José Antonio Alzate, animal instruments and reliable knowledge in New Spain in the eighteenth century

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Abstract

In the eighteenth century, naturalists in Europe and the Americas, being engaged in various practices for investigating nature, collected and observed live and dead animals in order to obtain and test various types of useful knowledge to science and natural history. The possibility that these specimens could be used as objects of study as well as instruments of observation gave these natural history collections a dimension that can be problematized nowadays from an epistemological and ontological perspective. This article demonstrates this phenomenon, based on the analysis of some of the practices of the naturalist José Antonio Alzate in New Spain.

Keywords: José Antonio Alzate (1737-1799); natural history; instruments; animals; collections.

María Eugenia Constantino[i]

[i] Professor, Universidad del Valle de México. Coyoacán – Ciudad de México – México

orcid.org/0000-0002-5696-5106

maru.cons@gmail.com

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> El reconocer un fenómeno ignorado por los demás naturalistas; presentarlo con sencillez, y con la confianza de que no se pueda impugnar por nuevas observaciones; [y] advertir las utilidades prácticas que puedan resultar a los hombres, son el móvil que debe dirigir a un aplicado a la historia natural, para presentar al mundo lo que ve, [y] lo que registran sus ojos, dirigidos por la verdadera crítica y por la ingenuidad.[1]
>
> José Antonio Alzate

The goal of this article is to show how, in the ardent search for reliable knowledge – rational, corroborated, verified and free of errors or fanciful notions – so characteristic of the eighteenth century,[2] animal specimens played two key roles in the development of the natural sciences: firstly, as "the" object of study, and secondly, as "an" instrument for observing different phenomena in the same animal. To this end, I will review some of the main practices of the New Spanish naturalist José Antonio Alzate;[3] from this point, I will show how his use of animal specimens depended on the type of knowledge he sought to obtain, giving them what we would now consider an ontological and epistemological dualism. The idea of proposing this double dimension arose in the context of other lines of research that, for some time, have been observing the role of animals in the construction of culture and science; they seek to understand more precisely the relationships between human and non-human animals so as to propose perspectives that help to construct more complex concepts of scientific or social facts and phenomena in which an animal was involved.[4]

The science-experiment-animal link has become more visible and problematic in the last two centuries than it was before the nineteenth century, because recognition of the ethical, moral and political issues in scientific experiments on animals only appeared in the West with the creation, in 1824, of the Royal Society for the Prevention of Cruelty to Animals in Britain (Burt, 2001, p.207). This occurred at almost the same time as the practices of vivisection and the study of electricity in organisms, showing the use of animal – living – bodies as one more instrument of medicine and physiology; nevertheless, early experiments of this type had been going on since the latter half of the eighteenth century.[5]

Looking at these events in which the body of the animal is a hidden protagonist and a fundamental part of the different methods and stages of experimentation, led me to wonder about the possibility of looking in it for a double dimension – both epistemological and ontological – as a scientific instrument, as well as the dimension it already possess *per se* as the object of study; bearing in mind that instruments are defined as a medium for seeing beyond the observing subject and the instrument itself, in a process of seeking information about a third actor: the thing observed. To uphold this idea, I turn to three proposals: that of Van Helden and Hankins (1994, p.4), who argue that instruments can also be "models or analogies of nature;" that of Bourguet, Licoppe and Sibum (2002, p.7), who say that instruments are not only identified with wood, metal or glass machines, but also with the human body – and, by extension, I would argue, with the animal body; and

Simon Shaffer's (2011, p.285) proposal, which points out that instruments serve to construct reliable knowledge and to facilitate communication among scientific communities, given their nature as intermediaries or mediators between the users or the epistemic communities, and the world. In his text, Schaffer associates the use of instruments with the eradication of error and the search for truth in the context of the European Enlightenment; an issue that, as David Bates (1996) writes, was one of the main ideologies of the Enlightenment, since in eliminating that form of disorder known as "error and prejudice," Enlightenment thinkers were seeking an order represented by "the achievement of truth and human well-being" (p.307). This premise helps us understand why, in colonization processes, rooting out errors and absurd notions in knowledge of non-European, or rather, non Hispanic territory and nature – which is what interests us here – was associated with a political notion of order and power.

The issue

In October 1790, José Antonio Alzate (2012) published his "Memoria acerca del *chupamirtos* o colibrí," ("Report on the *chupamirtos* o hummingbird") in the *Gaceta de Literatura de México*. His study was written in response to the lack of accuracy the naturalist had detected in the description of hummingbirds in the *Encyclopédie Méthodique,* and his goal was to correct the errors propagated in it during the previous three centuries. The opening paragraph of his report begins with a clear critique of his era's approach to natural history:

> If our knowledge of natural history were as solid as the propagation of such a pleasant subject, we should doubtless possess exact notions and fully verified facts. What is the use of all those dictionaries and books aimed at providing instruction for the reader, if most of the authors are mere copyists, who write because they read? Three centuries have passed since the discovery of America to these days, and in all that time there has been continuous trade between Europe and the Americas; many European nations have settled in the New World, and nevertheless, how is it possible that the history of the most noticeable bird, the hummingbird, should be so unreliable and full of falsehoods? (Alzate, 2012, p.25).

In these lines, the naturalist pointed to a problem repeatedly detected in the study of nature: that much of the knowledge being disseminated was not based on proven first-hand observations, but on the repetition of information that naturalists assumed to be true simply because it had been published;[6] and this went beyond the debates between Europeans and writers born in the Americas over territorial interests and indigenous knowledge, of which Alzate was a well-known proponent.[7]

Alzate's urge to highlight the flaws in natural histories of the hummingbird was sparked by statements that came from European authors such as Mauduyt, Badier and Father Labat, whom he criticized as follows: he said that Mauduyt's text published in the *Encyclopédie Méthodique* only provided dry nomenclature and data limited to the quantity of feathers, the size in inches and the number of different types of hummingbirds; that Badier claimed the birds only ate insects, merely because he had found some "corpses" when dissecting their entrails; and that Father Labat made unsubstantiated claims

about hummingbirds' song and taming. Finally, he pointed to all the naturalists after Francisco Hernández and Francisco Javier Clavijero who continued spreading the story of hummingbird lethargy in winter, without questioning or verifying it.

In his vocation as an enlightenment scholar, Alzate denounced the propagation of incorrect knowledge and took advantage of the wide readership and distribution of periodical press to expound his arguments. When he entered the public sphere, he drew attention to the problem of the various subjects in the natural sciences that needed to be revisited and rewritten, while setting an example for his peers in scientific debate and the use of objective methods to achieve experimentation that was based on methodical observation, comparison and quantification, which were often skewed by European naturalists and armchair scholars who wrote about the Americas without ever having traveled beyond their own desks.

The search for reliable knowledge about nature that Alzate advocated at the time was a consequence of the processes of colonization by European powers, which, in their quest to learn about, organize and appropriate the conquered territories ordered many voyages of exploration to assess the natural – and therefore economic – potential of the lands. The reports from those voyages were extensive observations of the travels performed by sea and land, compiled into texts of a scientific nature and travel narratives that, while based on observation and complemented by information provided by local residents, often contained erroneous or incomplete data that could only be confirmed after more observations and examination.

The errors or false information in travel narratives were well-known and understandable, if one took into account the authors' blending of fact with fiction and fantasy.[8] But the erroneous notions that emerged and remained unresolved in natural histories and other scientific texts could not be ignored, and needed attention at a time marked by reason and enlightened thought. Examples of these absurdities – specifically in relation to the animals of New Spain – can be seen in texts like the *Historia Natural de la Nueva España*, where the early Spanish physician and first explorer, Francisco Hernández,[9] recorded many of the curious things he found in his travels, turning to indigenous knowledge to explain things he was unfamiliar with, but also recording somewhat inaccurate information that was based on hearsay rather than systematic observation. His descriptions of the bird of paradise, which he said had no feet and lived permanently on the wing (Somolinos, 1960, p.347);[10] or the "*Tapayaxin*", a spherical lizard believed to bleed from the eyes so hard that the drops landed three paces away (p.380), portrayed fantastical animals that were later joined by others, such as fireflies that, according to Friar Bernardino de Sahagún (2002, p.1.056), had "a light like a candle in their tails and shone brighter than a candle when the night is very dark," or two-headed snakes and flying dogs, of which Pedro Franco Dávila, director of the Royal Cabinet of Natural History in Madrid, requested at least one specimen to add to his collection (Constantino, 2015, p.114).

The extraordinary and marvelous examples included in colonial natural histories were usually reproduced in European texts, whose authors, in the absence of live or properly-preserved dissected specimens, took a chance for credibility, although they could not compare the descriptions to reality, or discern the accuracy from errors of the original

authors. Naturalists, anxious to obtain one of these extraordinary specimens to determine the veracity of what was said about them, sought to get at least one example in decent conditions, just to complete the circle of knowledge about nature, which was made up of descriptions, drawings, classifications and specimens.

In the case of European naturalists, satisfying this need was complicated by the processes of collecting, preserving and transporting specimens from the Americas, Asia or Africa; however, for naturalists who lived in the colonies, such as Alzate, the process was simplified, logically, by their geographical proximity and opportunity to carry out longer observations in the field. This meant it was only necessary to detect the presumed errors, compare them through rational and methodical observation and analysis, record them and pluck up courage to enter the respective debates, or create them if needed.

Live animals: instruments of observation

As befitted a true enlightenment scholar, Alzate's (2012, p.26) critique of other naturalists in his "Memoria acerca del chupamirtos o colibrí" did not stop there. He went beyond questioning the "famished" authors who published works that merely contained reflections concerning other texts, and copied or invented data, proposing a natural history of hummingbirds based on lengthy observation of their behavior and physical characteristics, as well as local knowledge cultivated by the natives of New Spain. Thus, Alzate (2012, p.27) promised that his conclusions would "largely contradict the prevailing wisdom; but [they will] make up for that by being solid, and not dependent on reports." To achieve this, he captured a live hummingbird that was hatching on a nest with two tiny eggs; he collected it, nest and all, to be weighed and observed; later he wrote a detailed description of the place it had nested, the materials the nest was made of, the length of incubation, the feeding process, and the appearance and development of the chicks.

During this process, Alzate corroborated various things: that it was impossible to keep the tiny creatures alive by feeding them only sugar water or sweetened wine – as Father Labat had proposed; that the noise made by their beating wings could be heard "over twenty paces away" (Alzate, 2012, p.31); that in flight, the body stayed vertical while the wings stayed horizontal; that the bile sac is "of a magnitude that does not match the miniscule size of the bird" (p.34); and that even in winter, hummingbirds could be seen in some of the coldest places in Mexico.

His discussion of hummingbird behavior and nature was not at all innocuous, nor was it intended solely as a critique; it had, indeed, deep roots and motives, and belonged to the world of debates about the immaturity and degeneration of american nature and civilization, suggested in Europe by Buffon and De Pauw.[11] In the Americas, Alzate was one of their leading contenders, and, within his own arena, he sought to find the greatest possible number of truthful arguments to disprove these foreign hypotheses. According to Iris Montero (2016), Alzate saw the case of hummingbirds as the last link in the chain that would allow him to argue the singularity of nature in the Americas; therefore, Alzate's reliable knowledge not only served scientific objectivity, but involved with political truths that would help him shore up his position in the debate with his peers.[12]

Continuing his observations, Alzate's interest in demonstrating the authenticity of knowledge of these birds was not limited to what he had managed to corroborate on hummingbirds, since in other texts he also discussed the migration of swallows and their supposed dormancy, similar to torpor in hummingbirds.[13] In an appendix to his discussion of hummingbirds, he referred to the observations he had carried out for at least four years to verify whether the same group of swallows were returning to nest in the same site. His idea was to continue debating the errors published in the *Encyclopédie,* while defying the author of the "dictionary of birds" – Mauduyt – and all those who uphold the dormancy of swallows, to verify the facts. This dormant state, defended and supported by supposed observations by European naturalists, meant that swallows were spending "the cold period torpid in the depths of the sea, the lakes, or subterranean cavities or hollow tree trunks" (Alzate, 6 nov. 1788) – an idea that the Count Buffon had tried to temper by saying that there were two distinct species of swallows: those who could go underwater and those who took refuge in various cavities.

Alzate's observations on swallows took him quite some time. In 1788, he had already published in his *Gazeta de Literatura* the "Memoria sobre la transmigración de las golondrinas" in which he described the different phases and results of his observation: the first challenge had been to capture some birds in order to band their legs with wire rings so they could be identified if they returned. Then he sought to understand and verify whether swallows could come from distant countries or even the moon, as people thought; so he measured the time the birds could fly without a break, as well as how long it took them to cover certain distances. The questions beating in his head where "How could they get [fly] to the moon, which is ninety thousand leagues away? Where could they rest along the way? After leaving earth's atmosphere, what substance would support their wings so as to be able to fly?" (Alzate, 6 nov. 1788, p.83). The answers, as we might expect, did not need too many observations to prove that what was thought at the time was not viable; but, on the contrary, they helped to formulate a new question that asked for the construction of consensual knowledge based on observations by people placed at different geographic locations: "If, in all countries, observations were done of the time when the swallows appear or disappear, perhaps the problem of migration would be solved" (Alzate, 28 feb. 1789, p.112). This question, avoided for long time by other naturalists, was proposing a deeper search for answers.

The other issue on Alzate's mind was the supposed dormancy that so many spoke of. In order to test this idea, he captured some swallows and took them to the icehouse at the Real Estanco, where there was snow that maintained a temperature of "zero on the Réaumur scale." He left his specimen birds there for two weeks and returned to observe the results; then he found that the birds had died and their bodies were "hard as a rock," as well as gnawed by rats (Alzate, 6 nov. 1788, p.82). This proved, at least partially, that the claims of dormancy were not true, so it raised the prospect of immersing some other specimen birds so as to say for sure whether the belief in dormancy through immersion was possible.

As for the birds he had banded, Alzate followed them for the next four springs, corroborating that they were the same birds he had captured. The argument with which he defended his experiment and substantiated his conclusions was that, unlike the Europeans,

who had only tied colored thread to the birds' legs, wire rings were much less likely to come off or get lost, which allowed him to conduct a "more decisive experiment" with more solid results, and he did not stop there (Alzate, 2012, p.37). A couple of years later, in February 1792, he published further observations on swallows, asking why they could be seen in Mexico City even in winter.

When he referred to his method for recording observations, Alzate (6 nov. 1788, p.334) always stated explicitly that he kept an observation diary where he noted what he saw "without passion, without adhering to any system… with reliable, coherent data, intent only on copying what was observed". In his diary, he recorded his interpretation of the facts, phenomena or natural objects that interested him, and he would return to his notes when something new or disconcerting happened; but on these last occasion, what Alzate recorded were more doubts that certainties, since he could not entirely account why the phenomenon had occurred. The only probable explanations to his question were not totally reliable and went back to beliefs that had not been completely banished, of swallow dormancy and immersion in water – although there was also a belief that they spent the winter in Florida hibernating. However, as he continued to observe the birds' behavior and characteristics, Alzate was able to arrive at a more definite conclusion a couple of months later: there were swallows that overwintered in Mexico, and these were different to the ones known to inhabit Europe and Africa. Thus he proposed an answer that stressed diversity among individuals of the same species, whilst simultaneously raised new questions for other scholars.

The need to see the world through analysis of live animal specimens later led Alzate to undertake studies of *axolotls* (salamanders), cochineal insects, ants and silk worms, similar to his work on hummingbirds and swallows. His fundamental goal was always to study each species as a whole by looking at individuals, since as he wrote in another text, "every species of plant, every animal resembles its prototype" (Alzate, 16 dic. 1788), and these, from a naturalist's perspective, were the basic instruments for knowledge of the natural world. Methodical observation of individuals and detailed, accurate descriptions, also proposed by Buffon (1749-1766) in Appendix I to his *Histoire naturelle, générale et particulière, avec la description du cabinet du roy*, were the way to eliminate the "false conformities" seen in well-known natural histories up to that point, which had arisen thanks to scholars' lack of curiosity, imagination or speculation.

Animal dissections: instruments for experimentation

To write the natural history of an animal we know that it was – and still is – necessary to observe live animals *in situ,* because that is the only way to learn the characteristics and natural behaviors of the different species. However, we also know that not all naturalists had Alzate's good fortune in being able to carry out hundreds of observations at different points in life – both of the animal and/or the naturalist himself – and that not all animals could be observed for long periods, whether because of geographic inaccessibility, lack of time or because the creature could not survive outside its native habitat. Thus, the most viable solution for scholars and natural history enthusiasts since the sixteenth century

was the use of embalmed specimen, which ended up in collections that were then used to form cabinets of natural history.

Dissected animal collections circulated on other continents and in Europe as models of nature from faraway places, and they represented naturalists' attempts to solve their difficulty or impossibility to see live specimens up close so as to observe and study them. From the beginning, this problem caused them to seek alternative ways to materialize and stabilize knowledge, and gave rise to three basic technologies for bi- and tri-dimensional representations of nature. The first was to create inventories and descriptions that translated into words what was known about plants, animals and minerals;[14] the second was to produce drawings in an attempt to represent as realistically as possible the physical characteristics of the specimens, although the representations did not always reach the desired level of objectivity;[15] and the third was to create collections of dissected specimens that were embalmed or preserved in wine spirit. The combination of all of these would hopefully lead to reliable knowledge about the natural world that could not be seen at first hand, whilst pursuing the ideal of perpetuating the specimens, although in reality, from the moment a document or drawing was created, or an animal was dissected, the race towards its extinction had already begun. This was clearly a major threat, since as the specimens deteriorated, their particular physical characteristics altered, and therefore so did the truth that resided in them.[16]

Of the three technologies mentioned, time has shown that the animal collections were the most vulnerable, since few cases survived the attack of the agents of decay that threatened them, from the moment of dissection to their exhibition or preservation in natural history collections. This, of course, was one of the main concerns of naturalists interested in creating cabinets of natural history; therefore, some authors wrote in the *Encyclopédie Méthodique*, as well as other natural history texts, about different methods based on arsenic powder, *eau de vie* and tobacco,[17] which did not always yield good results and encouraged continual experimentation on dead animals, their hides and bones, in an effort to find a definitive method for preserving them in the best possible condition.

The search for the ideal preservation process was a challenge that involved the knowledge and experience of multiple actors with theoretical and/or practical knowledge of anatomy, chemistry or botany. Thus, the first embalming processes for species were performed by fishermen, butchers, surgeons, painters, some scholars and amateurs skilled in killing and carefully skinning an animal; while naturalists who had their own cabinets and were familiar with the necessary poisons set about testing the effect of different methods for preserving their collections, in this case using dissected animals as their instrument for experimentation and observation. José Antonio Alzate was also one of these observers, and like any scholar bent on disseminating knowledge, he also published his experiences in New Spain's periodical press.

Alzate's report of his observations on the use of brome grass – cebadilla – as a preservative for animal collections was published in the *Gaceta de México* on August 10, 1790 (Valdés, 1790, p.147). His motivation for doing this was to contribute to collecting practices of other nature scholars, by proposing a new method of preservation so it could be tested and corroborated by his peers. There were doubtless some aesthetic reasons for needing

to keep specimens well-preserved, since no collector liked having decaying specimens in his cabinet; however, in scientific terms, preserving animals was crucial, because correct description and taxonomy – the equivalent of creating an accurate natural history of an animal – depended on preserving the minutest details of its physical characteristics.

With this in mind, Alzate proposed testing a method he had found in three different places: the *Historia Natural* by Francisco Hernández, who had written on the antiseptic and poisonous properties of brome grass (Somolinos, 1960, p.11); and the practice of Latin American ranchers and French Capuchin friars, who used the ground-up powder of this plant to kill the worms that caused gangrene in calves' navels, as well as the lice that attacked them. Given these precedents and their supposedly good results, it was possible to envisage using the plant as a preservative agent for collections; so Alzate decided to carry out an experiment under apparently controlled conditions and with defined variables. So, for two years, he proceeded to observe the effects of brome grass on a pair of dissected pocket gophers he kept in his cabinet. His public report was as follows:

> It was proposed that I dissect two pocket gophers, known here as Tusas: I placed them very close to one another: I rubbed a little brome grass into the fur of one of them, and to the other I added no preparation: after two years at a distance of a quarter of a yard, the skin of the first was preserved in the condition it was in at the time of dissection; the second had been bald for over a year, as if I had shaved off the hair on purpose, leaving only the skin. If this experiment is repeated and yields the same result, cabinet owners can count on preservation of the animals they place in them, without having to weary themselves with the many other types of care prescribed as indispensable by the Authors of Natural History (Valdés, 1790, p.147).

In his text, Alzate gave a detailed account of a practice that mixed knowledges from different sources, starting with a well-known and much-discussed fact of the inadequacy and inefficacy of the preservation methods used until that time, while acknowledging some consequences: the inability to preserve colors in liquid media, the danger for the naturalists themselves and other observers of using certain poisons, and the impermanence of fur and feathers thanks to dry techniques. All of these were critical issues for a naturalist concerned with classification, but also for a collector who sought at all costs to display the splendor of his specimens. The problem of preservation, therefore, involved searching for a technique that was as harmless as possible for humans, but more aggressive on predators. Brome grass seemed like a good option. The fact of publishing in the *Gaceta* was, of course, no coincidence. If this experiment yielded results, it might be possible to overshadow European texts by showing that there were simpler and more effective methods than those proposed by French naturalists half a century earlier in the *Encyclopédie Méthodique*.

Thus, combining the knowledge in Hernández's text, practices among friars and ranchers, and the knowledge yielded by Alzate's own observations, led him to a method that brought back popular knowledge and transformed it into something that could become systematic if explored with the necessary rigor. Thus Alzate's suggestion that other naturalists should try it, report on their results, and appropriate the procedure if it was successful.

However, the case of this New Spanish naturalist was not the only one, and other collectors, and scholars described in other media using their collections of dissected animals to experiment with their own methods of preservation. In Spain, correspondents of Pedro Franco Dávila, the director of the Royal Cabinet of Natural History in Madrid – Real Gabinete de Historia Natural de Madrid – explained in their letters their own way of fighting decay agents that threatened their precious specimen collections. On July 16, 1777, the chaplain Donato de Arenizarra wrote to Dávila about preserving a set of birds he had sent him earlier, which were starting to decay. In his letter, the chaplain explained how the compounds used to poison worms made the birds lose their skin and feathers, although he had discovered that regular exposure to camphor and sulphur smoke prevented deterioration, whilst helping to stop moths from reproducing. Arenizarra wrote: "In two turtle-doves that I preserved some days ago, I find the truth of my experiments, and I believe they may suggest the birds will last, as disposed by his Excellency the Count of Floridablanca" (Calatayud, 1987, ref.444).

The smoking techniques referred to by Arenizarra were the ones suggested by Buffon in his *Histoire naturelle* and later by Mauduyt in his text in the *Enciclopédie Methodique*.[18] There, the naturalists described how, in order to keep collections free of moths and worms, they had to be smoked occasionally with flowers of sulphur or tobacco. Once this had been done and the containers had been filled with smoke, they had to be sealed so that the pests would be poisoned. It appears this method was well-known and used by naturalists in Spain, and according to the chaplain, it worked, although not permanently.

A couple of years later, on September 25, 1779, Cristóbal Villela, who corresponded with Pedro Franco Dávila from Palma de Mallorca, wrote to the director of the Royal Cabinet about the way his servant Bartholome was experimenting with methods of preparation and care for some birds he planned to send to Madrid (Calatayud, 1987, ref.56). In his missive, Villela asserted that Bartholome always used "a well-sealed jar of powdered pepper, Brazilian tobacco, alum and camphor" (Calatayud, 1987, ref.56) which he applied after having flayed the birds he was preparing to prevent them from discomposing. And although the naturalist had tested the effectiveness of powders in some cases, in others he had observed that clothes moth worms got in

> brown in color and full of tiny little legs, they eat away at them, without the powders either stopping them or killing them, or other worms, thousands of which are left by the blowflies during dissection; later I kill them, and the situation is quickly remedied, since when they find no fresh meat on which to feed they then die, and their mothers do not lay them in dried birds or fish, but the moths I speak of do not pardon the rarity of the best bird, nor the beauty of the finest fish, nor the fierceness of the quadruped (Calatayud, 1987, ref.56).

The battle against these worms with their many "tiny little legs" was at its height, and it seemed no powder, smoke or poison could stop them. Something that might help collectors was to get to know their enemy, so close study of insects – or entomology – was a necessary weapon for combatting them. This point had already been made in 1749 by Buffon and Daubenton in their *Histoire naturelle, générale et particulière, avec la description du cabinet du roi.* There, the naturalists recount their observations of how, especially in the

months of April and May, worms, beetles, clothes moths, butterflies and moths got into dissected animal bodies to eat their flesh, cartilage, skin, fur and feathers.

> That is when one must visit everything, and examine whether one perceives any trace of these insects, which is normally signaled by traces of powder around the places where they are hidden; in that case, damage has already been done, they will have got into something, so one should waste no time and work to destroy them: one should observe these small creatures until summer's end, when only the eggs are left, or else they are motionless and sluggish from the cold, so there is almost nothing to fear until the following April (Buffon, 1749-1766, p.9).

Daubenton and Buffon studied the effect on collections of pests, infestations and factors such as temperature and humidity; and rather than starting by asking about the effectiveness of preservation methods, they argued that knowing the behavior of decay agents was indispensable for determining preventive or restorative action for at-risk specimens or ones that had already been attacked by pests. Dissected animals were thus the basis for these observations and, based on their processes of decomposition, new or different conclusions could be drawn about how to improve preservation practices; also, about the behavior of other animals that appeared to be secondary but were, as in the case of insects, the true protagonists – or antagonists – of the scientific phenomenon under observation. Thus the collections were set up as qualitative and quantitative instruments for obtaining alternative data on natural history.

Organic instruments

In the context of eighteenth-century natural history, live and dead animals played an undeniable role in the development of knowledge about nature on different levels. Scientific practices developed by naturalists and scholars led to ontological and epistemological divergences which defined both the use or status of the animal and the type of knowledge obtained from it. Animal specimens played a dual role by representing themselves both as individuals and prototypes of their species, but also as mediators between naturalists, scholars, amateurs and the rest of the world, and they became elements of an epistemology operating since the seventeenth century, in which, as Ian Hacking has shown, knowledge was assumed to be a representation of nature in which natural objects were constructed only to be examined or contemplated (Hacking, 1996, p.157, 160). Thus, the symbolic construction of animals emerged as a basis for creating knowledge but also as a determining instrument that could verify correct conclusions and root out errors that had arisen at different points in history.[19] This was shown even on the continent of Asia at the turn of the century, when camel caravans and expeditions traveled between different pragmatic and epistemic worlds thanks to their use as a means of transport and as useful instruments of measurement for determining geographic distances based on the speed of their steps (Schaffer, 2017, p.181).[20]

In New Spain, José Antonio Alzate's practices and experiments showed this shift from using live animals as objects of study initially, and then as instruments of observation at a

second level of reading and interpretation. The first phase, which was denotative, involved performing an initial analysis determined by observation and measurement carried out through various categories of instruments that mainly yielded information made up of quantitative, descriptive and/or literal facts. This came out of a first reading of the signs and signals emitted by the species in question – such as, for example, their weight, measurements, colors or physical qualities, to mention but a few. In the trinomial required to construct reliable knowledge, this approach meant that the observer – the naturalist – looked at the thing observed – the animal – through a mediator – the instrument – which provided information that belonged solely and exclusively to the individual in question, but also laid the bases for a second level that transcended denotation, in which the naturalist looked at the individual as a prototype of its species. From there, the information was broadened by analysis, corroboration, interpretations and cross-referencing with other knowledge; reading became more robust, connotative and qualitative; and the specimens observed were transformed into mediators or instruments which, like lenses, magnified a knowledge that made it possible to observe the whole species through a few individuals.

In another case, when collections were used as the *locus* of control, the internal and external factors of preservation and decomposition of specimens were also observed as an example of the animal's instrumental dimension. By preserving specimens, the collections provided crucial support for experimentation and were used as useful mediators for testing the effectiveness of preservation methods, as well as the effects and actions of the agents of decay that wrought havoc on the condition of the specimens. Animal collections could be used to study a process, phenomenon or object other than the animals themselves, for example, in order to obtain information about the behavior of what are now called carrion insects or the effect of the environment on corpses. This fact could perhaps, given the similarities, be seen as an antecedent to what is nowadays the province of forensic entomology, in that it looks at the information provided by insects and arthropods for definitive proof to solve a crime or identify the natural, accidental or deliberate creation of agricultural pests.

As had happened in the past with mathematical tools, which started solely as instruments for travelers and ships but acquired other uses (Cházaro, 2011, p.740), natural history collections were useful for objectives beyond the cabinet: they mobilized forms of knowledge, formed part of the material culture of scientific practices and became central actors in the presentation of new, progressive technologies that in one way or another affected the construction of the natural sciences (Burt, 2001, p.206). In the case of animals preserved as a credible instrument of visualization, their main quality was not, as Nyhart (2004, p.308) argues in her reflections on natural history collections at the time, their "analogical power, their manipulability or ability to present things on a human scale," but the intrinsic characteristic of being displayed and considered as authentic, since each collected specimen was an animal in its own right, regardless of whether it was presented as a model, in an artificial way.

This implied that once animals were added to a collection, they were not questioned, because people usually took what they saw of them as true, even though it might not correspond with reality. When observers looked at dissected specimens in cabinets of natural

history, they did not question their credibility because they believed they were standing "in the presence of the real thing" (Nyhart, 2004, p.308). This perception arose and was maintained because, in theory, the animal remained apparently the same – just lifeless – and had not been transformed to the extent that spectators might think its physical characteristics were not true. It did not matter if the specimen had already undergone a whole process of dissection, desiccation and reconstruction, as long as there were no major changes visible and it could still be considered valid, credible and real. The animal, in this case, would be an object invested with objectivity, and any information derived from it would be considered reliable, regardless of whether its behavior in life was different than in captivity, or whether its physical characteristics had altered with death. The mere fact that it was an object created by nature, and not man-made, ultimately ruled out the possible presence of error and that, for the naturalists, was what enabled the production of reliable knowledge.

The shift from live animal to a naturalistic one implied, then, a metamorphosis that Clifford (1995, p.270) explained as the mutation of "exotic curiosity" into "source of information," since on being removed from its original environment and also transformed into a collection object – whether alive or dead – the specimen took on layers of symbolism full of information, codes and meanings that were usually visible only to those who knew how to interpret them. José Antonio Alzate's discussions appealed to this both directly and obliquely; he argued that the reliability in natural history that people sought depended completely on naturalists whose dedication meant they would have the curiosity to study the specimen and to search for and detect the errors in what was known and said about it; but above all, they would know how to configure and use it to shed light on different categories of information. Thus, he showed that the intent and diversity of uses and practices can determine the density of knowledge, shaping the epistemological and ontological dualism that arose in the practices of naturalists, but is still present in scientific practices in our own time.

NOTES

[1] Recognizing a phenomenon ignored by other naturalists; presenting it simply, confident that it cannot be impugned by new observations; [and] showing the practical uses it may yield for mankind, are the motives that should guide a scholar of natural history to present what he sees, [and] what his eyes register, to the world, guided by a spirit of genuine critique and ingenuity.

[2] On scientific debates about the criteria for truth in knowledge as it arose and was revised in eighteenth-century New Spain, see Miruna Achim (2008).

[3] José Antonio Alzate (1737-1799), who was born in New Spain, was a man of letters, a religious, visionary and erudite naturalist who was committed to Enlightenment thought; and a defender of autochthonous knowledge, who advocated for popularizing knowledge via the periodical press. He corresponded with the Academy of Sciences in Paris and the Royal Botanical Garden in Madrid; and contributed to advancing science with multiple observations, experiments, proposals and debates. He was one of the illustrious figures in the colonial era in Mexico. On his life and work see Peset (1987); Saladino (2001); Aceves (2001); Achim (2012); and Sánchez (2012).

[4] The role of animals as pets, as religious figures, and for utilitarian and experimentation purposes by man, has become a topic of study for different disciplines and has shaped current Animal Studies, in which Lorraine Daston and Gregg Mitman analyze, from the perspective of anthropomorphism, different issues in which animals are the protagonists. The bibliography on Animal Studies is extensive, but for the purposes of this article the following are suggested: Burt (2001); Fudge (2002); Emel, Wilbert, Wolch (2002); Daston, Mitman (2005). For Latin American cases see Norton (2013, 2015); Few, Tortorici (2013).

[5] In his article, Jonathan Burt (2001, p.215) speaks of the historical role played by animals in the exploration of the properties and conceptualization of electricity, and he notes the work done by Giambattista Beccaria in 1753, as the first significant experiment to run an electric current through animal body parts. Burt also mentions the debates between Galvani and Volta on "animal electricity," which was understood to be electrical stimulation in human and animal bodies, and its use in medical experiments in the late eighteenth and nineteenth century. Thus, it can be claimed that, up until the present, animals have been used as sample instruments, for example, by the medical and cosmetic industries, which use animals to observe the possible reactions of the human body to various stimuli, experiences or products; or, in the case of bees, as a technology for detecting minefields.

[6] One of the arguments Alzate used to defend his critique was, according to Miruna Achim (2012, p.20-21), that travel books were written to give readers an exotic, exaggerated view of faraway places, and that they played into the competition for the European market, in that publishers sought to make rapid sales and did not care whether the contents were true.

[7] Alzate was an active participant in the dispute over the degeneration of nature in the Americas, led by De Pauw and Buffon. His position, clearly, was in favor of the inhabitants of the Americas and in defense of indigenous knowledge; that was the origin of some of his criticisms to Europeans, but also of his contribution to clearing up errors or absurdities.

[8] On travel literature, see the work of Juan Pimentel (2003).

[9] See Somolinos (1960); Ayala (2005); Pardo (2002).

[10] On this issue, see the studies by José Ramón Marcaida (2014a, 2014b) on the bird of paradise and its representations in art and natural history.

[11] See Antonello Gerbi's book (1982) on these disputes.

[12] See Iris Montero's work on these birds and the debates about them. In her texts, the author gives an extensive historical and cultural overview of the birds' nature and symbolism (Montero, 2015, 2016).

[13] Belief in hummingbird torpor persisted after Francisco Hernández's texts appeared in Europe, there he argued that hummingbirds spent the winter dormant and immobile, hanging from a tree by their beaks until springtime. See Montero (2016) on these debates.

[14] On the role of travel inventories and advice in the context of nature collections, see the texts by María Eugenia Constantino (2015, 2016).

[15] On drawings of nature in the Americas, particularly those done on Spanish botanical expeditions, see the work of Daniela Bleichmar (2007, 2008, 2012), who proposes and explores the idea of a visual etymology for the images.

[16] A striking example of how the preservation of collections affected the knowledge constructed from embalmed specimens can be seen in the case of the bird of paradise. This bird, native to New Guinea and the Moluccan archipelago, started to become known around the sixteenth century in Europe thanks to accounts by travelers and merchants, who thought it belonged to a strange family of birds with no feet, whereas in reality they saw specimens whose feet had been cut off to keep the precious plumage in the best possible condition for sale (Marcaida, 2014a, 2014b).

[17] On preservation practices for animal specimens in cabinets in New Spain, see Constantino and Lafuente (2012). On the preservation methods used in eighteenth-century France, see Péquignot (2002).

[18] In 1773, the French naturalist Pierre Jean Claude Mauduyt asserted that dry preservation methods needed to use spices and other strong-smelling or tasting powders to drive away insects. If one wanted to kill bugs, it was necessary to use poison also (Péquignot, 2002, p.65; Buffon, 1749-1766, p.8-11).

[19] According to Bates, during the enlightenment, error needed to be eliminated "in the name of truth and progress." Once incorrect information had been detected and recognized by "the light of reason," it should not be allowed to persist in science or society because that represented a form of disorder at a point when people were seeking order and hierarchy in the world and the knowledge they held. Therefore, if their intention was to deliver society from ignorance, they had to root out the absurdities present in knowledge (Bates, 1996, p.307).

[20] On this topic, see the practices of James Rennell and Pierre-Simon Girard, who calculated the speed of camel caravans on the routes between the Mediterranean and the Persian Gulf, and Cairo with Suez. See Simon Schaffer's (2017) article.

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