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Linnaeus in Italy

The Spread of a Revolution in Science

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How Language Matters

Lazzar von Spallanzanus and Carlo Linnei

MARC J. RATCLIFF

Appearing in 1765, the first two scientific publications of the naturalist Lazzaro Spallanzani, one of the most important experimentalists in Italy, were issued in a single volume and show an intriguing tension: his *Saggio* or essay on his microscopic observations was written in Italian, while his *Dissertation* on how a stone skips over water was in Latin.[1] From that original tension between two languages, charged with very different overtones, I will attempt in this paper to reconstruct the evolving relationship between Spallanzani and Carl Linnaeus. However, I am less interested in the personal relationship between these two major figures than in how each one is emblematic of certain scientific traditions of the 18th century.

Whether to write a scientific text in Latin as opposed to Italian and, more generally, the question of what language to use for a scientific publication were important issues for 18th-century scholars. Spallanzani was able to write in Italian as well as in elegant Latin, for he had been educated as a philologist. Before deciding to devote himself to a career in science, he published in the 1750s a critique of a translation of Homer's *Iliad* and another short essay on inscriptions. He began conducting scientific experiments during the 1760s after establishing contacts with John Turberville Needham, a Catholic priest and Fellow of the Royal Society who had revived the debate over spontaneous generation.[2] The *Saggio* was Spallanzani's answer

[1]Lazzaro Spallanzani, *Saggio di osservazioni microscopiche concernenti il sistema della generazione, De lapidibus in aqua resilientibus* (Modena: Soliani, 1765).
[2]On Needham, see Marta Stefani, *Corruzione e generazione. John Turberville Needham e l'origine del vivente* (Florence: Olschki, 2002).

to the theories of both Needham and Buffon and made him famous in academic circles. Using this as his introduction, he started to correspond with the famous scholar Charles Bonnet of Geneva (1720–1793) and their letters reveal much about the use of language in science, showing that it was far from a purely academic question. The *Saggio* was written in Italian and when in 1770 Spallanzani was attacked by the philologist Girolamo Ferri for not writing in Latin, he replied with two arguments:[3] firstly, modern nations used vernacular languages, and secondly, Latin was a dead language that lacked the characteristics required to meet the modern needs of scientific expression. Therefore Spallanzani refused to write in Latin, and indeed all of his subsequent works were written in Italian. At the same time, the authority of Linnaeus was gaining ground as the century drew to a close, and both he and his students and followers wrote in Latin. However, Spallanzani rejected much of Linneaism.[4] To understand this situation it is necessary to address the issue of scientific language,[5] its status in the second half of the 18th century, and the ways in which scholars trained in different traditions dealt with the question.

LANGUAGE AND TRADITIONS OF NATURAL HISTORY

The Tensions of Language in Italy

In a paper published many years ago, Renato Mazzolini discussed Girolamo Ferri's position and demonstrated that Spallanzani formed part of a broader trend of modernization that was slowly relinquishing the use of Latin for Italian.[6] The first signs of this trend could be seen very early, and then in the works of Galileo and his followers such as Francesco Redi and Antonio Vallisneri, all of whom wrote in Italian. Although in the 18th century many scholars still used Latin for their texts, writing a scientific text in Latin remained the sign of a certain elite. In the realm of the sciences, Latin was used principally in four circumstances: for communication (together with French) between members of the international network of scholars, by academics lecturing at the universities, by the medical profession, and among naturalists.

[3]Spallanzani to Ferri, 20 July 1770. In *Carteggi di Lazzaro Spallanzani*, ed. Pericle Di Pietro, *Edizione nazionale delle opere di Lazzaro Spallanzani*, 12 vols. (Milan: Mucchi, 1984–1990), 1984, t. 4, p. 245.
[4]See Marc J. Ratcliff, "Lazzaro Spallanzani e la guerra delle lingue scientifiche," in *Teoria e pratica dell'esperienza scientifica. Lazzaro Spallanzani e le scienze della natura nel Settecento*, eds. Walter Bernardi and Marta Stefani (Florence: Olschki, 2000), pp. 375–392. Lucien Plantefol, "Spallanzani botaniste," in *History and Philosophy of Life Sciences*, 1987.
[5]On scientific language, see Charles Bazerman, "The problem of writing knowledge," in Charles Bazerman, *Shaping Written Knowledge: The Genre and Activity of the Experimental Article in Science* (Madison: University of Wisconsin Press, 1988), pp. 3–17.
[6]Renato G. Mazzolini, "La questione del latino in una lettera di L. Spallanzani a Girolamo Ferri," *Episteme*, 10(1976):313–326.

In contrast, using vernacular languages in published works was considered an appropriate sign of modernity.

The linguistic geography of scholarly Europe during the second half of the 18th century had radically changed in comparison to the first half of the Enlightenment period. New linguistic communities had emerged and they began to have a marked impact on the circulation and construction of scientific knowledge. For instance, the growing number of vernacular journals in the German *Länder* offered a suitable platform for encouraging the circulation of scientific German everywhere, and other European countries followed the same general trend at their own pace. A major tension that scholars had to deal with at this time was the difference between a *universal* language, a *vernacular* language, and an *artificial* language—all competing to format the rules of communication among scholars. First, with regard to *universal* languages, I am not referring to the attempts (going back to Raymond Lulle or Leibniz) to create a scholarly means of communication whose extent was universal, the history of which has been analyzed, for example by Umberto Eco.[7] I am referring instead to the fact that a certain language may impose itself due to the political and economic supremacy of the culture behind it (for instance, the ascendancy of English today) and be regarded as a "universal language" by the main players of the period.[8] Latin had served as a universal language in this sense, strengthened by its links with the Catholic religion, until the 17th century, whereas French came to be widely regarded in the 18th century as the universal language for science. Nevertheless, probably because French was also the language of the aristocracy, certain scholars such as Jean le Rond d'Alembert continued to look upon Latin as the language that best answered the needs of the scholarly world.[9] Second, at the same time *vernacular* languages were providing strong support for the expansion of national communities of scholars who used their own vernacular languages to write and disseminate their work. The proliferation of scientific journals in Europe during the second half of the 18th century illustrates clearly the competing expansion of those languages, a situation that led to a virtual babelisation of scholarly communication. With regard to the third element, or *artificial* languages, the most successful example was probably Linnaeus' codification of Latin in order to standardize and facilitate communication among naturalists. For Linnaeus, Latin was the ideal linguistic material because it could be artificially recreated and modernized to serve his purpose of unifying natural history.

One last element that helps to explain Spallanzani's resistance to Latin, and Linnaeism, is that the Italian model of scientific language in the 17th century was deeply influenced by literature; Galileo wrote dialogues and Francesco Redi belonged to the literary *Accademia della Crusca*. Indeed, this aspect of culture was so important

[7]See Umberto Eco, *La ricerca della lingua perfetta* (Rome: Laterza, 1993).
[8]See, for instance, Antoine Rivarol, *Discours sur l'universalité de la langue française* (Berlin, Paris: Prault, 1785).
[9]Jean Le Rond d'Alembert, "Sur la latinité des modernes," in *Mélanges de littérature, histoire et philosophie* (Berlin, Paris: Briasson, 1753).

that at the beginning of the 18th century a scholarly career could be seriously hindered by the inability to express oneself in proper literary Italian. The apothecary Diacinto Cestoni, a friend of Redi and a noteworthy experimentalist, refused to publish many of his works and letters because he thought his style was not sufficiently literary.[10] A descriptive language with no verbs such as Linnaean Latin, so disciplining to the imagination, would not have been willingly adopted by Spallanzani, for it constituted the exact opposite of a literary style and as such, he must have believed, would probably be rejected by the public. Even during the second half of the 18th century, scholars felt obliged to draw upon literary models in their scientific writings. After all, up until the French Revolution scholars were conscious that they belonged to a community that was referred to as "La République des Lettres," and in any case the term *scientific community* actually represents an anachronism as far as the 18th century was concerned.

The Traditions of Natural History

It would be insufficient, however, to limit our discussion to language; the importance of naturalistic traditions and the scholars' management of the boundaries of each tradition must be stressed in order to understand Spallanzani's rejection of Linnaeism. The existence of two main traditions in natural history has been pointed out by many historians of science—for instance Joseph Schiller and Roselyne Rey, who have described the separate traditions of physiology and systematics.[11] More recently, in a work on Buffon, Thierry Hoquet discussed the naturalist's attempts to set up an experimental natural science without classifications.[12] Now, what form did these traditions—systematics and experimentalism, with their opposing structures—take in our two protagonists, Spallanzani and Linnaeus?

With regard to systematics, Linnaeus wished to exercise full control over men, knowledge and the means of communication in natural history. His determination to found a "republic of botanists" demanded the creation or redrafting of all the rules in use by naturalists for writing about natural history. Some of these were implicit and he transformed them into explicit rules, others were created, some were rejected. One crucial problem that Linnaeus dealt with was to find a language that would allow naturalists to share their reading of nature, and to establish an artificial code that would make this grammar available for use by everybody in the same way.

[10]On this issue, see Dario Generali, "Uno speziale che superava la sua condizione. Il caso dell'invisibilità postuma di Diacinto Cestoni," in *Figure dell'invisibilità. Le scienze della vita nell'Italia d'antico regime*, eds. Maria Teresa Monti and Marc J. Ratcliff (Florence: Olschki, 2004), pp. 83–118.

[11]Roseline Rey, "L'espèce entre science et philosophie chez Charles Bonnet," in *Histoire du concept d'espèce dans les sciences de la vie* (Paris: Fondation Singer-Polignac, 1985), pp. 79–99; Joseph Schiller, *La notion d'organisation dans l'histoire de la biologie* (Paris: Maloine, 1978).

[12]See Thierry Hoquet, *Buffon Histoire naturelle et philosophie* (Paris: Champion, 2005), chap. 7, in particular p. 253.

This problem of communication was in large part resolved thanks to the several rules laid down by Linnaeus in his *Fundamenta botanica* and *Philosophia botanica*. The invention, or more exactly the establishment of the binomial nomenclature,[13] based on the abbreviations used by his pupils during the 1740s and 1750s,[14] also revealed itself to be a powerful tool for unifying nomenclature and classification.

However, as is well known, Linnaeus had many opponents. One of his fiercest critics was Buffon; the essay *De la manière d'étudier et de traiter l'histoire naturelle* that opened the first volume of his *Histoire naturelle générale et particulière* (1749) contained an attack on the Linnaean system. Systematics was a science of words and not of facts, affirmed Buffon.[15] This criticism would resonate strongly among other experimentalists, such as Charles Bonnet, providing perhaps his main point of agreement with Buffon. From the mid-1760s onwards, after he had published his books on parthenogenesis (1745), psychology (1754, 1760), and *Contemplation de la nature* (1764)—the first pre-Linnaean handbook of natural history—Bonnet was regarded as one of the leading natural experimentalists and philosophers in Europe. He was a strong opponent to nomenclatures, which he considered lists of totally worthless words. But, more importantly for us, Bonnet was Spallanzani's mentor, teaching him the techniques and skills of the experimental tradition, although Spallanzani proved to be innately gifted in this domain. Both agreed on the poor quality of many of the experiments presented by Linnaeus and his pupils in *Amonitates Academicae*, one of the grounds for Spallanzani's scorn for Linnaeus. He therefore concurred, along with many others, in Bonnet's dismissal of nomenclature. In fact, this position was not unusual during the 1760s, when many naturalists still had not accepted Linnaeus' rules for nomenclature. Most preferred the classical nomenclature of Bauhin-Tournefort, particularly in Italy, where the Florentine physician Giovanni Targioni Tozzetti used the French system in his experiments on the microfungi responsible for wheat rust (1767), and a colleague of Spallanzani's, Bonaventura Corti, also did in his 1774 study on internal movements in plants.[16]

Therefore Linnaeus on the one hand, and Bonnet and Spallanzani on the other, were representatives of two strongly demarcated and profoundly different traditions.

[13]See John Lewis Heller, "The early history of binomial nomenclature," in J. L. Heller, *Studies in Linnaean Method and Nomenclature* (Bern: Peter Lang, 1985).

[14]See Lisbet Koerner, "Carl Linnaeus in his time and place," in *Cultures of Natural History*, eds. Nicholas Jardine et al. (Cambridge: Cambridge University Press, 1996), p. 150.

[15]Georges Leclerc de Buffon, "De la manière d'étudier et de traiter l'histoire naturelle," in *Oeuvres complètes de Buffon* (Paris, 1866), p. 29 [orig. ed., Paris: Imprimerie Royale, 1749]. On this, see Hoquet, *op. cit.*, note 12, p. 224.

[16]Bonaventura Corti, *Osservazioni microscopiche sulla tremella et sulla circolazione del fluido in una pianta aquajuola* (Lucca: Rocchi, 1774). Joseph Quer, *Flora espanola*, 6 vols. (Madrid: Joachin Ibarra, 1762–1784). In the early 1760s Horace-Bénédict de Saussure used the French system in his letters to Haller; see *The Correspondence between Albrecht von Haller and Horace-Bénédict de Saussure*, ed. Otto Sonntag (Bern: Huber, 1990), pp. 68–82.

Indeed, many scholars viewed these two traditions as being hermetically sealed off from one another, although some were able to draw upon both in their work. Albrecht von Haller (1707–1778), for instance, wrote several books on the systematics of alpine plants, but he was equally well known for his physiological enquiries.[17] And while Spallanzani was famous for his experiments in the natural sciences, he also knew how to apply the Linnaean nomenclature and classification. For instance, as curator[18] he arranged the natural history exhibits of the Museum of Pavia in accordance with the system of Linnaeus, whose handbooks had in fact been imposed by the Austrian administration. Yet for Spallanzani as well as Haller these two fields remained distinct, and their attitude illustrates not only the resistance to Linnaeism in various quarters, but also the conceptual difficulty many had in crossing the boundaries established between the two traditions of experimentalism and systematics. Particularly for some of the leading "orthodox" scholars of the time, they represented two fields as dissimilar and impermeable to one another as geography and chemistry; each had its own symbols, language, practices and fields of application and very few scholars, up until the 1760s, sought to combine the two.

Scientific Language Practices in the Experimental Tradition

A Matter of Facts and a Matter of Language

To better understand why certain scholars resisted so strongly the notion of crossing these boundaries, we must examine more closely just what characterized these traditions.

The experimental tradition has been described in various ways by historians of science. Concrete work, procedures, experimentation, and more generally the matter of facts and rhetorical tools have been scrutinized, and much attention has been devoted to the actual reproduction of experiments in order to understand the construction of experimental communities. Yet, although Shapin and Schaffer spoke of literary technologies, they did not focus on the issue of artificial language.[19] Artificial and technical language is an aspect that has been addressed by historians of

[17]See on Albrecht von Haller, *Albrecht von Haller. De formatione cordis in ovo incubato*, ed. Maria Teresa Monti (Basel: Schwabe, 2000); and Hubert Steinke, *Irritating Experiments: Haller's Concept and the European Controversy on Irritability and Sensibility, 1750–1790* (Amsterdam, New York: Rodopi, 2005).

[18]See Alessandra Ferraresi, "Lazzaro Spallanzani docente di storia naturale all'Università di Pavia. Gli esordi," in *Il cerchio della vita*, eds. Walter Bernardi and Paola Manzini (Florence: Olschki, 1998).

[19]Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life* (Princeton: Princeton University Press, 1985), pp. 60–65.

systematics such as William Stearn, John Heller and Mary Slaughter,[20] and less by historians of experimental science. Therefore, one way to characterize the demarcation between these two traditions—which have actually given rise to separate historiographic traditions—is to understand how their practitioners dealt with the *matter of language*, as opposed to the matter of facts. According to the naturalists of the period, the functioning of language and communication were necessary steps to understand nature. We might even venture to characterize our two traditions as an opposition between "recessive" and "dominant" attitudes towards the matter of language. One dominant feature of Linnaeism was its concentration on the matter of language, whereas matters of fact were not treated with as much care, and thus could be considered "recessive." On the contrary, the priority attributed to matters of fact was a dominant trait in the experimentalist tradition, and the matter of language turns out to have been recessive. One indication of the existence of this schema was Bonnet's response in 1766 when Spallanzani asked him what language he should use to write his scientific papers. The Italian naturalist believed that French would provide him with a broader European audience, but Bonnet said instead that he had better write in his own language, adding that conducting experiments was sufficiently difficult without having to deal with the additional problem of language.

Distinguishing in this way between the matter of language and the matter of facts does not mean that the systematicists did not deal with facts, or experimentalists with language. But it does demonstrate the classes of problems that each tradition considered to be a priority within its research fields.

Scientific Language Practices in Spallanzani's Works

How did Spallanzani deal with the matter of language in practical terms? He used the Linnaean nomenclature for plants,[21] and as to his language and writing style Bonnet gave him much sensible advice—for example to avoid a boring prolixity.[22] Recent studies by Maria Ferrucci and Maria Teresa Monti have shed important light on this issue. Maria Ferruci investigated Spallanzani's approach to language in his earlier works, and especially in the *Saggio di microscopiche osservazioni*.[23] Through a careful perusal of his manuscripts and published works, she found that Spallanzani actually copied many terms and sentences from texts in the Italian experimentalist

[20]William T. Stearn, *Botanical Latin*, 4th ed. (Portland, Oregon: Timber Press, 1995); John Heller, *op. cit.*, note 13; Mary M. Slaughter, *Universal Language and Scientific Taxonomy in the Seventeenth Century* (Cambridge: Cambridge University Press, 1982).

[21]Lazzaro Spallanzani, *Expériences pour servir à l'histoire de la génération des plantes et des animaux* (Geneva: Chirol, 1785).

[22]Bonnet to Spallanzani, 8 August 1767, in Di Pietro, *op. cit.*, note 3, 1984, t. 2, p. 68.

[23]Maria Ferrucci, " 'La mano ristette.' Strategie del candore nei giornali delle infusioni di Lazzaro Spallanzani," in *Ecriture et mémoire. Les carnets médico-biologiques de Vallisneri à E. Wolff*, ed. Maria Teresa Monti (Milan: FrancoAngeli, 2006), pp. 49–70.

tradition. It seems that he was looking for a procedure that would help him to write properly, in a literary style, and according to the standards of the Italian tradition. The strategem of borrowing gave him direct access to words and expressions that might otherwise be difficult to retrieve at the right moment.

In a recent book on Spallanzani's experiments with regeneration in worms and his contacts with scholars all over Europe who were working on the same problem, Maria Teresa Monti discusses on a few pages the language used by Spallanzani in the mid-1760s. He avoided dealing with nomenclature[24] and—especially with regard to the anatomy of the worm—did not feel the need to use a technical language based, for instance, in Latin or Greek. He seems to have been "satisfied with resorting to expressions taken from spoken language and even from dialect."[25] Indeed many local expressions can be found in his notebooks on worms, such as "zucchette" (little pumpkins), or "bracciatelle" (little arms); such terms were not suitable for a scholarly paper,[26] but he frequently did incorporate literary figures of speech. The deployment of ordinary language was taken for granted not only to describe the anatomy of animals but also, as Monti noted, to "make reference to animal species of which Spallanzani knew perfectly well the Linnaean names."[27] On these occasions he recycled vernacular language, reusing in a new context both everyday and literary language.

All of these examples show not only that Spallanzani worked conscientiously to polish his language skills, but also that he delighted in playing with words, rhythms, and meaning. Thanks to the reservoir of sentences that he took from the experimental literature, he could use stylistic techniques to make a specific impression on his audience, strengthening his rhetoric and making it more convincing. This could, in a pinch, lead his contemporaries to think that he possessed his own scientific-literary style, one of the guarantees for a scientific reputation in Italy. As Buffon said, "le style c'est l'homme" (the style is the man), adding that only well-written works would be remembered by posterity. In contrast, there was no better machine for eliminating personal style and getting one's ideas swallowed up in a crowd of anonymous words than artificial Linnaean Latin.

LINNAEUS AND HIS INFLUENCE ON THE EXPERIMENTALISTS

Linnaeus and the Microscopic World

While Linnaeus was best known for his work on systematics, he also conducted work in areas where Bonnet and Spallanzani made significant contributions, such as the theory of anti-spontaneism in the generation of microscopic water animalcules,

[24]Maria Teresa Monti, *Spallanzani e le Rigenerazioni. L'inchiesta, la comunicazione, la rete* (Florence: Olschki, 2005), p. 334.
[25] Monti, *op. cit.*, note 24, p. 334.
[26]Monti, *op. cit.*, note 24, p. 335.
[27]Monti, *op. cit.*, note 24, pp. 334–335.

which they both defended. Linnaeus studied and classified a genus of microscopic bodies that he denominated *Chaos*, but signally failed to follow the rules that he himself had established for imposing order on natural history.

In the 12th edition of *Systema Naturae* (1767), we find the genus *Chaos*, consisting of various species that escaped the morphological and vital standards of animality. Linnaeus identified five "species": *Chaos redivivum*, *C. protheus*, *C. fungorum*, *C. ustilago*, and *C. infusorium*. Yet he altered all the basic rules of classification, nomenclature and reference in order to do so, and it was not by chance that the genus was named as early as 1758 *Chaos*. The disorder arose as much from the characters of these entities as from the attempts to exchange information about them between scholars. Were the species of *Chaos* "reproducible" linguistically speaking? How could they be described? While all the other genera were assigned positive characters, this genus was an exception, being defined by negative characters—no limbs, no sense organs. Furthermore, the binomial name did not designate a single species, as was the case everywhere else in Linnaeus' system, but could refer to more than one species! *Chaos redivivum* was used to identify Needham's eels revived from fish paste, but also eels resuscitated from vinegar, considered by various authors to be two separate species.[28] Thirdly, small animals undergoing morphological transformations were placed in this genus as well, such as *C. protheus*, whose "proper form cannot be determined."[29] Fourth, this genus included species that were believed to transmute from animal to vegetable or the reverse, notably *C. fungorum*, defined as the seeds of fungi, and *C. ustilago*, the powdery fructification from vegetables. Fifth, *Chaos infusorium* was presented as if it were one species, even though Linnaeus cited a series of microscopists from the 17th century onwards, thus implicitly drawing upon hundreds of observations. And sixth, the members of *C. infusorium* were defined in terms of their environment rather than, as everywhere else in Linnaeus's works, the morphology of the animals.

As a consequence, in dealing with these animalcules Linnaeus made extensive compromises on each rule of the Latin tradition that he himself had institutionalized in order to enroll people in his "army of botanists." Because of their deviant morphology, methods of generation, and speciation, the infusoria constrained Linnaeus to modify his praxis in communicating scientific knowledge. Nomenclature, definition, determination and synonymy were all turned upside down, becoming respectively equivocal, negative, ambiguous and presented without abbreviation or references. Indeed, for *C. infusorium*, instead of providing the usual list of authors and synonyms with abbreviations and references, Linnaeus contented himself with a chronological list of "micrographic authors."[30] And although he cited many naturalists including Leeuwenhoek, Joblot, Baker, Needham, and Ledermüller, he did not mention Spallanzani.

[28]Carl Linnaeus, *Systema Naturae*, 12th ed. (Holmiae: Salvii, 1767), p. 1326.
[29]Linnaeus, *op. cit.*, note 28, p. 1326.
[30]Linnaeus cited Harris, Hooke, Griendel, Bonanni, Leeuwenhoek, Cuno, Baker, Needham, Adams, Hill, Joblot, Walker, Rösel, and Ledermüller.

How Experimentalists Changed Their Minds about Linnaeism

Nevertheless, it would be erroneous to think that the experimentalists, and among their leaders Bonnet and Spallanzani, did not gradually change their minds with regard to Linnaeism. One figure who contributed to bringing about this shift was the eminent Danish naturalist, Otto-Friedrich Müller, who shaped the field of the systematics of microscopic animalcules from 1770 onwards. In the spring of 1766, during a European tour that would take him to Italy (where he performed entomological studies around Turin), Müller stopped in Geneva, where he had the opportunity to meet Charles Bonnet.[31] The two, who shared the same interest in insects and microscopic animalcules, began to correspond and send each other copies of their scientific publications. In 1771 Bonnet received a copy of Müller's book (in German) describing his extensive experiments on the regeneration of worms, in which he established that several aquatic worms underwent generation through scission. Spallanzani was informed of this discovery at the beginning of 1772.[32] Even though he disliked nomenclatures and the Linnaeans, Bonnet evidently wished to bridge the gap between the two traditions, and he asked Müller, who had announced that he was about to publish a substantial work on the infusoria, if he was aware of the two books of Needham and Spallanzani on the subject. In April 1773, Müller replied that he was not familiar with Spallanzani's work, but had asked his bookseller to obtain a copy for him.[33]

In a letter dated 7th April 1773, Müller informed Bonnet of his latest work, *Vermium terrestrium et fluviatilium*, a copy of which reached Geneva several months later through Haller. Published in 1773, this book created the modern systematics of infusoria following the Linnaeans' rule of nomenclature and classification, and in this way Müller rescued the microscopic animalcules from the chaos created by merging them in a single genus, when the confusion was really in Linnaeus' head. Müller acknowledged his debt to the traditions of both experimentalism and systematics by dedicating his book to Linnaeus, Haller and Bonnet, the latter two representing the experimentalist tradition. This is another indication that many scholars were beginning to feel the need to reconcile traditions that had been kept separate by their professors. In October 1773, Bonnet finally received his copy of *Vermium*, read it, and asked for Haller's opinion on it, although he could not conceal his own enthusiasm: "What do you think of Müller's work on animalcules?" he exclaimed. "No one dared to classify them up until now. We're much ignorant about them. But Spallanzani will do a better job than classifying them—he will give us their story."[34] Both Bonnet and Haller counted therefore on Spallanzani's experimental skills to repeat and test Müller's observations, which seemed to confirm the transmutation theories of Needham.

Nevertheless, Bonnet remained deeply impressed by Müller's identification and classification of about 400 animalcules, and in his letters to various colleagues, among them Felice Fontana,[35] he communicated his enthusiasm regarding the work. This is quite significant in the context of our discussion, because it is one of the only cases during the course of Bonnet's scientific career wherein we find him praising a study in systematics. In September 1774, he wrote to Spallanzani, telling him that, "it would be very useful if you could consult this book before publishing your own work."[36] He knew that since 1770 Spallanzani had been working on several objections raised by Needham with regard to his microscopic observations, and in March 1775 we find the experimentalist Bonnet once again reiterating to Spallanzani, a fellow experimentalist, that he should read a "Linnaean" book.[37] Yet, when in 1776 Spallanzani published *Opusculi di fisica animale e vegetabile*, his second book confirming the hypothesis of anti-spontaneism in microscopic animalcules, although he cited Müller he did not use the Linnaean nomenclature.

Conclusion

Spallanzani left his mark on the scientific world at a time when the influence of Linnaeus was growing in every part in Europe. He was one of the most celebrated Italian experimentalists of the time, and his attitude toward Linnaeism could be taken as a significant indication of the acceptance of Linnaeism in northern Italy.

At the end of the Enlightenment, the last barriers of resistance to Linnaean systematics and nomenclature fell, as the generation of scholars who had long opposed Linnaeus passed away one by one—Buffon died in 1788, Bonnet in 1793, and Spallanzani in 1799. All the same it should be noted that from the 1760s onwards, many naturalists in Europe, including some from the Italian states, had already begun to make use of Linnaeus' nomenclature. And these included not only amateur naturalists such as Rousseau, who praised Linnaeus' system, but also some of the most prominent figures in the natural sciences. By the end of the century experimentalists were being converted to Linnaeism, and this conversion took the form of a merging of the two traditions, whereas the previous attitude had been to keep them rigidly

[31]Müller to Bonnet, 3 August 1766, Bibliothèque publique et universitaire (hereafter BPU), Geneva, Ms Bo 28, f. 197.
[32]Bonnet to Spallanzani, 18 January 1772, in *Lettres à l'abbé Spallanzani de Charles Bonnet*, ed. Carlo Castellani (Milan: Epistemé, 1973), p. 229.
[33]Müller to Bonnet, 7 April 1773, BPU Ms Bo 31, f. 192. Already in August 1771, Müller replied from Copenhagen: "It is not easy to get here the writings of Mr Spallanzani & Nedham." Müller to Bonnet, 19 August 1771, BPU Ms Bo 30, f. 287v.
[34]Bonnet to Haller, 6 October 1773, in *The Correspondence between Albrecht von Haller and Charles Bonnet*, ed. Otto Sonntag (Bern: Huber, 1983), p. 1101.
[35]Bonnet to Fontana, 20 May 1775, BPU Ms Bo 74, f. 204v.
[36]Bonnet to Spallanzani, 24 September 1774, Castellani, *op. cit.*, note 32, pp. 266–267.
[37]Bonnet to Spallanzani, 25 March 1775, Castellani, *op. cit.*, note 32, p. 275.

apart. In this new approach, the matter of language and the matter of facts were no longer dominant or recessive traits. Instead, a single new discipline emerged that from the 1790s onwards gathered together all the strands of the natural sciences and showed scholars how to go about dealing with both matter of facts *and* matters of language. Thus, treatises in the natural sciences published at the beginning of the 19th century taught both the language and the practices of science. In other words, while it is known that Linnaeus led a revolution in botany, I would suggest that his impact was even broader. Through this synthesis of experimentalism and Linnaeism, a second revolution was actually being prepared that would lay the foundations for the language of the emerging science of biology in the first part of the 19th century.

After the examples given in *Amonitates academicae* of an amalgamation of the experimental and the systematic languages, more and more researchers beginning in the 1770s were combining the experimentalist's language with Linnaean nomenclature and morphological language.[38] This was no mere change in the names being used, but a fundamental shift in the linguistic geography of sciences; perhaps an apt image would be of two linguistic "word masses" that collided and finally coalesced. This event, involving the movement in the plate tectonics of scientific languages, brought together their two major functions: describing facts and what the author does (the language of the experimental tradition) and the object being studied (the language of systematics). Therefore, alongside the requirement for the reproducibility of the procedures in the experimental tradition, the object itself had to be "replicable."[39] Let us imagine a scholarly text in which all the procedures are described so that the experiment can be easily repeated, but the organisms are *not* identified according to a shared set of rules; they are simply described using ordinary language. Such an approach would greatly diminish the possibility of someone else reproducing the experiment, due to the lack of "repetition of the organism." The problem might not be very serious if the experiment is being carried out on a cow, but if a less familiar organism is involved, such as a small insect or worm, a water insect or a microscopic entity, then things become much more difficult, if not impossible, to disentangle. With little exaggeration, such was the situation in the experimental tradition during the 18th century.

As far as Spallanzani is concerned, he came to accept Linnaeism in his research on animals during the 1780s.[40] The trajectory of his reception of Linnaism ran as follow: during the 1760s he definitely made no use of it, rejecting artificial language even though he was greatly interested in the problems of language. Then he progressively had to deal with Linnaean systematics, at least in the area of botany as curator of the Pavia Museum, but he continued to protect his animal investigations—

[38]On the mingling of the two languages, see Marc J. Ratcliff, "Code méthodologique et langue naturaliste: les écrits de Louis Jurine (1751–1819) dans les traditions des sciences de la nature," in *Louis Jurine (1751–1819) chirurgien et naturaliste*, eds. René Sigrist et al. (Geneva: Droz, 1999), pp. 415–442.
[39]See on this Ratcliff, *op. cit.*, note 38, 1999, pp. 415–420, 438–439.
[40]Monti, *op. cit.*, note 24, p. 334.

especially those on microscopic animalcules—from defilement by the artificiality of the Linnaean art. During the 1770s, he did not follow Bonnet's advice to study Müller's work, and in 1780 we still find no systematic use of the Linnaean language in his *Dissertation on animal and vegetable*. Therefore, in his most important works he did not apply any of the Linnaean skills. Historians of science have long discussed the conversion of Spallanzani and Haller to the concepts of pre-formation and epigenesis. But perhaps one aspect that deterred Spallanzani, Bonnet and many other experimentalists was in fact Linnaeus' artificial *pre-formation of communication*, which was quite the opposite of the epigenesist attitude towards the matter of language that had evolved in the experimental tradition. Then, in the early 1780s Spallanzani changed his mind about using this pre-formed and artificial language, perhaps because the Linnaean tide had by now become irreversible.

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