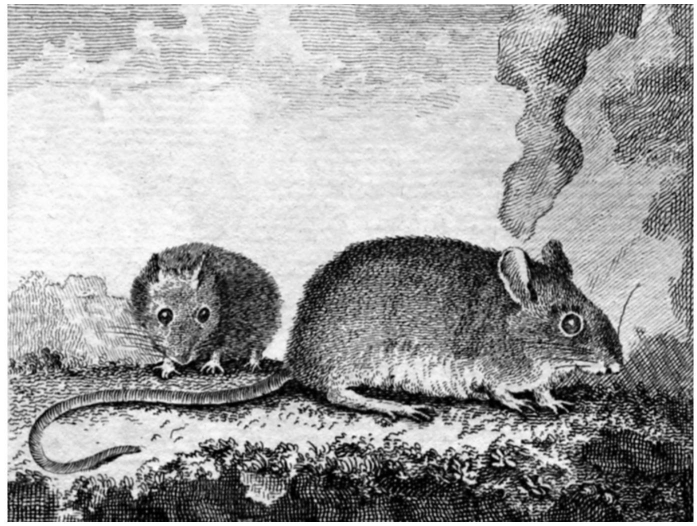

Fig. 4. Long-tailed field mouse (Buffon 1780–1785, IV:facing page 288).

They were less numerous in the spring due to winter mortality. He also studied some caged long-tailed field mice and made an interesting discovery (Buffon 1749–1789, VII:330, 1780–1785, IV:289):

I once kept a dozen of these mice in a cage, and furnished them with food every morning at 8 o'clock. One day they were neglected for about a quarter of an hour, when one of their number was eaten by the rest; next day another suffered the same fate; and, in a few days, only one remained. All the others had been killed, and partly devoured; and even the survivor himself had his feet and tail mutilated.

This experience was undoubtedly in his mind when he challenged Aristotle's claim (*Historia Animalium* 580b10–581a5) that a population crash of rats was caused by rains. It was clear to Buffon (1749–1789, VIII:281, 1780–1785, IV:281) that the rats had eaten the available food and then turned on each other; they could avoid the rains.

Buffon deliberately did not present the mammals in a systematic order, as Linnaeus did, but he nevertheless distinguished between the herbivores, some of whom we have just reviewed, and the carnivores, on whom he wrote a special essay in 1758 (1749–1798, VII:3–38, 1780–1785, IV:164–195). In it he emphasized the fact that predators are essential for preventing their prey species from overrunning the earth, consuming all the available food, and then dying of famine and contagion. At this point he has moved beyond arguments of physiological necessity and accepted ecological arguments for the balance of nature. In the same essay he provided a variety of arguments to "prove" that humans were intended to eat meat.

Large predatory mammals seem to have fired Buffon's imagination, and he wrote of the wolf as "naturally clownish and dastardly, but want makes him ingenious and necessity gives him courage" (1780–1785, IV:197). But when he turned to life histories, he forsook anthropomorphisms for the facts. Female wolves come into heat for only 12–15 days a year, and gestation is about 100 days, compared to 60 days for dogs. He thought this difference showed they are different species. Both sexes of wolves can mate in their second year, they are fully grown at the end of two or three years, and they can live for 15 or 20 years.

As he and Daubenton worked their way through the diversity of mammals, Buffon sought generalizations on

Fig. 5. Black wolf (Buffon 1780–1785, IV:before page 213).

which he could write essays in addition to the natural histories of species. One such essay was the one on predation; another, in volume IX (1761), compared and contrasted the species of the Old and New Worlds. He divided the essay into three parts: "Animals Peculiar to the Old World" (1780–1785, V:90–112), "Of Animals Peculiar to the New World" (1780–1785, V:112–123), and "Of Animals Peculiar to Both Continents"(1780–1785,V:123–152). By "both continents" he meant both worlds, since he compared species of North and South America with those of Eurasia and Africa. He had more data on Old World species than on New World species, and he made some errors because of limited New World data. He found that there were similarities between some Old and New World mammals, such as wolves, bears, deer, and hares, and he could not decide whether they represented the same or different species. He wisely decided that this question could only be decided by breeding experiments between similar individuals of different sexes bred between representatives from the Old and New Worlds and then to see if they produced fertile offspring. He correctly concluded that these similarities indicated that there was or had been a land bridge between Asia and North America. He also saw that South America had species that were distinct from Eurasia, Africa, and North America, and concluded that this was a result of its isolation from other continents.

Buffon was also impressed by the fact that North America lacked as many large mammals as Eurasia and Africa and concluded that this was because America had a less favorable climate and soil than the Old World. We now know that this paucity of large species was due to Quaternary extinctions which Paul Martin (1970) attributed to the sudden arrival of big game hunters who killed off the animals for food. Although Martin's hypothesis was strongly debated for three decades, Tim Flannery (2001) has shown that it is the only hypothesis that accounts for all the facts. Buffon's misinterpretation of the cause of the paucity of large American mammals led him to write in volume 14 (1766) an essay, "Of the Degeneration of Animals"(1780–1785, VII:392–452, 1954:394–413). Buffon made an important contribution to the history of biogeography (Browne 1983:23–25, Hofsten 1916:237–242), but his essay on the degeneration of American animals and peoples was an exercise in Eurocentric prejudice. However, he did argue that since Europeans, Asians, Africans, and Americans can all interbreed and produce fertile offspring, they are still all one species, and if those distant people returned to their native country, they would regain their original features and color. This could be tested by bringing Negroes from Senegal to Denmark and having them breed only with each other. Interestingly, he did not specify where the native country of people was, because he did not have to. All European readers would understand that that country was within Europe.

However, animals, as they moved into distant regions, would change more rapidly than people, and therefore they might become different species (Buffon 1780–1785, VII:397, 1954: 395B).

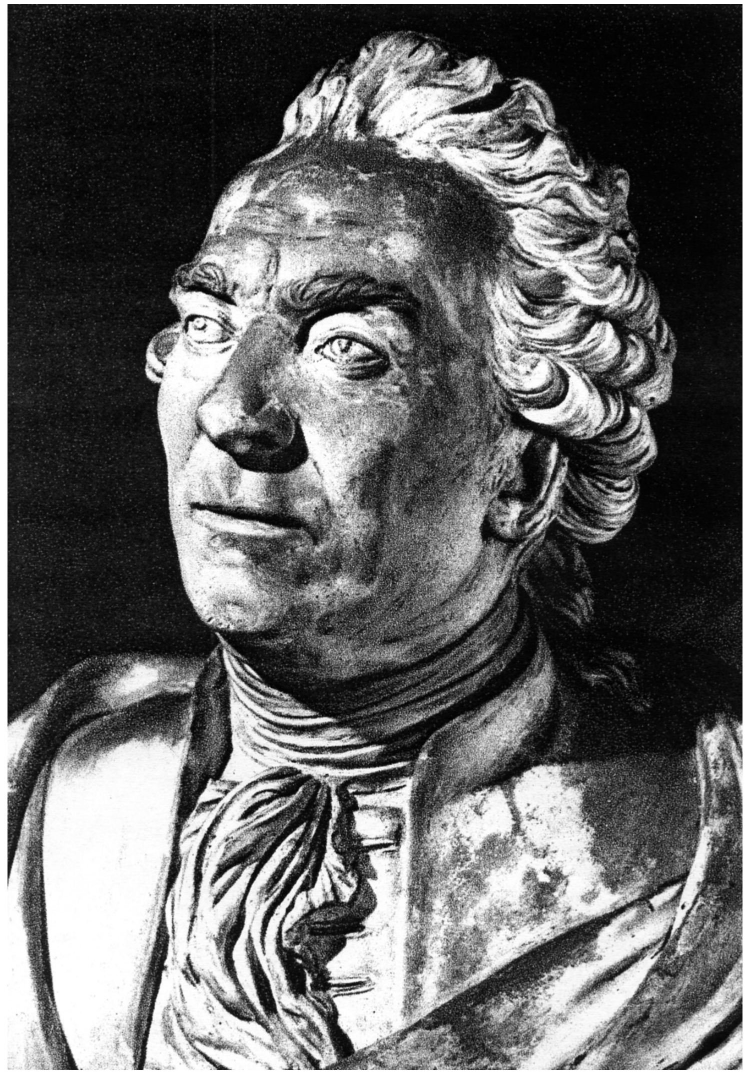

Fig. 6. Buffon at age 65. Bust by J. B. Defernex.

> *In brute animals, these effects are greater and more suddenly accomplished; because they are more nearly allied to the earth than man; because their food being more uniformly the same, and nowise prepared, its qualities are more decided, and its influence stronger; and because the animals, being unable to clothe themselves, or to use the element of fire, remain perpetually exposed to the action of the air, and all the inclemencies of the climate. For this reason, each of them, according to its nature, has chosen its zone and its country: For the same reason, they remain there…And, when forced by men, or by any revolution on the globe, to abandon their native soil, their nature has undergone changes so great, that, to recognize them, recourse must be had to accurate examination, and even to experiment and analogy.*

He thought climate, food, and slavery were the three causes of degeneration in animals (by slavery, he meant domestication), and he discussed each cause at some length. He thought that elk in America are smaller than in Europe, but enormous antlers found underground in Canada show that they were larger when they arrived than they are now. He also thought that species that migrated from the cold north to the hot tropics became smaller (Buffon 1778:179, 1954:401, translated in Bowler 1992:123).

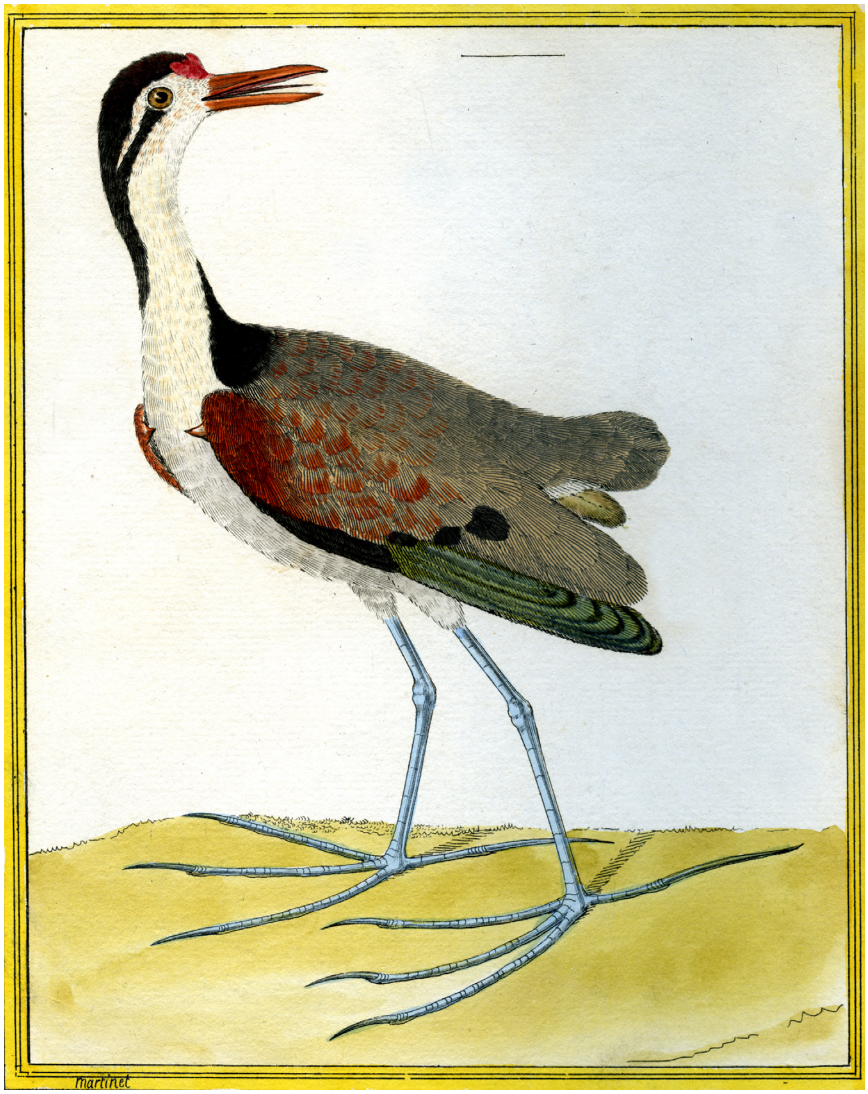

Fig. 7. Jacana of Brazil. Plate 846 of *Planches enluminées*. Copy of one of eight plates which I bought at a book auction at Duke University in 1954 (two of which are dated "1770" by the seller in pencil).

...the earliest and greatest formation of animated beings occurred in the high, elevated regions of the north, from whence they have successively passed into the equatorial regions under the same form, without having lost anything but their great size; our elephants and hippopotamuses, which appear large to us, had much larger ancestors during the time in which they inhabited the northern regions where they have left their remains.

He ended this essay with a list of the genera and species which are common to both "continents" (Old and New Worlds), those which are peculiar to the Old World, and those which are peculiar to the New World. Logically, these lists should have come at the end of his essay on this subject (in volume IX, 1761), but apparently he had not compiled it that early.

Buffon's essay provided scientific evidence of the superiority of Europeans and European animals to foreign people and animals, and there were plenty of other Europeans who were eager to add their own evidence in confirmation; but there were American skeptics (Gerbi 1973). Foremost among them was Thomas Jefferson, who went to France as a diplomat in 1784. Jefferson had already written his *Notes on the State of Virginia* in 1781–1782, but only published it in Paris in 1785, with a French translation published in 1786, a London edition in 1787, and in Philadelphia in 1788. It was written in response to a series of questions posed to him by a French diplomat, and it is organized into chapters answering those questions. Chapter 6, on the productions of Virginia, contains a lengthy table on the weights of European and American mammals, preceded and followed by lengthy discussions (Jefferson 1984:165–191) to refute Buffon's claims. Jefferson had bought a "panther" (cougar) skin before sailing to France to give to Buffon, whom he met in late 1785 or early 1786. Buffon was impressed by the size of the skin, but remained skeptical of Jefferson's claims about the size of American deer species. Jefferson therefore wrote to friends in America, who sent him skins, antlers, and bones of white-tailed deer, elk, and moose, which did convince Buffon. Jefferson said Buffon promised to add notes on them to a latter volume of his *Histoire naturelle* but died before doing so (Henline 1947, Martin 1952:180–191, Miller 1988:61–63, Bedini 1990:125–196). Buffon's biographer (Roger 1997*a*:416) points out that Buffon had already backed away from his 1766 claims about the degeneration of North American mammals in his 1778 treatise, "Des Époques de la Nature" (Buffon 1954:117–229), but since he had not explicitly repudiated his earlier ideas, they still seemed current to Jefferson in 1786.

In 1757 Buffon's bitter rival, Réaumur, died. Réaumur not only produced a monumental treatise on insects (Egerton 2006*b*) but also collected one of the two largest and best "cabinets" of natural history (Torlais 1961:315–345, Laissus 1986*b*), emphasizing birds, (the other, that of Sir Hans Sloan, became the foundation of the British Museum). Réaumur had arranged for Mathurin-Jacques Brisson (1723–1806) to manage and describe his cabinet in 1749 (Taton 1970). In his will, Réaumur left his cabinet to the Académie Royale des Sciences, but Buffon was able to have it transferred to the Cabinet du Roi at the Jardin du Roi, where it was unavailable to Brisson. Nevertheless, Brisson published his six-volume *Ornithologia* in 1760, which is a careful, detailed catalog of all the known species of birds (Stresemann 1975:53–54, Farber 1982:7–15, Walters 2003:54–56), with plates engraved by François-Nicolas Martinet (born 1731).

Louis-Jean-Marie Daubenton collaborated with Buffon from 1745 to 1766. Their collaboration ended after Buffon decided to drop Daubenton's anatomical studies from new editions of the *Histoire naturelle* (Farber 1975, Limoges 1978:112). To help produce the nine-volume *Histoire naturelle des oiseaux*, Buffon turned to new associates. There were two groups of collaborators, one set working on the text and the other on the illustrations. Daubenton had started work on the illustrations in 1765 and seems to have supervised the separate publication of 138 plates under the title *Planches enluminées*, which included 35 plates devoted to corals, insects, amphibians, and reptiles. After plate 96, all were of birds, and there were a total of 1008 plates. After Daubenton departed from the project, his cousin, Edmé-Louis Daubenton (1732–1785), took charge. Some of the plates were published bound in Buffon's *Histoire naturelle des oiseaux*, but all of them were also published separately. Many plates include the name of the engraver, Martinet, who changed employers with the transfer of Réaumur's birds from Brisson to Buffon (Cowan 1967, 1968, Farber 1982:12, 22).

Buffon's main collaborator for the text on birds was initially his long-time friend, Guéneau de Montbeillard (died 1785), who lasted through volume six but tired of Buffon's constant pressure for his articles, which were corrected and returned for changes (Roger 1997*a*:381–382). Guéneau was "overworked and in poor health" when he quit (Kay 1970:107). He was replaced by Gabriel-Léopold-Charles-Amé Bexon (1747–1784), who had become an assistant to Buffon and Guéneau in 1772, and began to collaborate in writing articles in 1777. In the introduction to volume VII (1780) Buffon announced Guéneau's departure and Bexon's collaboration (Bremond d'Ars 1936, Kay 1970). Buffon also conferred on more than a dozen naturalists the honorific title of Correspondant du Cabinet du Roi in recognition of their contributions of information and specimens on birds from Europe and abroad (Anderson 1970–1971, 1973–1974, 1974, Farber 1982:18–19).

Buffon apparently thought in his later years that new species may have arisen from the wanderings of animals from their native land. Was this a theory of evolution? This question has been carefully examined (Wilkie 1956, 1959, Greene 1959, Lovejoy 1959, Bowler 1989:72–77, 1992:180–186, Gayon 1992:463–539), and although his relevant writings are ambiguous and contradictory, in his later years he seems to have had a vague hypothesis of devolution: new species possibly degenerated from original species after they migrated into new climates. Just how vague his thinking was on this subject is illustrated by this passage from the first volume of *Histoire naturelle des oiseaux* (1770–1783, I:38, translated in Stresemann 1975:56).

> *A sparrow or a warbler has perhaps twenty times as many relatives as an ostrich or a turkey; for by the number of relatives I understand the number of related species that are sufficiently alike among themselves to be considered side branches of the same stem, or at least ramifications of stems that grow so closely together that one can suspect they have a common root, and can assume that originally they all sprang from this root, of which one is reminded by the large number of their shared similarities; and these related species probably have separated only through the influence of climate, food, and the procession of years, which brings into being every realizable combination and allows every possibility of variation, perfection, alteration, and degeneration to become manifest.*

In conclusion, Buffon sponsored and substantially wrote a series of thick volumes on the natural history of mammals and birds, and these volumes attracted a wide audience. His theoretical ideas were often rather vague and changed over time, but those ideas were probably less important as background for ecology than were the narrative natural histories.

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