

The Development of Taxidermy and the History of Ornithology

By Paul Lawrence Farber*

INTRODUCTION

On MAY 25, 1749, in response to an inquiry concerning a rumor that a catalogue of the Cabinet du Roi at the Jardin du Roi was being printed, René-Antoine Ferchault de Réaumur (1688–1757) wrote to an acquaintance that Georges-Louis Leclerc de Buffon (1707–1788), *Intendant* of the Jardin du Roi, and Louis-Jean-Marie Daubenton (1716–1800), *Garde* of the Cabinet du Roi, had expanded their original mandate to publish such a description and had announced a plan to print a universal natural history.¹ Réaumur went on to express his skepticism regarding the project. He suspected that it would be largely encyclopedic, drawing on the observations recorded by other naturalists and explorers; for the Cabinet du Roi, although rich in plants, precious stones, and shells, lacked a substantial collection of ores, insects, and birds. Moreover, the few birds in the Cabinet du Roi had been largely destroyed by insects during the past year, because they were not prepared so as to resist attack.²

Considering the animosity between Réaumur and Buffon,³ one might regard Réaumur's skeptical remarks about the project and his appraisal of the collection as a veiled expression of hostility. To dismiss it as such, however, would be to overlook a statement of one of the major technical problems confronting naturalists of the eighteenth century: the preservation of specimens. That the bird skins in the Cabinet du Roi were ruined by insect pests does not indicate negligence on Daubenton's part; rather it indicates the state of taxidermy at the time. The subject is worth pursuing. During the eighteenth century European naturalists and collectors came to possess an enormous quantity of information and material sent back from Africa, Asia, and

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*Department of General Science, Oregon State University, Corvallis, Oregon 97331.

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¹*Lettres inédites de Réaumur* (La Rochelle: Académie des Belles Lettres, Sciences et Arts de la Rochelle, 1886), pp. 78–79.

²*Ibid.*

³For a discussion of this antipathy see Jean Torlais, "Une rivalité célèbre: Réaumur et Buffon," *Presse médicale*, June 1958, 66(46):1057–1058, and his biography: *Réaumur, un esprit encyclopédique en dehors de "l'Encyclopédie"* (Paris: Desclée de Brouwer, 1936).

the New World by explorers, colonists, and professional naturalist-collectors.⁴ The resultant expanded empirical base for natural history raised technical, theoretical, and philosophical problems, and the solutions to these problems constituted many of the preconditions for the emergence late in the century of specialized disciplines such as ornithology. This article will investigate the history of one key problem: the preservation of bird specimens.

THE PROBLEM

That Part of Natural History which can offer to us the largest Series of agreeable Objects and actually offers a vast Number which are not sought after merely for the Pleasure of looking upon them; viz. that Part which treats of Birds, has remained as yet very imperfect, nor has it yet made them sufficiently known to us, because no considerable Collections have hitherto been made of them; and those who had begun to make any soon became weary of going on, having had the Mortification to see them every Day destroyed by ravenous Insects, in spite of all the care that had been taken to preserve them against their Teeth.⁵

When Réaumur published the small pamphlet that contained this statement he was in the process of assembling an ornithological collection larger than any then extant. As his remarks indicate, he believed that the problem of preserving bird skins had impeded others from making permanent collections, and he promised to the public a work describing an easy means for conserving dead birds.⁶ Unfortunately, Réaumur did not live long enough to publish this projected treatise on taxidermy, and so his pamphlet on preparing avian specimens for shipment constituted what most of his

⁴The influx of natural history data into Europe is described in Paul Fournier, *Voyages et découvertes scientifiques des missionnaires naturalistes Français a travers le monde pendant cinq siècles* (Paris: Lechevalier, 1932), Raymond P. Stearns, *Science in the British Colonies of America* (Urbana: University of Illinois Press, 1970), and Adrien Davy de Virville, *Histoire de la botanique en France* (Paris: Société d'édition d'enseignement supérieur, 1954).

⁵René-Antoine Ferchault de Réaumur, "Divers Means for preserving from Corruption dead Birds, intended to be sent to remote Countries, so that they may arrive there in good Condition. Some of the same Means may be employed for preserving Quadrapeds, Reptiles, Fishes, and Insects, by M. de Reaumur, F.R.S. and Memb. Royal Acad. Sc. Paris. translated from the French by Phil. Hen. Zollman, Esq; F.R.S.," *Philosophical Transactions of the Royal Society*, 1748, 45:305. I have quoted this eighteenth-century translation because it retains the style of the time and because it is more widely available than the original and now very rare pamphlet by Réaumur: *Différens moyens d'empêcher de se corrompre les oiseaux morts qu'on veut envoyer dans des pays éloignez et de les y faire arriver bien conditionnez. Quelques-uns de ces mêmes moyens peuvent être aussi employez pour conserver des quadrapèdes, des reptiles, des poissons et des insectes* (n.p., n.d.). In the original the quotation is on p. 1. All other translations are by the author unless otherwise noted. Although the above-mentioned pamphlet is now scarce, Réaumur wrote in Jan. 1746, in a letter to Abraham Trembley (1700–1784), "J'ai distribué dans toutes les parties de l'Europe et dans toutes celles du monde un petit imprimé dont vous trouverez ici un exemplaire." This letter is printed in Maurice Trembley, *Correspondance inédite entre Réaumur et Abraham Trembley* (Geneva: Georg, 1943), p. 250.

⁶Réaumur, *Différens moyens*, p. 1. Réaumur referred to this projected work and restated his opinion that the progress of ornithology had been checked by the ignorance of proper taxidermic methods in "Moyens d'empêcher l'évaporation des liqueurs spiritueuses, dans lesquelles on veut conserver des productions de la nature de différens genres," *Mémoires de l'Académie Royale des Sciences, Année M.DCCXLVI*, pp. 485–486. The dossier "Réaumur" at the Archives de l'Académie des Sciences de Paris contains numerous manuscripts in Réaumur's hand of observations and experiments on the preservation of dead birds. Many of these appear to be written after 1746 and suggest that Réaumur did not publish his treatise on taxidermy in the late 1740s because he had not finished his studies on the subject. Some naturalists of the second half of the eighteenth century claimed that Réaumur relied exclusively on fumigation to keep his collection free of insects. The manuscripts in the Réaumur dossier show that he was searching for a better method.

contemporaries knew of his methods. Written primarily for amateurs and travelers in the colonies, the pamphlet describes several standard preserving techniques.

The first, and according to Réaumur the method most commonly practiced, is to remove the skin from the bird's body and to stuff it with a soft substance (such as flax, wool, hay) or to stretch it over a solid mold that approximates the actual shape of the living animal.⁷ Réaumur warned his readers that this method requires considerable skill and suggested a second procedure that is simpler. This consists of transporting in strong brandy the bird skin after it has been washed of any blood, gutted, the body cavity stuffed, and wrapped in such a manner as to protect the feathers from becoming rumped. Small birds may be placed in glass jars or in wooden barrels. The latter is preferable, since barrels are less likely to break in transit and are capable of holding large birds as well as many smaller ones. Better yet, after the birds have soaked in brandy (a minimum of eight days to six weeks depending upon the size) they may be taken out and packed in chaff or straw in a box, which must then be very carefully sealed to prevent insects from penetrating. Brandy keeps the flesh from rotting but will not render the bird body resistant to pests.

Embalming, the third method described by Réaumur, also checks decay but does not ward off insects. To embalm a bird the preparator empties the body of the bird, then fills it and the neck with either aromatic spices or a drying agent such as alum or lime.⁸ The bird is next placed in the container in which it is to be shipped, buried in more of the powder, and allowed to dry for several weeks. Réaumur's fourth method

⁷There were several variations of this technique. E.g., James Petiver (1660?–1718), the famous English collector, requested in the advertisement prefacing his *Musei Petiveriana centuria quarta & quinta* (London: Smith and Walford, 1628), that persons sending him small birds should stuff the skins with "Ockam [Oakum] or Tow mixt with Pitch or Tar, and being thoroughly dried in the Sun, wrap them up close and keep from moisture." For an interesting discussion of Petiver and natural history collecting, as well as a reprint of Petiver's "Brief Directions for the Easie Making and Preserving Collections of all Natural Curiosities"—a now scarce printed sheet similar in intent to Réaumur's pamphlet—see Raymond P. Stearns, "James Petiver, Promoter of Natural Science," *Proceedings of the American Antiquarian Society*, 1952, N.S., 42:243–365.

⁸Embalming had been a suggested method for a long time. Pierre Belon (1517–1564) advised the use of salt in his *L'histoire de la nature des oyseaux* (Paris: Cauellat, 1555), Vol. I, p. 8. Manasseh Cutler (1742–1823) suggested that bird skins be cured with equal parts of alum, saltpeter, and pepper, then dried in an oven. See "Doctor Cutler's Method of Preserving the Skins of Birds," *Collections of the Massachusetts Historical Society*, 1795, 4:9–10. Pehr Kalm (1716–1779) reported, when he visited England on his way to America in 1748, that Mark Catesby (1683–1749) sprinkled snuff on the inside of the gutted bird and then dried it in an oven, after which he sprinkled snuff all over the bird to keep away insects. See Pehr Kalm, *Kalm's Account of His Visit to England on His Way to America in 1748*, trans. Joseph Lucas (London: Macmillan, 1892), pp. 51–52. The anonymous article "Von Verwahrung der Vogel und Thiere mit einem sonderlichen balsamischen Geiste," in the *Hamburgisches Magazin*, 1756, 16:92–95 gives a recipe composed of aromatics. In spite of the variety of substances used, embalming materials were not always available to collectors in the colonies. For example, Pierre Poivre (1719–1786), one of Réaumur's main suppliers of bird specimens, complained in a letter written in 1757, "vous serés surpris que j'aie encore suivre mon ancienne methode pour la conservation des oiseaux, et que je n'aie pas Suivre celle que vous m'avés apprise par vous derniers lettres: mais vous m'excuserés quand vous sçaurés que cette methode est impracticable dans les país surtout ou j'ai faites mes collections on n'y trouve ni baril ni tonellier, ni alum, ni Sel. on a bien de la peine a avoir le dernier article pour les besoin de la vie, et nos colonies manquent absolument de tout, point d'alum point d'espirit de vin, point de drouges etc." Letter from Poivre to Réaumur, Mar. 19, 1757, dossier "Poivre," Archives de l'Académie des Sciences de Paris. Although Réaumur's pamphlet describes four methods, in his personal letters he seems to have stressed embalming to men in the colonies—in spite of the problems of which Poivre complained. Jean Chaia in his article "Sur un correspondance inédite de Réaumur avec Artur, premier médecin du Roy à Cayenne," *Episteme*, 1968, 2:36–57, 121–138, reproduces a letter that Réaumur wrote (May 1, 1746) to Jacques-François Artur (1708–1779) in which he advises that important collector to employ this third method using alum, aromatics, and so forth.

is a variation of his third one. It is essentially a faster method of drying the bird by placing the gutted specimen, stuffed with soft material to reduce shrinkage and held by a frame to maintain a natural attitude, in an oven that is not excessively hot.⁹

The four methods described by Réaumur were inadequate for the needs of the time. Réaumur himself noted that the main impediment in the development of major ornithological collections—and hence in the development of ornithology—was the problem of insect pests. Although one could prevent immediate deterioration of bird specimens and could transport them great distances, using the techniques outlined above, the danger of the destruction of collections by insects remained. It also came to be realized, later in the eighteenth century, that the methods themselves caused serious problems. Prolonged contact with alcohol damaged bird feathers and distorted the bird's flesh. Salt and alum ultimately caused disintegration of the specimen. Oven heat often made the flesh brittle, and the failure to remove all fat, especially with birds such as ducks and geese, led to stained plumage and deterioration.

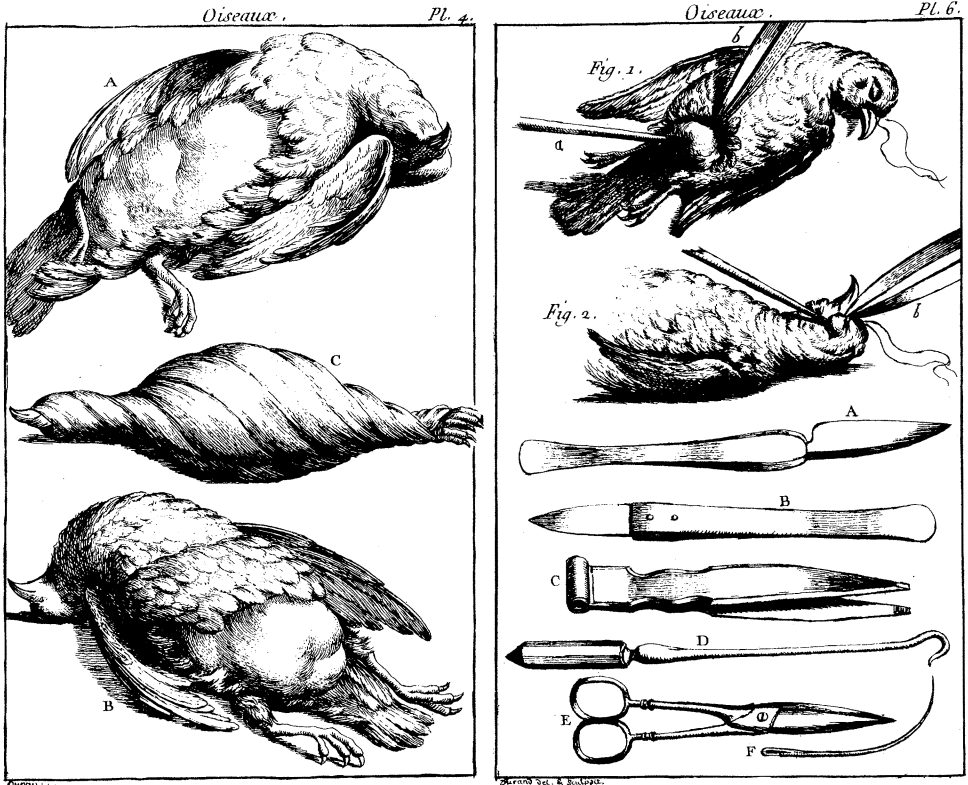
Although the techniques described by Réaumur were insufficient to insure a lasting collection, they continued to be the major taxidermic procedures for many years. We can see evidence of this by looking at what was perhaps the earliest treatise on taxidermy, the *Mémoire instructif sur la manière de rassembler, de préparer, de conserver et d'envoyer les diverses curiosités d'histoire naturelle* by Étienne-François Turgot (1721–1788).¹⁰ Although the *Mémoire instructif* discusses methods of preserving “les différentes Curiosités d’Histoire Naturelle,” the preparation of birds occupies the first and most extensive chapter and reflects Turgot's belief that birds present the most difficult problems for the naturalist. Turgot recommended that most birds be skinned, and he described several procedures, all of which call for emptying the skull and leaving it and some of the wing and leg bones in place. After the skin has been removed from the carcass, as much fat as possible is removed from the skin and the inside of it sprinkled with alum and camphor. It is then stuffed with a soft material, wrapped with a strip of linen, and placed in a box filled with cotton containing substances with a “strong and penetrating odor.”¹¹ Lastly, the box is carefully sealed. Small birds need only be gutted and placed in *eau-de-vie* which, since the alcohol extracts blood and fat from the body, will have to be replaced with fresh *eau-de-vie*, this time diluted with water and mixed with alum. Birds to be sent a short distance are to be treated like small birds, with the difference that after they have soaked in strong *eau-de-vie* for fifteen days they may be removed, packed in soft materials, and dispatched.

With the exception of its caveat concerning the removal of fat, Turgot's manual did not progress much beyond Réaumur's. Although longer and more detailed, especially concerning the skinning of birds, the manual concentrates on preparing birds for shipment and does not attempt to provide an answer to the pressing question of how to preserve collections of bird specimens once they arrive at their destination.

⁹Réaumur was especially taken with this last method because it produced specimens that looked natural. For his enthusiasm over this method see his letter of Mar. 25, 1749, to Artur in Chaia, “Sur une correspondance inédite de Réaumur,” p. 125.

¹⁰[Etienne-François Turgot], *Mémoire instructif sur la manière de rassembler, de préparer, de conserver et d'envoyer les diverses curiosités d'histoire naturelle* (Paris: Bruyset, 1758).

¹¹“Matières d'une odeur forte & pénétrante, soit du piment, soit du camphre, soit des étoupes on du coton imbibés d'essence de térébenthine” (*ibid.*, p. 13). Turgot warned his readers that if they used the latter, they must be careful that none of it touched the skin, for it would ruin the feathers.



Two plates from one of the earliest treatises on taxidermy, Etienne-François Turgot's *Mémoire instructif sur la manière de rassembler, de préparer, de conserver, et d'envoyer les diverses curiosités d'histoire naturelle* (Lyon: Bruyset, 1758), Plts. 4 and 6. The one on the left shows three bird skins stuffed with soft materials, one bird being wrapped with a strip of linen. The plate on the right illustrates stuffing a bird with cotton, placing cotton in an eye socket, and tools for taxidermy.

TOWARD THE DEVELOPMENT OF A SATISFACTORY METHOD

In 1770 the Royal Society of London received four letters addressed to the president and members of the society from Mr. Tesser Samuel Kuckahn (d. 1776) on the preservation of dead birds.¹² His first letter frankly states the exasperation felt by European naturalists over the state of taxidermy since Réaumur first called attention to the problem of maintaining collections:

Considering the number of virtuosi, who apply themselves to the collecting natural curiosities of the insect, bird, and beast kinds, it is surprizing that so few have endeavoured to discover effectual means of preserving their curiosities, when collected . . . it is too common to see people, for want of knowing better methods, persevering in those which their own experience, and that of their acquaintance, daily convinces them are ineffectual: although they have the mortification of seeing their collections, which have been made with great trouble and expence, continually dropping into decay. I think I have

¹²"Four Letters from Mr. T. S. Kuckhan [sic], to the President and Members of the Royal Society, on the Preservation of Dead Birds," *Phil. Trans.*, 1771, 60:302-320.

tried most, if not all, the methods that have been published or practised for many years past, with all the care and attention I could, and it was not till after the loss of much time and many fine subjects, birds in particular, that I set myself to find out such methods, drugs, and liquors, as would effectively penetrate and perfectly cure all the parts, so as to keep them plump and full.¹³

In the detailed criticism of the various methods employed in his day which followed, Kuckahn not only stressed the insufficiency of the techniques to maintain the specimen in a proper state of preservation, but also complained that the prepared birds totally failed to simulate the bird in its natural state. His second letter cautions the reader to take great care when collecting birds. The collector must not allow blood to ruin the feathers, and he must take into account the season and age as well as the sex of the bird. Most importantly, however, he should note the bird's behavior so as to be able to recreate a realistic pose in the finished museum specimen.

His third letter describes the two mixtures to be used in preserving: a liquid varnish made of raw turpentine, camphor, and spirit of turpentine; and a dry compound made of corrosive sublimate, saltpeter, alum, sulfur, musk, pepper, and ground tobacco. His last letter details his entire method. This calls for the collector to remove the soft inner parts of the bird and as much flesh as possible, then to apply the varnish and the powder to all the remaining portions and to the skin. Next, the skin is stuffed with tansy, wormwood, hops, and tobacco. An artificial wooden breastbone is inserted, and the eyes are replaced with large beads. Brass or iron wires are then inserted into the bird to arrange it in a lifelike pose. The final steps are to varnish the feet and bill and to dry the bird in an oven.

Birds so treated, according to Kuckahn, are perfectly preserved, however still subject to insect attack. Therefore, avian specimens should be carefully enclosed in sealed cases that have been washed with camphor and spirit of turpentine. As a final piece of advice, Kuckahn suggested that the cases be occasionally washed, that they be kept in a dry room out of direct sunlight, and that the birds be periodically baked to destroy insect eggs.

Kuckahn's procedures were clearly addressed to the problems of maintaining an ornithological collection, and in this sense he went further than Réaumur or Turgot, who published advice on the preparation of birds for transport only. The Royal Society must have been impressed by Kuckahn's procedures, for they elected him a fellow in 1772, and his certificate states that he was "well versed in natural history and already known to the Royal Society and the public by his curious observations on the best methods of preserving birds and the specimens he has given of his great skill in preparing them and readjusting some animals that were much damaged in the Society's museum."¹⁴

Kuckahn's reputation was not confined to the British Isles. In 1773 the abbé Jean-François Rozier (1734–1793) published a translation of the four letters in his journal *Observations sur la physique, sur l'histoire naturelle et sur les arts*.¹⁵ While Kuckahn's evaluation of the state of taxidermy was appreciated in France, his proposals were

¹³*Ibid.*, pp. 302–303.

¹⁴*Certificates of the Royal Society, 1767–1778*, unpagged. The Royal Society was especially concerned with taxidermy at this time, for it had just been given a large gift of material from the Hudson Bay Company and was planning a large-scale collecting project in the New World. See Stearns, *Science in the British Colonies*, pp. 254–376, for a discussion of the society's plans.

¹⁵"Sur la maniere d'embaumer les oiseaux," *Observations sur la physique, sur l'histoire naturelle et sur les arts*, 1773, 2:147–154. This journal is often referred to as *Journal de physique*, the short form of its later title.

subjected to critical scrutiny. Pierre-Jean-Claude Mauduyt da la Varenne (1730–1792), physician, naturalist, and later the author of the *Ornithologie* in the *Encyclopédie méthodique*, cogently argued that Kuckahn's method did not improve upon earlier techniques and was open to the same criticisms:

The author concludes his four letters by warning that birds prepared by his method will be destroyed by moths in a short time if they are not enclosed in well sealed cases. But this drawback is precisely the weakness of all the other methods. If this is the case, as he admits, then his method is not preferable to those used by other men. I would say, in addition, that it is not even equal to the other methods, for it demands precautions and expense which the others do not require, and by following it one nevertheless equally fails to obtain one's goal. But more importantly, the reason that we must reject his method is that it exposes one, for no purpose, to the great risks of fire and poison.

The author of the method I am discussing prescribes in one passage the composition of a varnish made with spirit of turpentine, and in another passage the use of corrosive sublimate. There can be no person who is unaware of the risks that are involved in making varnishes. It demands great attention and requires the experience and skill of a trained artist. The thick, fetid, black vapor that heated turpentine emits, can catch fire suddenly, ignited by a light incautiously brought near, or igniting itself by a draft from an open window or door which pulls the smoke down on to the coals whose heat causes the vapors to rise. To give the recipe of such a varnish, to make it known to people ignorant of the details of a new and dangerous art, is to expose them to the almost certain danger of harming themselves, and to prepare for them—in what was undertaken for a simple amusement—the misfortune of seeing their ruin and that of their fellow citizens.

Corrosive sublimate is a dreadful poison, which should be entrusted only to an artist, who in harnessing or directing its force can produce a beneficial remedy. To place it into ignorant or reckless hands is to entrust them with a weapon with which by merely touching it they can injure themselves. Or if it is by chance stolen, one is exposed to the frightful consequences of recklessness and the crimes of spite, of jealousy, of cupidity, of vengeance, indeed, of all the passions. It is, then, with more than enough justification, that I have said that the proposed method exposes those instructed to dangers for which the risk alone is greater than the promised benefits, which it, moreover, cannot produce.¹⁶

After dismissing Kuckahn's four letters, Mauduyt took the occasion to comment on the general state of taxidermy:

I will first show empirically that most of the methods, perhaps all the methods, that have been proposed up till now concerning the preservation of dried animals from insect attack, are on the one hand dangerous and on the other do not produce that which they promise. I will next show by argument that such a method is partly very difficult to discover and partly not worth searching for because it seems to be impossible to find. I shall conclude by relating the surest methods and the easiest ways to supplement them.¹⁷

Mauduyt wrote that in his collection he had animals prepared according to all the known methods, plus specimens sent to him by numerous individuals who had employed strong poisons in a variety of ways and who claimed that their techniques were unailing.¹⁸ These latter specimens he placed in containers and introduced insect pests. Nothing else was added. He found that the insects not only devoured the "prey," but they multiplied as easily and in as great a number as they did when placed

¹⁶Pierre-Jean-Claude Mauduyt, "Lettre à l'auteur de ce Recueil, sur la maniere de conserver les animaux desséché," *Obs. phys. hist. nat. et arts*, 1773, 2:391.

¹⁷*Ibid.*, p. 392.

¹⁸Mauduyt owned a large *cabinet d'histoire naturelle* that was well known in its day. For an interesting discussion of these collections see Yves Laissus, "Les cabinets d'histoire naturelle," in René Taton, ed., *Enseignement et diffusion des sciences en France au XVIIIe siècle* (Paris: Hermann, 1964).

with untreated specimens.¹⁹ Alternative methods, he went on to show, were equally unacceptable, either because they ruined the specimen or were ineffective. To complete this glum picture he described the various insect pests and explained how and when they cause havoc. His final advice was that the collector should become familiar with the first signs of insect attack, fumigate the cases periodically,²⁰ and try to keep the cases tightly sealed.

CONFLICT

Mauduyt's letter to Rozier's journal has greater historical importance than its significance as a French criticism of Kuckahn's method. In May 1771 Mauduyt had received some birds, prepared according to a secret formula by Jean-Baptiste Bécœur (1718–1777), an apothecary and naturalist of Metz.²¹ Mauduyt's sweeping condemnation of taxidermic methods made no exception for Bécœur's preparation, and Bécœur was outraged by what he considered to be an unjust rejection of his technique. He had attempted numerous substances over a period of many years in his quest for a preservative that would protect specimens from all insect attack. He believed he had found a formula that annulled the exhalations which he thought were responsible for attracting various insect pests,²² but he was not ready to publish the details of his preservative. As he explained in 1775,

. . . it has cost me a lot of time and expenditure. . . . If my discovery concerned the health or welfare of men, I would hear only the cry of humanity and sacrifice to the public the fruit of my work. But as my secret cannot be placed in that class, I believe that I can wait without qualm while I am repaid for the trouble and expense that it has caused me. This is especially so considering its future use, for not only is it applicable to dried animals but also to furs, woolens, anatomical pieces; in a word, to anything subject to being consumed by insects. It is therefore something of great importance for commerce.²³

Bécœur was in an awkward situation. He believed that he had developed a commercially valuable preservative, and he wanted to profit by it. The problem confronting him was how to advertise his invention without revealing its secret. What Bécœur did was to attempt to gain fame for his preservative by having birds prepared by him placed on public display. To this end he presented several specimens to the Cabinet du Roi in 1755 with the hope of obtaining recognition from Buffon and Daubenton.²⁴ It was probably with similar intent that Bécœur gave Mauduyt some

¹⁹Mauduyt, "Lettre a l'auteur de ce recueil," p. 392.

²⁰Mauduyt suggested using the vapors of burning sulfur, a common method of fumigation at the time (*ibid.*, pp. 406–408).

²¹On Bécœur's life and career see Paul Dorveaux, "Les grands pharmaciens. XIV.—BÉCOEUR apothicaire à Metz et taxidermiste," *Bulletin de la Société d'Histoire de la Pharmacie*, 1923, No. 39:225–237 and No. 40:277–290. Dorveaux's study is the only extensive article on Bécœur. It draws heavily on the earlier biographical memoir read by Dominique-Nicolas-Hyacinthe-Louis Bardou-Duhamel before the Société Royale des Sciences et des Arts de Metz in 1778 (Bibliothèque Municipale de Metz, MS 1353) and later printed as "Mémoire historique sur Jean-Baptiste Bécœur," *Mémoires de l'Académie de Metz*, 1863–1864, 45:269–277. Bécœur states, on p. 139 of his "Lettre à M. Rousseau, auteur de ce Journal, sur un article du Journal de Physique," *Journal encyclopédique*, 1774, 3:135–151, that he gave Mauduyt several prepared birds.

²²Bécœur, "Lettre à M. Rousseau," p. 149.

²³Jean-Baptiste Bécœur, "Fin de la réplique de M. Bécœur à la lettre de M. Mauduyt, insérée dans le *Journal de physique* du mois de Novembre 1774," *J. encyc.*, 1775, 5:143.

²⁴Bécœur claimed that Buffon and Daubenton were impressed by his method. Bécœur quotes letters to this effect in his "Lettre à M. Rousseau." The original letters, to my knowledge, are not extant. The only detailed discussion of taxidermy by Buffon or Daubenton I have located is an unpublished memoir that

prepared birds in 1771. One can, therefore, appreciate his irritation over Mauduyt's article; for not only did it attempt to demonstrate the insufficiency of all the allegedly perfect methods, it also claimed that it was impossible to discover a satisfactory preservative.

In defense Bécœur published a sarcastic letter in the *Journal encyclopédique*, which opens with a scathing attack on the "pseudonymous author" whom he claimed forged Mauduyt's name.²⁵ He then criticized two of the main points of Mauduyt's article: his rejection, based on experiment, of the value of poisons as well as of all other preservatives, and his assertion of the futility of searching for an adequate preservative. The latter Bécœur dismissed as too defeatist to be taken seriously by naturalists. The former he examined more closely. If insects are starved they will eat anything, he reasoned, so that placing a preserved bird in a sealed box with them and observing its consequent destruction is not a conclusive experiment. Bécœur wanted to stress this, and it is not difficult to see why. His method claimed to eliminate the exhalations that *attracted* insects. Of course insects would decimate specimens if they were forced to. The issue, according to Bécœur, was whether or not insects would attack properly prepared birds if they had a choice. As an alternative experiment Bécœur suggested that birds prepared in different ways be placed with insects and then watched to see which one was attacked last. The one attacked last, or not at all, could then be judged as the one best preserved.

Bécœur also questioned Mauduyt's report that the insects that destroyed poisoned specimens flourished and reproduced as well as insects fed on unpoisoned specimens.

Buffon sent via Benjamin Franklin (1706–1790) to the American Philosophical Society. It is entitled "Memoir instructif sur la maniere de conserver les oiseaux et autres objects d'histoire naturelle, envoyé par M. Daubenton le jeune de la part de M. Le Comte de Buffon au Docteur Franklin pour être Communiqué à la Société Philosophique américaine établie à Philadelphie" (c. 1774). The memoir deals only with methods of transporting birds and other specimens from the colonies to France, and it is in the tradition of Réaumur and Turgot. Specifically it recommends that small birds be gutted, stuffed with cotton and aromatics, then allowed to dry. Larger birds are to be skinned first, and then prepared as the smaller ones. Finally, birds should be carefully packed in aromatics and shipped in tight cases. The manuscript is in the Historical Society of Pennsylvania (Library Company of Philadelphia Manuscripts).

²⁵Since Dorveau's calendar of the Mauduyt-Bécœur controversy is incomplete and slightly inaccurate (Dorveau, "Les Grands," p. 282) I shall list the references here:

1. Pierre-Jean-Claude Mauduyt, "Lettre à l'auteur de ce recueil, sur la maniere de conserver les animaux desséchés; par M. MAUDUIT, Docteur-Régent de la Faculté de Médecine en l'Université de Paris," *Obs. phys. hist. nat. et arts*, 1773, 2:390–412.
2. Jean-Baptiste Bécœur, "Lettre à M. Rousseau, auteur de ce Journal, sur un article du Journal de Physique," *J. encyc.*, 1774, 3:135–151.
3. Pierre-Jean-Claude Mauduyt, "Réponse de M. Mauduit, médecin de la Faculté de Paris, à une Lettre de M. BÉCOEUR, apothicaire à Metz, adressée à M. Rousseau; insérée dans le Journal Encyclopédique du mois d'Avril 1774," *Obs. phys. hist. nat. et arts*, 1774, 3:360–367. This letter, with the addition of a short note by M. Rousseau supporting Bécœur, the absence of a short unsigned editor's note supporting Mauduyt, and a few minor changes also appeared as: "Réponse de M. Mauduyt, médecin de la faculté de Paris, à une lettre de M. Bécœur, apothicaire à Metz," *J. encyc.*, 1774, 4:523–533.
4. Jean-Baptiste Bécœur, "Réponse de M. Bécœur, à la lettre de M. Mauduit, médecin de la faculté de Paris, insérée dans le *Journal encyclopédique du 15 Juin dernier*," *J. encyc.*, 1774, 6:513–524.
5. Jean-Baptiste Bécœur, "Fin de la réponse de M. Bécœur à la lettre de M. Mauduit, médecin de la faculté de Paris, insérée dans le *Journal encyclopédique du 15 Juin dernier*," *J. encyc.*, 1774, 7:129–138.
6. Pierre-Jean-Claude Mauduyt, "Réponse de M. Mauduit, docteur-régent, de la Faculté de Médecine de Paris; à la seconde critique de M. BÉCOEUR, apothicaire à Metz; insérée dans le second volume de Septembre du Journal encyclopédique de 1774," *Obs. phys. hist. nat. et arts*, 1774, 4:397–400.
7. Jean-Baptiste Bécœur, "Réplique de M. Bécœur à la lettre de M. Mauduit, insérée dans le *Journal de physique* du mois de Novembre 1774," *J. encyc.*, 1775, 4:495–505.
8. Jean-Baptiste Bécœur, "Fin de la réplique de M. Bécœur à la lettre de M. Mauduit, insérée dans le *Journal de physique* du mois de Novembre 1774," *J. encyc.*, 1775, 5:142–147.

After quoting Mauduyt's conclusion that poisons are useless since they have no effect on insects, Bécoeur wrote: "It is unfortunate that this inference cannot be supported. The nature of the poisons cited by the author would have to have changed completely in order that their destructive virtue be inactive against twelve or fifteen species of the four or five different genera which ruin our collections. The poison would even have to have for them a fecundating property."²⁶

Bécoeur's discussion on poison is perplexing. He evidently desired to refute Mauduyt's assertion that poisons are ineffectual, and yet he went on to state that his preservative did not make use of them.²⁷ During his lifetime Bécoeur did not reveal his formula, but after he died his secret passed to the taxidermists of the Muséum National d'Histoire Naturelle.²⁸ It consists of a mixture of powdered white arsenic, soap, salt of tartar, camphor, and powdered lime.²⁹ One can only speculate about the inconsistency between Bécoeur's repudiation of poisons and the recipe for his arsenical soap. Considering the potentially lucrative possibilities of his invention, he might have been deliberately misleading his competitors. Or perhaps when he criticized the use of poisons he meant only substances that give off poisonous vapors or that are caustic.³⁰ Whatever his motive was, he disagreed with Mauduyt's alternative recommendation—periodic fumigations. These Bécoeur believed would in time ruin the appearance of the collection.

The Bécoeur-Mauduyt controversy resulted in a series of letters by the two protagonists. The debate was not, however, very fruitful. Mauduyt responded, in no uncertain terms, that he indeed was the author of the *Journal de physique* article.³¹ On that point there was no further disagreement; on all the other issues they remained at loggerheads. Mauduyt tried to explain the survival of insects after they had destroyed poisoned specimens with the highly questionable assertion that it was due to their fine discriminating sense organs which allowed them to select the morsels of flesh from among the poisonous molecules. On the experimental design itself, he held it to be adequate and did not accept Bécoeur's alternative suggestion.³²

It is not necessary to repeat all the details of their dispute. Each cited examples to support his position, each rejected the arguments of his opponent, and the debate remained unresolved.³³ Bécoeur refused to make public the formula of his preserva-

²⁶Bécoeur, "Lettre à M. Rousseau," p. 138.

²⁷*Ibid.*, pp. 138, 142.

²⁸The Muséum was the name given to the Jardin du Roi and the Cabinet du Roi after its reorganization in 1793. It is not clear exactly how the secret passed to the naturalists of the Muséum. Dorveaux, in his article "Les grand pharmaciens," p. 286, wrote that one of Bécoeur's nephews worked at the Muséum, and it was through him that the formula became known.

²⁹See notes 43 and 44 below for details of the recipe.

³⁰Immediately following his statement that poisons are not necessary to preserve birds Bécoeur wrote: "Il y a trente ans que j'ai fait ma découverte, & que je manie mon préservatif; il y en a vingt-cinq que je couche dans le cabinet où je conserve ma collection; & jamais (quoique la piece soit forte resserrée par la multitude des animaux), ni la vapeur de ceux-ci, ni le maniment de mon spécifique, n'ont dérangé ma santé" ("Lettre à M. Rousseau," p. 138).

³¹Mauduyt, "Réponse . . . à une lettre," p. 360.

³²*Ibid.*, p. 362.

³³Mauduyt recognized the degree of disagreement and stated: "Il n'est pas possible de concilier nos deux sentimens; il nous reste donc à défendre chacun le nôtre. Nous pouvons à ce sujet recueillir l'avis des personnes éclairées, ou avoir recours au raisonnement" (*ibid.*). Bécoeur recognized the difficulty of trying to convince Mauduyt that he had an adequate solution to the problem, and in the first part of his final two-part letter on the subject wrote: "Tout le monde sçait le trait de ce sophiste qui nioit le mouvement. Pour toute réponse, quelqu'un se mit à marcher devant lui. Je crois vous avoir présenté un argument pareil à celui de cet homme qui confondit le raisonneur subtil, & je crois devoir de même, après cela, imiter son silence" (Bécoeur, "Réplique," p. 498).

tive so that it could be tested by others, and Mauduyt held that his experiment demonstrated the insufficiency of Bécœur's preservative. When Bécœur died in December 1777 it appeared that the controversy, although inconclusive, had ended.³⁴

During the last decades of the eighteenth century and first part of the nineteenth, naturalists continued to devise new methods of preservation. The two most well known were those put forth by the abbé Denis-Joseph Manesse (1743–1820) and Pierre-François Nicolas (1743–1816). Manesse contended that insects were attracted to bird skins by the decomposing fat left on the skins. He claimed that poisons were ineffective against the attacks of ravaging insects but that one could chemically remove the oily materials from the bird skins and thereby get at the root of the problem.³⁵ The logic of Manesse's argument was valid, but unfortunately experience soon showed that the desired result was not obtained by following his long and complicated instructions. Nicolas appreciated Manesse's attention to the removal of fat from bird skins, but he felt that some additional protection was necessary. Like Mauduyt and Manesse he rejected the use of poisons;³⁶ instead, he proposed a two-step procedure that called for soaking the skin in a tanning solution and then treating it with a soapy pomade.³⁷ Though Nicolas claimed to have had extraordinary success with his technique, other naturalists failed to duplicate his results, and for this reason his method did not win many adherents.

Other writings on preservation during this period made use of earlier techniques. Philippe Pinel's (1745–1826) instructions to the expedition sent to search for Jean-François de Galoupe de La Pérouse (1741–1788) relied on Kuckahn's method, supplemented with some arsenic.³⁸ Marie-Jacques-Philippe Mouton-Fontenille de la Clotte (1769–1837) and Jacques-Marie Hénon (1750–1809) in their popular manual reviewed all the known methods but relied primarily on the spirit of turpentine to protect bird skins.³⁹

RESOLUTION

During the Bécœur-Mauduyt controversy naturalists were aware of the claims and counterclaims concerning the use of violent poisons to protect bird specimens. And

³⁴Even the test of time proved inconclusive—and ironic. After Bécœur's death his collection was purchased by the Duke Carl II von Pfalz-Zweibrücken (1746–1796), who also purchased Mauduyt's collection. Both collections were destroyed by invading French republican troops in 1793 when they burned the duke's castle. See Ernst Hartert, "Eine bedeutende Vogelsammlung des 18. Jahrhunderts," *Ornithologische Monatsberichte*, 1923, 31(4):73–75 for a brief description of the duke's collection based on a catalogue uncovered by the author that mentions the presence of Mauduyt's collection. François Levillant, *Histoire naturelle des Oiseaux d'Afrique* (Paris: Gide, 1824), Vol. II, p. 74, states that Bécœur's collection was purchased by the duke after Bécœur's death. Wilhelm Petry, "Eine bedeutende Vogelsammlung des 18. Jahrhunderts," *Ornith. Monatsber.*, 1937, 45(5):157–162 describes the destruction of the duke's collection.

³⁵The abbé Denis-Joseph Manesse described his experiments and explained his techniques in his *Traité sur la manière d'empailler et de conserver les animaux, les pelleteries et les laines* (Paris: Guillot, 1787).

³⁶Nicolas had taken part in the Mauduyt-Bécœur controversy by publishing in Rozier's journal a short article that rejected the use of poisons and claimed a better method of preserving bird skins from insect attack. See, Pierre-François Nicolas, "Supplément à la réponse de M. Mauduyt, docteur en médecine de la Faculté de Paris, à une lettre de M. Bécœur, apothicaire à Metz, insérée dans le *Journal Encyclopédique* du mois d'avril 1774," *Obs. phys. hist. nat. et arts*, 1774, 4:150–154.

³⁷Nicolas' instructions, along with lengthy discussions of alternative methods, which he considered inferior to his, can be found in his *Méthode de préparer et conserver les animaux de toutes les classes, pour les cabinets d'histoire naturelle* (Paris: Buisson, 1801).

³⁸Philippe Pinel, "Mémoire lu à la Société d'Histoire Naturelle, sur les moyens de préparer les quadrupèdes, & les oiseaux destinés à former des collections d'histoire naturelle," *Obs. phys. hist. nat. et arts*, 1791, 39:138–151.

³⁹Marie-Jacques-Philippe Mouton-Fontenille de la Clotte and Jacques-Marie Hénon, *Observations et*

although the use of poison continued to be decried as ineffectual or hazardous (or both), by 1830 arsenic, especially arsenical soap, had become the standard preservative against insect attack.⁴⁰ It came to be so for two reasons: first, because it worked, and second, because it was adopted and popularized by the preparators at the Muséum National d'Histoire Naturelle. There is not much to say about the first reason: arsenical compounds are effective poisons and have proven their worth as insecticides.⁴¹ The second reason needs further elaboration. Bécoeur had had some contacts with the Jardin du Roi and had given prepared birds to the Cabinet du Roi. In his own lifetime, however, he did not reveal the formula for his arsenical soap. After his death, his secret passed to the taxidermists of the Muséum and became the method of preparation there.⁴² Louis Dufresne (1752–1832), the most famous of the Muséum taxidermists, popularized Bécoeur's formula,⁴³ first in an article on taxidermy which he wrote for the *Nouveau dictionnaire d'histoire naturelle* and then in a separately published extract from the expanded second edition of the *Nouveau dictionnaire*.⁴⁴ Dufresne's endorsement impressed many naturalists, because what he was describing was the method used at the Muséum, which then had one of the largest and most important collections of preserved birds. Moreover, it was a collection known to be in an excellent state of preservation. Dufresne also had a

experiences sur l'art d'empailler et de conserver les oiseaux (Lyon: Bruyset, 1801). The second edition of this work was enlarged and entitled *L'art d'empailler les oiseaux* (Lyon: Bruyset, 1802).

⁴⁰There is the major exception of Charles Waterton (1782–1865), who advised the use of corrosive sublimate dissolved in alcohol. See his *Wanderings in South America, the Northwest of the United States, and the Antilles in the Years 1812, 1816, 1820, & 1824, with Original Instructions for the Perfect Preservation of Birds, &c. for Cabinets of Natural History* (London: Mawman, 1825). Waterton believed that dissolving corrosive sublimate in alcohol was better than dissolving corrosive sublimate in water, since the alcohol could better penetrate the specimen. In this sense Waterton's method may be regarded as an attempt to improve upon Kuckahn's use of dry corrosive sublimate or Johann Reinhold Foster's (1729–1798) suggestion to use corrosive sublimate or arsenic dissolved in water as a preservative. See Foster's *A Catalogue of the Animals of North America. Containing an Enumeration of the Known Quadrupeds, Birds, Reptiles, Fish, Insects, Crustaceous and Testaceous Animals; Many of Which Are New, and Never Described Before. To Which are Added, Short Directions for Collecting, Preserving and Transporting, all Kinds of Natural Curiosities* (London: White, 1771). Unfortunately corrosive sublimate causes bird skins to disintegrate.

⁴¹They have been accepted not without concern over the deleterious effects arsenical compounds can have on man. See, e.g., James Whorton, "Insecticide Spray Residues and Public Health: 1865–1938," *Bulletin of the History of Medicine*, 1971, 45(3):219–241. Recently W. D. Buchanan has written, "In the relevant literature, there is a frequent reference to the hazard to taxidermists arising from the use of arsenious oxide." See W. D. Buchanan, *Toxicity of Arsenic Compounds* (Amsterdam: Elsevier, 1962), p. 55.

⁴²I do not want to imply that Bécoeur was the only person ever to think of using arsenic. As I have mentioned in n. 40, Foster recommended arsenic dissolved in water. Similarly, Charles Wilson Peale (1741–1827) independently discovered the value of arsenic when he began putting together his famous collection of birds. See Charles Coleman Sellers, *Charles Wilson Peale* (Philadelphia: American Philosophical Society, 1947), Vol. I, p. 253.

⁴³Bécoeur's formula was first printed by François-Marie Daudin (1774–1804) in his *Traité élémentaire et complet d'ornithologie, ou histoire naturelle des oiseaux* (Paris: Bertrandet, 1800), pp. 445–446. Daudin stated that he was given the information by Dufresne. The following year (1801) Nicolas, in his *Méthode de préparer et conserver les animaux*, also described Bécoeur's recipe, although he stated that it was ineffectual.

⁴⁴*Nouveau dictionnaire d'histoire naturelle* (Paris: Deterville, 1803–1804). The second edition was published between 1816 and 1819, and the extract came out as *Taxidermie ou l'art de préparer et de conserver la dépouille de tous les animaux, pour les musées, les cabinets d'histoire naturelle, . . .* (Paris: Deterville, 1820). Dufresne gave the following recipe on p. 13 of the last cited work:

Campre	5 onces.
Arsenic en poudre	2 livres.
Savon blanc	2 livres.
Sel de tartre	12 onces.
Chaux en poudre	4 onces.

personal collection of great repute, put together over a period of forty years, which he sold in 1819 to the University of Edinburgh.⁴⁵ The fine state of his collection was added evidence of the lasting value of Bécœur's arsenical soap.

A measure of Dufresne's success in popularizing Bécœur's formula can be judged by the proliferation of writings on taxidermy published during the nineteenth and early twentieth centuries. A review of that literature shows that instead of laments over the sad state of ornithological collections, as appeared in the eighteenth century, one finds dozens of treatises confidently describing methods of preserving birds—practically all of which recommend Bécœur's soap or some variation on it.⁴⁶ The collectors of the nineteenth century, then, no longer regarded taxidermy as a problem but considered it a technique.

SIGNIFICANCE

The emergence of ornithology, in the late eighteenth and early nineteenth centuries, as a professional discipline was contingent upon a set of preconditions. First, there had to be a sufficient amount of basic data relating to a set of interesting and fruitful questions. Next, appropriate institutional frameworks had to exist in which these questions could be investigated, discussed, and resolved. Finally, certain technical problems that had impeded the study of ornithology had to be solved.

Taxidermy was one such problem. Its importance can best be appreciated by describing its relationship to some of the other central developments in the emergence of ornithology. The most important of these was the establishment of large, stable collections at the end of the eighteenth and the beginning of the nineteenth centuries.⁴⁷ The permanence of these collections depended upon proper methods of preparation. In Paris Bécœur's arsenical soap was employed in what constituted

⁴⁵For a well-documented discussion of the sale of Dufresne's collection see Jessie M. Sweet, "The Collection of Louis Dufresne (1752–1832)," *Annals of Science*, 1970, 26:33–71. Sweet writes that the Dufresne collection contained 1,640 bird specimens and 800 eggs. Many of these specimens have been identified in the current collection of the Royal Scottish Museum. Although Dufresne's collection was famous for its fine state of preservation, it is ironic to note that the university museum later lost confidence in the efficacy of arsenic to ward off insects and supplemented its preservation technique by baking its specimens. See Jessie M. Sweet, "Instructions to Collectors: John Walker (1793) and Robert Jameson (1817); with Biographical Notes on James Anderson (L.L.D.) and James Anderson (M.D.)," *Ann. Sci.*, 1972, 29:397–414.

⁴⁶The major variation on Bécœur's method was the use of powdered arsenic. Some of the more important treatises are: Captain Thomas Brown, *The Taxidermist's Manual* (Glasgow: Fullarton, 1835); Edward Bowdich, *Taxidermy* (London: Longman, 1820); P. Évangéline, *L'art de préparer, monter et conserver les oiseaux, suivi de la manière de prendre, préparer et conserver les papillons et autres insectes* (Paris: Dentu, 1841); *Instructions pour les voyageurs et pour les employés dans les colonies, sur la manière de recueillir, de conserver et d'envoyer les objets d'histoire naturelle. Rédigée sur l'invitation de Son Excellence le Ministre de la Marine et des Colonies, par l'administration du Muséum royal d'histoire naturelle* (Paris: Belin, 1824); Johann Friedrich Naumann, *Taxidermie oder die Lehre Thiere aller Klassen am ein fachsten und zweckmässigsten für Naturaliensammlungen auszustopfen und aufzubewahren praktisch bearbeitet von J. Fr. Naumann* (Halle: Schwetschke, 1848); William T. Hornaday, *Taxidermy and Zoological Collecting* (New York: Scribners, 1891); and William Swainson's two works on the subject, *Instructions for Collecting and Preserving Zoological Subjects* (Liverpool: Harris, 1820) and *Taxidermy, Bibliography and Biography* (London: Longman, 1840). In the twentieth century: *Handbook of Instructions for Collectors, Issued by the British Museum (Natural History)* (London: British Museum [Natural History], 1902; numerous editions, the latest 1970); R. Didier and A. Boudarel, *L'art de la taxidermie au XX^e siècle* (Paris: Lechevalier, 1918); and Reginal Wagstaffe and J. Haverlock Fidler, *The Preservation of Natural History Specimens* (London: Witherby, 1968).

⁴⁷Hugh Strickland (1811–1853) in his "Report on the Recent Progress and Present State of Ornithology," *Report of the Fourteenth Meeting of the British Association for the Advancement of Science*, 1844: 216–217, lists the major ornithological collections of the period.

Europe's largest and most important public collection, that of the Muséum. In Holland, Coenraad Jacob Temminck (1778–1858) was also indebted to Bécœur's arsenical soap for the fine state of his collection, which at the time was thought the richest private collection in Europe.⁴⁸ By contrast, across the Channel, the specimens in the British Museum in the early part of the nineteenth century were being destroyed through neglect and lack of proper preservation.⁴⁹ To state that large ornithological collections came into being during the late eighteenth and early nineteenth centuries because the problems of taxidermy were solved would be inaccurate—the history of ornithological collections is considerably more complicated—however, it can be stated that without proper methods of preservation these collections could not have come into existence.

The ornithological museum, public or private, served to do more than charm the curious visitor with nature's beauty and richness. In a very meaningful sense these institutions determined the character of the nascent discipline of ornithology. They did so because they were the main locus of professional work. If one checks through the ornithological literature of the period, one finds that the predominant concerns centered on classification and bird lists, either comprehensive or local. These areas of research reflect the interests of men associated with large collections. Similarly, most of the major ornithologists are thought of and identified by their museum associations. Louis Pierre Vieillot (1748–1831), Georges Cuvier (1769–1832), René Lesson (1794–1849), and Henri-Marie Ducrotay de Blainville (1777–1850) were associated with the ornithological collection of the Muséum; George Robert Gray (1808–1872) with the British Museum; Heinrich Gottlieb Ludwig Reichenbach (1793–1879) with the Königlich-zoologisches Museum (Dresden); Johann Jakob Kaup (1803–1873) with the Grossherzoglichen Naturalien-Cabinet (Darmstadt); Temminck and Baron Frédéric de La Fresnaye (1783–1861) are thought of in connection with their own collections; and Charles-Lucien Bonaparte (1803–1857), the great cosmopolitan ornithologist, is known for having visited all the major collections in connection with his monumental bird lists. These men, and numerous others, were among the first researchers to have available to them large stable collections, and it is quite understandable that their first interests would be in classifications and catalogues.

Related to the interest in classification and bird lists, and also related indirectly to the consequences of improved taxidermic techniques, was the growing attention given to geographical distribution in the first half of the nineteenth century. In part this interest was a result of the observations made during the extensive explorations done by naturalists. Charles Darwin (1809–1882) and Alfred Russel Wallace (1823–1913) were two of the more famous of these zoologists who made long voyages and were struck by the facts of geographical distribution. The naturalists in museums

⁴⁸Temminck was doubly connected to the arsenical method. A sizable portion of his collection was purchased from William Bullock (fl. 1795–1840), who had one of the largest private collections in Europe, which he displayed in his London museum. Bullock was the author of *A Concise and Easy Method of Preserving Subjects of Natural History* (London: By the author, 1817), which advocates arsenic. More directly Temminck was linked to the arsenical method through a family friend, François Levaillant (1753–1824), who had been trained in ornithology by Bécœur.

⁴⁹This fact was lamented at the time, and memory of it continues to distress those concerned with collections. Among the specimens lost because of the lack of proper preservation were many birds from Captain James Cook's (1728–1779) explorations. See P. J. P. Whitehead, "Zoological Specimens from Captain Cook's Voyages," *Journal of the Society for the Bibliography of Natural History*, 1969, 5(3):161–201. For a discussion of the state of the British Museum ornithological collection see *The History of the Collections Contained in the Natural History Departments of the British Museum* (London: British Museum [Natural History], 1906), Vol. II, pp. 49–171.

who studied the specimens sent back by explorer-naturalists from all over the world were equally fascinated with geographical distribution. Given a large stable collection, it was possible to examine specimens with an eye toward geographic variation and begin to search for regularities of geographical distribution. Louis Agassiz (1807–1873), who founded the Museum of Comparative Zoology in Cambridge, Massachusetts, wanted his collections to shed light on the questions of geographical distribution. Similarly, Philip Lutley Sclater (1829–1913), drawing on the collections in London at the middle of the nineteenth century, hoped to begin a scientific determination of the primary divisions of zoological regions.

The large collections of the first half of the nineteenth century made possible by effective taxidermy, in addition to influencing the problems pursued in ornithology, also changed the style of ornithological writing. Increasingly ornithologists, who had the benefit of immense collections to work with, turned their attention to detailed studies of particular groups of birds. The writing of monographs requires the meticulous comparison of thousands of specimens often from distant areas. Unless these specimens can be maintained in a satisfactory state, the task becomes overwhelming. It is inconceivable that the monographs that proliferated during the last century could have been written without the aid of stable and sizable collections.⁵⁰

The ornithological monographs of the nineteenth century are among the most splendid works produced in natural history. Contributing largely to the quality of the works were the illustrations, whose accuracy and artistic merit became one of the most striking aspects of early professional ornithology.⁵¹ In the second half of the eighteenth century significant improvements in the field of ornithological iconography had begun with the work of François-Nicholas Martinet (1731–?), who produced the plates for Mathurin-Jacques Brisson's (1723–1806) *Ornithologie* and for Buffon's celebrated *Histoire naturelle des oiseaux*.⁵² Accurate illustrations, which were to

⁵⁰Writing at the end of the nineteenth century, Alfred Newton (1829–1907) stated, "On reviewing the progress of Ornithology since the end of the last century, the first thing that will strike us is the fact that general works, though still undertaken, have become proportionally fewer, and such as exist are apt to consist of mere explanations of systematic methods that had already been more or less fully propounded, while special works, whether relating to the ornithic portion of the Fauna of any particular country, or limited to certain groups of Birds—works to which of late years the name of "Monograph" has become wholly restricted—have become far more numerous." Alfred Newton, *A Dictionary of Birds* (London: Black, 1896), p. 21. The size of ornithological collections grew dramatically during the nineteenth century. Philip Sclater in 1857 described the collection of the Academy of Natural Sciences of Philadelphia as the best in the world and stated that it possessed 27,000 specimens. See Philip Sclater, "Notes on the Birds in the Museum of the Academy of Natural Sciences in Philadelphia, and Other Collections in the United States of America," *Proceedings of the Zoological Society of London*, 1857, 25:1–8. The British Museum (Natural History) had approximately 35,000 specimens by 1872, and by the turn of the century 400,000. See *The History of the Collections*, Vol. II, pp. 87–88.

⁵¹The development of ornithological illustration is one of the few facets of the history of ornithology that have been studied extensively. See René Ronsil, "L'art français dans le livre d'oiseaux. Éléments d'une iconographie ornithologique française," *Mémoires du Muséum National d'Histoire Naturelle*, 1957, Ser. A, 15(1), Claus Nissen, *Die illustrierten Vogelbücher* (Stuttgart: Hiersemann, 1953), and Jean Anker, *Bird Books and Bird Art* (Copenhagen: Munksgaard, 1938).

⁵²Jacques-Mathurin Brisson, *Ornithologie ou méthode contenant la division des oiseaux en ordres, sections, genres, espèces et leurs variétés à laquelle on a joint une description exacte de chaque espèce* (Paris: Bauche, 1760). It is interesting to note that Brisson's *Ornithologie*, in addition to containing the plates by Martinet, was one of the best pieces of early descriptive ornithology. Alfred Newton wrote of Brisson, "as a descriptive ornithologist the author stands even now unsurpassed" (*A Dictionary of Birds*, p. 9). René Ronsil, in his "L'art français," p. 27, wrote, "*L'Histoire Naturelle des Oiseaux*, de Buffon, illustrée par Martinet, est vraiment la base de l'iconographie, le point de départ d'une ère nouvelle pour cette branche qui devoit trouver son plein épanouissement quelques lustres plus tard, tout début du XIX^e siècle."

reach high artistic standards in the splendid productions of John Gould (1804–1881), and John James Audubon (1785–1851), supplemented careful descriptive writings and helped to create a reliable foundation of descriptive literature for ornithology. Illustrations were assured a permanent place in ornithology by the introduction of lithographic techniques by William Swainson (1789–1855).⁵³ The use of lithography was significant for several reasons. It allowed for a more lifelike depiction of plumage, and it generally increased the accuracy of illustrations because naturalists could draw directly onto the stone instead of relying on engravers, who often had little appreciation for scientific illustration. Also, lithographs were considerably less expensive to produce than engravings or woodcuts, so journals could afford to include illustrations on a regular basis and inexpensive editions of high quality could be printed. Exact artistic depictions and discerning descriptions of thousands of birds, however, could not be made wholly on living or freshly killed specimens. Without proper taxidermic procedures, the growth and development of ornithological illustration would have been seriously impeded.

The solution of the problem of preserving birds not only made possible large permanent collections, which in turn influenced the questions people asked in their study of birds as well as the genre of ornithological literature, but also it led to the development of certain key concepts in ornithology. The one most directly related to taxidermy is the idea of type-specimens. This notion grew out of the need to standardize the methods used to order the ever-growing empirical base of information in ornithology. Especially pressing was the procedure relating to new species. Since questions often arose concerning the original description of a new species, naturalists recognized the desirability of a reliable identification of the particular specimen used by an author to name a new species. Properly labeled type-specimens quickly became recognized by ornithologists as the ultimate arbitrators in classification; they also served as name carriers. By convention if the species was later divided into two species, or rearranged in some other manner, whichever group included the type-specimen was given the original name. Type-specimens came to be among the most valued and protected holdings of natural history museums during the nineteenth century.⁵⁴ They were carefully labeled and available for examination as reference material. If a type-specimen is lost, it can be replaced, but this often entails great difficulty, especially if the species is scarce or from a remote region. More important, although a single type-specimen is replaceable, the very notion of a type-specimen implies the existence of a stable, readily accessible collection.

In the emergence of modern ornithology during the first half of the nineteenth century ornithological collections were central. These collections helped to suggest certain questions to be investigated and allowed for the detailed study of particular

⁵³For a contemporary appreciation see the review "Swainson's Zoological Illustrations," *Edinburgh Philosophical Journal*, 1821, 4:209. Strickland in his "Report on the Recent Progress," pp. 202–203, also discussed the importance of lithography for the advancement of ornithology.

⁵⁴*The History of the Collections*, Vol. II, p. 64, states: "The value of type-specimens, and the index which their possession gives to the importance of a Museum, are now so universally recognized that a few lines may be devoted to the richness of the British Museum in this respect." A recent reference work states: "As type-specimens are of particular and permanent value as standards of reference in nomenclature, they should be regarded as 'the property of science.' A special responsibility rests on museums for the custody and proper labeling of type-specimens." See A. Landsborough Thomson, *A New Dictionary of Birds* (New York: McGraw-Hill, 1964), p. 846. For a discussion of the historical importance of the concept of a type-specimen see Paul Lawrence Farber, "The Type-Concept in Zoology during the First Half of the Nineteenth Century," *Journal of the History of Biology*, 1976, 9:93–119.

groups as well as the investigation of geographical distribution. The labeling of type-specimens helped to standardize nomenclature and afforded a standard of reference for classification. Improvements in ornithological illustration made for wider dissemination of the information gleaned from collections. Taxidermy, directly or indirectly, contributed to all of these major developments in the emergence of professional ornithology. The evolution of taxidermy, therefore, was a key technical achievement, and individuals who played important roles in its history, such as Réaumur, Bécoeur, and Dufresne, deserve recognition as men who substantially contributed to the foundations of modern ornithology.