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The Desire to Contribute: An Eighteenth-Century Italian Woman of Science

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FROM THE SIXTEENTH TO THE EIGHTEENTH CENTURY, Europe experienced what most historians of science describe as a scientific revolution. The revolution's new philosophies, expounded by Galileo, Descartes, Newton, and Leibniz, became increasingly popular among the educated classes, as did the skills of experimentation and observation.[1] Women also participated in the revolution: it became acceptable and fashionable in French, English, and German society for educated women to keep informed of new scientific discoveries. In spite of an enhanced interest in science, the scientific knowledge of most society women remained superficial.[2] However, a few women, working either independently or as assistants, had a professional role in science. Gabrielle Emilie, the marquise du Châtelet (1709–1749), was responsible for spreading knowledge of Newton's physics and Leibniz's metaphysics in France. Marie Lavoisier acted as assistant to her husband, Antoine Lavoisier, during his experiments.[3] In England, Caroline Herschel assisted her brother William, the astronomer royal. During a period of ten years, she discovered eight comets and three nebulae. In Germany, Maria Winkelmann, trained in astronomy by a family friend, married an astronomer, which enabled her to continue in her field by acting as assistant to her husband in the Berlin Academy.[4]

Despite their achievements, the scientific activity of these women was thwarted by the societies in which they lived. Emilie du Châtelet failed to become a member

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[1] Thomas S. Kuhn, in *The Structure of Scientific Revolutions* (1962), 2d edn., enl. (Chicago, 1970), objects to a single scientific revolution and envisages several revolutions that occurred through several centuries. The idea of a scientific revolution is found in E. Zilgel, "The Sociological Roots of Modern Science," *American Journal of Sociology*, 47 (1942): 544–62; Alexander Koyré, "The Significance of the Newtonian Synthesis," reprinted in Koyré, *Newtonian Studies* (London, 1965), 3–24; A. Rupert Hall, *The Scientific Revolution, 1500–1800: The Formation of the Modern Scientific Attitude* (Boston, 1956), 5–37; and Richard S. Westfall, *The Construction of Modern Science: Mechanisms and Mechanics* (New York, 1971), 1–80.

[2] Margaret Alic, *Hypatia's Heritage: A History of Women in Science from Antiquity through the Nineteenth Century* (Boston, 1986), 77–78; Marilyn Bailey Ogilvy, *Women in Science: Antiquity through the Nineteenth Century* (Cambridge, Mass., 1986), 11–15; Londa Schiebinger, *The Mind Has No Sex? Women in the Origins of Modern Science* (Cambridge, Mass., 1989), 38–39.

[3] Alic, *Hypatia's Heritage*, 135–45; Carolyn Iltis, "Madame du Châtelet's Metaphysics and Mechanics," *Studies in History and Philosophy of Science*, 8 (1977): 29–48.

[4] Schiebinger, *Mind Has No Sex*, 83–85, 262–63.

of the Academie Royale des Sciences and therefore could not participate in the exchange of ideas in the academy. Caroline Herschel, in spite of having had her astronomy findings published in the *Philosophical Transactions* of the Royal Society of London, was not a member of the society. Maria Winkelmann's attempts to become an assistant astronomer at the Berlin Academy after her husband's death failed, notwithstanding a recommendation from Leibniz.[5] The recently founded scientific academies generally followed the practice long established in universities of excluding women from their activities.[6]

In Italy, however, a few women succeeded in carving out a niche for themselves in the new scientific order. They were excluded neither from the universities and the scientific academies nor from the knowledge expounded by these institutions.[7] One of the most important of these women was Laura Bassi Verati, who lived in Bologna, a town in the Papal Estates, during the eighteenth century.[8]

LAURA MARIA CATERINA BASSI, the only surviving child of a lawyer of moderate means, was born in Bologna on October 20, 1711. Her father, through his work, had contact with members of the town's aristocracy. When she was five years old, Bassi began to study Latin under the supervision of her cousin Father Lorenzo Stegani, who also taught her French and arithmetic.[9] At the age of thirteen, she began to study philosophy under Gaetano Tacconi, the family doctor, who taught

[5] Schiebinger, *Mind Has No Sex*, 62–63, 92, 263; Londa Schiebinger, "Maria Winkelmann at the Berlin Academy," *Isis*, 7 (1987): 174–200.

[6] Schiebinger, "Maria Winkelmann," 174–75.

[7] See Paul Oskar Kristeller, "Learned Women of Early Modern Italy: Humanists and University Scholars," in *Beyond Their Sex: Learned Women of the European Past*, Patricia H. Labalme, ed. (New York, 1980), 95–102; G. L. Masetti-Zannini, *Motivi storici della educazione femminile: Scienza, lavoro, giuochi* (Napoli, 1982), 7–70; H. J. Mozans, *Woman in Science: With an Introductory Chapter on Woman's Long Struggle for Things of the Mind* (1913; Cambridge, Mass., 1974); Emma Tettoni, "Le scienziate italiane," in *La donna italiana descritta da scritrici italiane* (Florence, 1890), 263–88; R. Farina and M. T. Silano, "La pastorella d'Arcadia contesta: Il settecento femminista in Italia," in *Esistere come donna* (Milano, 1983), 27–35; *Alma Mater Studiorum: La presenza femminile dal XVIII al XX secolo* (Bologna, 1988), 20–157.

[8] See P. Cazzani, "Laura Bassi," in *Studi e inediti per il primo centenario dell'Istituto Magistrale Laura Bassi*, Elio Melli, ed. (Bologna, 1960), 9–15.

[9] A short description of Bassi's early education is given by the scientist herself on the back of a letter from Flaminio Scarselli dated Rome, July 20, 1743, in Biblioteca Comunale dell'Archiginnasio di Bologna (hereafter, BCAB), Ms. B. 2024: *Lettere autografe scritte da illustri italiani e stranieri alla celebre dottoressa bolognese Laura Maria Catterina Bassi e al marito di lei Giuseppe Veratti*; and a prose work by L. Stegani, in *Rime in lode della Signora Maria Catterina Bassi, cittadina bolognese aggregata all'Accademia dell'Istituto delle Scienze di Bologna prendendo la sua laurea dottorale in filosofia* (Bologna, 1732). For a description of Bassi's family before her marriage, see Archivio Arcivescovile di Bologna (hereafter, AAB), *Status animarum* per la Parrocchia di San Lorenzo di Porta Stiera, 1732; and BCAB, Bassi, Laura, Cartone 1°, fasc. Ia: notizie riguardanti Laura Bassi, sec. XVIII, in *Due cartoni contenendo autografi, scritti e documenti biografici, diplomi ed elogi della Bassi*, sec. XVIII. In terms of property, Bassi's father belonged to the bourgeoisie, according to Luigi dal Pane's definition of bourgeois holdings in *Economia e Società a Bologna nell'età del risorgimento* (Bologna, 1969), 171–77. Dal Pane states that a member of the bourgeoisie owned an average of 8,287 lire in property at the time as compared to an average of 105,404 lire for the aristocracy. For the value on Bassi's property, see BCAB, Bassi-Veratti, *Atti notarili e vari riferenti alle famiglie Bassi e Veratti*, Cartone 1°: Piano di divisione dell'Ecc.^{mo} Dott; Giuseppe Veratti, June 18, 1785.

at the University of Bologna and was a member of the town's Academy of Sciences.[10]

The young woman's ability to handle public disputations was tested several times before she had to face her official public disputation in defense of her set of theses on April 17, 1732. Frequent meetings, attended by several members of the Academy of Sciences and, after 1731, by Cardinal Lambertini, the future Pope Benedict XIV, took place at her home. Bassi made such a powerful impression at these meetings that the men made her a voting member of the Academy of Sciences four weeks before her public disputation.[11]

The degree of philosophy was conferred on Bassi May 12, 1732, and on June 27 of the same year she defended twelve new theses in the Archiginnasio, the seat of the university. This feat permitted her to ask the Bologna Senate for a lectureship at the university. At Cardinal Lambertini's insistence, the Senate eventually granted Bassi a lectureship in universal philosophy on October 29, 1732; however, it also ruled that, because of her sex, Bassi was not to be permitted to teach in public at the Archiginnasio unless commanded by her superiors.[12] As it happened, the administration commanded her over the years of her service to give several lessons at the Archiginnasio but never on a regular basis. Nevertheless, Bassi's salary continued to increase, from 500 lire until, by 1760, it reached 1,200 lire per annum, one of the highest at the university.[13]

[10] See the back of a letter from Scarselli dated Rome, July 20, 1743, in BCAB, B. 2024: *Lettere autografe*; G. Cenerelli, ed., *Lettere inedite alla celebre Laura Bassi scritte da illustri italiani e stranieri con biografia* (Bologna, 1885), 228. Tacconi had been made a member of the Academy of Sciences in 1717, where he had presented a single paper in medicine. See Richard L. Rosen, "The Academy of Sciences of the Institute of Bologna, 1690–1804" (Ph.D. dissertation, Case Western Reserve University, 1971), 151, 209.

[11] See the back of a letter from Scarselli dated Rome, July 20, 1743, in BCAB, B. 2024: *Lettere autografe*; BCAB, Letter no. 32 of Giampietro Zanotti to G. Riva, Bologna, April 15, 1732, in B. 382: *Lettere di Giampietro Zanotti al Padre Giampietro Riva.* Cardinal Lambertini became archbishop of Bologna in 1731, see M. Rosa, "Benedetto XIV," in *Dizionario biografico degli italiani* (hereafter, *DBI*) (Rome, 1960–), 8: 393–408.

[12] The ceremonies associated with the defense of the theses, her degree, and the granting of a lectureship are discussed in detail by Giovanni Fantuzzi, *Notizie degli scrittori bolognesi* (Bologna, 1782), 2: 384–91; Caterina Ferrucci's biography "Laura Bassi," in Carolina Bonafede, *Donne bolognesi insigni* (1845; Bologna, 1971), 173–82; Ernesto Masi, "Laura Bassi e il Voltaire," in *Studi e ritratti* (Bologna, 1881), 157–71; see particularly G. B. Comelli, *Laura Bassi e il suo primo trionfo* (Bologna, 1912), 3–47; A. Garelli, "Biografia," in Cenerelli, ed., *Lettere inedite*, 11–29; Cazzani, "Laura Bassi," 9–15; Archivio di Stato di Bologna (hereafter, ASB), Fondo: *Senato*, serie: Diari, anni 1714–41, 11 e 12, ff. 131–32, May 14, 1732, and ff. 133–34, June 28, 1732; Laura Bassi, *Theses: De aqua corpore naturale elemento aliorum corporum; Parte universi; D.D.D.*; a Bononiae ex typographia Laelli a Vulpe MDCCXXXII; BCAB, Letter no. 3 of G. Zanotti to Riva, Bologna, June 22, 1732, in B. 382; BCAB, Letter no. 219 of G. Zanotti to Eustachio Manfredi, August 30, 1732, in B. 163, *Lettere famigliari e a diversi di Giampietro Zanotti*; ASB, Fondo: *Senato*, serie: Vacchetoni, Registro 60, f. 203, August 25, 1732; ASB, Fondo: *Senato*, serie: Partiti, vol. 35, f. 45, dies 29 octobris 1732.

[13] For Bassi's lectures at the university, see Bassi to Flaminio Scarselli, May 12, 1745, in Elio Melli, "Epistolario di Laura Bassi Verati," in Melli, *Studi e inediti*, 105–06; ASB, Fondo: *Assunteria di Studio*, serie: Atti, anni 1735–43, vol. 23: Acts of December 5, 1739, and December 11, 1739, f. 44; November 15, 1741, f. 67; serie: Atti, vol. 24: Acts of January 22, 1749, f. 2, February 7, 1749, f. 2v, February 16, 1750, f. 17, April 7, 1750, f. 21v, April 14, 1750, f. 23v. For Bassi's salary, see Luigi Simeoni, *Storia dell'Università di Bologna*, Vol. 2: *L'età moderna* (Bologna, 1947), 95. Women who wove either hemp or silk in the town at the time received 12 to 15 *baiocchi* per day on average. If they worked 365 days a year, which was very unlikely, they would be paid from 219 to 275 lire a year (20 *baiocchi* = 1 lira). See Alberto Guenzi, *La fabbrica delle tele fra città e campagna: Gruppi professionali e governo dell'economia a Bologna nel secolo XVIII* (Ancona, 1987), 113–29.

Other nominations followed: in 1745, Bassi became a member of the newly founded Benedettina Academy, which had been created within the Academy of Sciences by Pope Benedict XIV and named after him. This academy consisted of a class of twenty-four scholars selected from the best-known members of the Academy of Sciences, and they received 100 lire a year for presenting original works at the academy annually at a pre-determined date and for attending three-quarters of all academic meetings. The pope organized the Benedettini in order to increase the quantity of research done at the Academy of Sciences. The number of dissertations presented to the academy had been declining since 1734–1735 and reached an all-time low in the early 1740s, during the War of Austrian Succession.[14] Then, in 1766, Cardinal Alessandro Albani, Cardinal Protector of the Collegio Montalto, nominated Bassi as preceptor to the college's students in experimental physics. The college had been founded by Pope Sixtus V and was essentially a free seminary for students of Marche Province, who ranged in age from eighteen to twenty-four. While at the college, the students attended lectures at the university or at the professors' homes to obtain degrees in either law or theology and law. From 1704 on, the students were also introduced to courses in the sciences, for which Bassi was, from 1766 to her death in 1778, one of the lecturers.[15]

Finally, in 1776, Bassi became professor of experimental physics at the Institute of Sciences, a larger body of which the Academy of Sciences was part. The institute, which opened its doors in 1714, was a public institution whose goals were not only to provide scientific facilities to the members of the Academy of Sciences but also to teach the sciences to university students by a different approach than the method used at the university, that is, with an emphasis on observation and experimentation.[16] Bassi's promotions to preceptor and eventually professor in experimental physics at the Collegio Montalto and the Institute of Sciences, respectively, came after many years of teaching experimental physics at home to students attending the university.[17] Her teaching at home began after her

[14] Nadia Urbinati, "Physica," in Walter Tega, ed., *Anatomie Accademiche*, Vol. 2: *L'Enciclopedia scientifica dell'Accademia delle Scienze di Bologna* (Bologna, 1987), 123–26; Rosen, "Academy of Sciences," 72–73, 100; E. Nardi, ed., *Atti dell'Accademia delle Scienze dell'Istituto di Bologna* (Bologna, 1988), 8–10. For the disruption in the Papal Estates caused by the War of Austrian Succession, see Franco Venturi, *Settecento riformatore*, Vol. 1: *Da Muratori a Beccaria 1730–1764* (Torino, 1969), 102–03.

[15] A rough copy of Bassi's thank you letter to Cardinal Albani is found on the back of Pio Fantoni's letter to Bassi dated Rome, July 9, 1766, in BCAB, B. 2024: *Lettere autografe*; BCAB, B. 2727: "Pubblica Accademia di lettere avutasi nel Collegio Montalto dagli alunni del medesimo in lode della loro precetrice Laura Bassi"; Giuseppe Cagni, "Il Pontefico Collegio 'Montalto' in Bologna (1585–1797)," *Barnabiti Studi*, 5 (1988): 7–194.

[16] See "De professoribus Instituti," in *De Bononiensi Scientiarum et Artium Instituto atque Academia, Commentarii*, known as *Commentarii*, vol. 6, 1783, 31–44; Rosen, "Academy of Sciences," 32–34. Marta Cavazza, *Settecento inquieto: Alla origini dell'Istituto delle Scienze di Bologna* (Bologna, 1990), 203–35.

[17] For students attending her course, see Cenerelli, ed., *Lettere inedite*, 62, 74–75, 80, 141, 147; Lazzaro Spallanzani's letter, Reggio, May 29, 1755, in *Epistolario di Lazzaro Spallanzani*, Vol. 1, B. Biagi, ed. (Florence, 1958), 5; Bassi to M. Caldani, February 7, 1768, in Melli, "Epistolario di Laura Bassi Verati," 168–69; BCAB, Letter no. 3668 of Caldani to Veratti, February 7, 1766, in *Lettere di L. MarcAntonio Caldani*, Collezione Autografi (hereafter, Collez. Aut.) XII, 3665–3764; BCAB, Letter no. 3016 to Bassi, Naples, January 2, 1773, in *Lettera di Bovi Rocco*, Collez. Aut. X, 3016; *Avvisi di Bologna*, no. 8, 25 febbraio 1778, BCAB, Bassi, Laura, *Due cartoni*, Cartone II: opusculi e stampe riguardanti Laura Bassi, no. 8; John Morgan, *The Journal of Dr. John Morgan of Philadelphia from the*

marriage to Giuseppe Veratti, a graduate of the University of Bologna in philosophy and medicine (1734) and lecturer in physics there from 1738 on.[18]

LAURA BASSI'S RISE TO THE TOP OF ACADEMIC LIFE in Bologna could perhaps be explained in terms of her education, degree, lectureship, or occasional lectures at the university, but other Italian women had also registered such achievements. Italy had a tradition of providing education to some women, mostly of the ruling families, the urban aristocracy, or the professional elite.[19] The women usually studied languages (Latin, Greek) and history and philosophy under male tutors. What was studied depended on the tutor, at least initially, and on the period. Thus, while women's writings in the fourteenth century stressed a knowledge of the Bible, those of the fifteenth century emphasized a knowledge of Greek and Roman classical literature. A knowledge of Aristotelian philosophy was demonstrated by both Costanza Varano and Cassandra Fedele in the fifteenth century and by other educated women in the sixteenth and seventeenth centuries. Plato became increasingly popular in the sixteenth and early seventeenth century, while Cartesian philosophy gained ground in the late seventeenth century.[20] In spite of statements by humanists such as Leonardo Bruni in the fifteenth century and Alessandro Piccolomini in the sixteenth that mathematics, geometry, astronomy, and science were not convenient subjects for women to study since they were not likely to use them, some women engaged in these studies if the teachers were available to them.[21] Laura Ceretta (1469–1499) studied both mathematics and astronomy and made astronomical observations with her uncle. Olimpia Fulvia

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City of Rome to the City of London, 1764; Together with a Fragment of a Journal Written at Rome, 1764 (Philadelphia, 1907), 98–99. For the times of her lectures, see Bassi to Scarselli, June 14, 1755; and Bassi to Giacomo Casanova, May 7, 1772, in Melli, "Epistolario di Laura Bassi Verati," 148–49, 174; Morgan, *Journal*, 98–99.

[18] Several of these attempts to teach at home were made in conjunction with her husband. Bassi initially taught mathematics, while Veratti taught experimental physics. After 1749, Veratti no longer taught at home. See Nota di "requisiti" 1739, Nota di "requisiti" 1746, Nota di "requisiti" 1750, and letter to Scarselli, June 14, 1755, all in Melli, "Epistolario di Laura Bassi Verati," 87, 128, 144, 148; for Veratti's requests, see ASB, Fondo: *Assunteria di Studio*, serie: Requisiti dei lettori, Busta 57, fasc. 2, requests of 1743, 1752, 1770; Biblioteca Gambalunga di Rimini (hereafter, BGR), Bassi to Bianchi, 1738, in *Lettere autografe al Dott. Giovanni Bianchi*, in Fondo: *Gambetti*, Posizione: Bassi. For Veratti's degree and position at the university, see ASB, Veratti, Giuseppe, filosofo-medico 1737–1793, Fondo: *Assunteria di Studio*, serie: Requisiti dei lettori, Busta 57, fasc. 24, 1738; Giuseppe Veratti in *Commentarii*, vol. 2, 1745, pt. 1ª, p. 154; Fantuzzi, *Notizie*, 9: 193. Veratti spelled his surname with two t's, unlike Bassi, who, for reasons unknown, spelled it with one t after marriage. See BGR, Bassi's letter to Bianchi soon after her marriage, April 26, 1738, Fondo: *Gambetti*, Posizione: Bassi.

[19] Margaret King, "Book-Lined Cells: Women and Humanism in the Early Renaissance," in Labalme, *Beyond Their Sex*, 67; Kristeller, "Learned Women," 95–97; Margaret L. King and Albert Rabil, Jr., eds., *Her Immaculate Hand: Selected Works by and about the Women Humanists of Quattrocento Italy* (Binghamton, N.Y., 1983), 16–25.

[20] King and Rabil, *Her Immaculate Hand*, 33, 42–43, 70–77; Masetti-Zannini, *Motivi storici della educazione femminile: Scienza*, 7–10; Lucia T. Traversi, "Verso l'inserimento delle donne nel mondo accademico," in *Alma Mater Studiorum*, 20–21.

[21] Alessandra del Fante, "Amore, famiglia e matrimonio nell'Istituzione di Alessandro Piccolomini," *Nuova rivista storica*, 58, fasc. 5–6 (settembre–dicembre 1984): 511–26; G. L. Masetti-Zannini, *Motivi storici della educazione femminile (1500–1650): Morale, religione, lettere, arte e musica* (Bari, 1980), 15, 20.

Morati (1526–1555) was educated in natural philosophy, as was Margherita Sarrocchi Birago (1560–1617), who also had extensive knowledge of geometry. Elena Lucrezia Cornaro Piscopia (1646–1684) added mathematics and astronomy to her studies in theology, philosophy, and dialectics.[22]

What her philosophy teacher Gaetano Tacconi taught Laura Bassi can be surmised, to a certain extent, by the forty-nine theses she had to defend in order to obtain a degree. Six of the theses were in logic, sixteen in metaphysics, and sixteen in physics, specifically, the nature of matter, motion, and meteors. The rest of the theses were concerned with the nature of the mind or soul. In good Aristotelian tradition, these theses separated the intellectual and sensitive capacities of the soul. Aristotelian influences can be detected in Thesis IX of physics dealing with motion, whereby the surrounding medium was viewed as having the capability to impart movement to the object.[23] Cartesian influences can be detected in *De causis*, Thesis IX, whereby no second cause had such a force that it could act at a distance. Other Cartesian influences are found in the physics section, particularly in the concept of extended matter.[24] Paracelsian influences are apparent in the physics section in *De meteoris*, Thesis XIII, in the gunpowder concept of thunder and lightning.[25] The influence of the Galilean and Torricellian school is found in *De motu*, Theses X and XI of the physics section, whereby the motion of liquids was dependent on gravity. Only Thesis V of the section *De anima* illustrates Newton's influence, specifically his theory on light and color found in his *Opticks*.[26]

Even Bassi's public disputation, degree, and membership at an academy of sciences had precedents. Bittizia Gozzadini (1209–1261) and Elena Cornaro Piscopia had received degrees in law and philosophy at Bologna and Padua, respectively. Gozzadini, Novella Calderini, and Dorotea Bocchi may have taught occasionally at the University of Bologna, the first two in law during the thirteenth and fourteenth centuries respectively, Bocchi in medicine during the early fifteenth century. Cassandra Fedele (1465–1558) delivered orations at the University of Padua. In 1722, Maria Delfini Dosi successfully defended her theses in law at the University of Bologna; however, through lack of support, she failed to obtain a degree. Women were also members of academies with scientific research interests. Piscopia had been made a member of Padua's Accademia dei Ricoverati. Several women were members of Bologna's Accademia dei Gelati; others were attached to the town's Accademia degli Inquieti, the future Academy of Sciences,

[22] Masetti-Zannini, *Motivi storici della educazione femminile: Scienza*, 37–49; G. Gabrieli, "Luca Valerio Linceo," *Rendiconti della R. Accademia Nazionali dei Lincei: Classe di scienze morali . . .*, serie 6, vol. 9 (1933): 691–727. Nicola Fusco, *Elena Lucrezia Cornaro Piscopia, 1646–1684* (Pittsburgh, 1975), 50–51.

[23] Thesis IX, Ex Physica, De motu, in Laura Bassi, *D.O.M. Laura Maria Catherina Bassi Civis Bononiensis Academia Instituti Scientiarum Socia Se Suaque Philosophica Studia Humiliter D.D.D.*, a Bononiae ex typographia a Laelli a Vulpe, MDCCXXXII; Hall, *Scientific Revolution*, 19–20.

[24] Marta Cavazza discusses the Cartesian influences on Bassi's theses in *Settecento inquieto*, 250–53; see the theses in Bassi, *Philosophica Studia*.

[25] Bassi, *Philosophica Studia*. See also Allen G. Debus, "The Paracelsian Aerial Niter," *Isis*, 55 (1964): 43–61.

[26] See Bassi, *Philosophica Studia*. For Galilean influences on the motion of liquids, see C. S. Maffioli, "Guglielmini vs. Papin (1691–1697): Science in Bologna at the End of the Seventeenth Century through a Debate on Hydraulics," *Janus*, 71 (1984): 250–53.

albeit none of these academies was publicly funded, as the Academy of Sciences was.[27]

Bassi was aware of the women who had preceded her, of their accomplishments, and of how they could serve as an example to her.[28] Most important, the men who supported her, such as Cardinal Lambertini and Jacopo Beccari, understood that women had played a role at the University of Bologna in the past; therefore, these men saw no reason why they should not do so again.[29] In Lambertini's case, he had the clout to act on his beliefs. Since his arrival at Bologna in 1731, Lambertini, as the town's archbishop, had worked to ensure that the Bologna senators, who controlled appointments at the university and the Institute of Sciences, would allow Bassi to defend her theses, give her a degree, and appoint her as a lecturer at the university. He proposed her as a symbol of the moral value of education. Bassi's accomplishments would enhance the prestige of the town and of the university, as had the accomplishments of other women in the past.[30] In spite of the cardinal's best efforts, the Senate and several men in the academic community, of whom the physician Giovanni Bianchi could be used as an example, felt that Bassi's degree, lectureship, and membership in the public Academy of Sciences should remain purely symbolic: she was not to lecture at the university or use the facilities at the Academy of Sciences unless requested to do so by the authorities in charge of those institutions.[31]

Bassi could have rested on her laurels, received the money that was granted her, and made an appearance only when invited by the university administration; however, she refused to fade into the background as women had done in the past. Instead, after what might appear to be a period of hesitation, Bassi actively sought support from the men who encouraged a larger role for women in the academic and scientific life of the town and thus ensured herself a regular place in this life. In fact, through her twenty-nine years of teaching and through the dissertations she presented yearly at the Academy of Sciences from 1746 on, Bassi not only participated in the scientific life of the town but contributed substantially to it.[32]

[27] There are doubts whether Bittizia Gozzadini ever received a degree. For Gozzadini, see Bonafede, *Donne bolognesi insigni*, 3–12; Fantuzzi, *Notizie*, 4: 209; for Elena Piscopia, see Fusco, *Elena Lucrezia Cornaro Piscopia*, 37–38, 62. For Delfini Dosi, see Traversi, "Verso l'inserimento," 21–30; for Fedele, see King and Rabil, *Her Immaculate Hand*, 21–22, 70–73. See also Kristeller, "Learned Women," 95–102.

[28] BCAB, Bassi, Laura, *Due cartoni*, Cartone I, fasc. 2, ff. 9, 12.

[29] See Giovanna Tilche, *Maria Gaetana Agnesi* (Milano, 1984), 90–91.

[30] Rosa, "Benedetto XIV," *DBI*, 8: 394. For Benedict XIV's actions on Bassi's behalf, see BCAB, Giovanni Giacomo Amadei, *Libro delle cose che vanno accadendo in Bologna e principalment quelle che spettano il governo si civile si ecclesiastico*, B. 517, c. 4r; BCAB, Letter no. 219 of G. Zanotti to E. Manfredi, August 30, 1732, in B. 163: *Lettere famigliari*; ASB, Fondo: *Senato*, serie: Vacchetoni, registro 60, f. 203, August 25, 1732; ASB, Fondo: *Senato*, serie: Partiti, vol. 35, f. 45, dies 29 octobris 1732.

[31] BGR, Giovanni Bianchi to Mons. Lepprotti, February 19, March 12, and June 17, 1733, in Sc.Ms. 963: *Lettere autografe di Giovanni Bianchi a Mons. Leprotti, 1733 al 1745*.

[32] Many of the dissertations Bassi presented at the Academy of Sciences—discussed later in the section dealing with her scientific activities—reflect the leading issues of the time in science: electricity, chemistry, heat, and hydraulics. The dissertations she gave yearly at the Academy of Sciences included: April 28, 1746: On the Compression of Air; April 27, 1747: On the Air Bubbles Observed in Fluids Relieved from Air Pressure; April 25, 1748: On the Air Bubbles Excited in Fluids; April 24, 1749: On the Center of Gravity; April 30, 1750: Latin dissertation (topic not known); April 29, 1751: On Two Problems of Hydrometry; April 13, 1752: mathematical dissertation; April 19,

In this achievement, Bassi is significantly different from the women who preceded her.

Several biographical sketches of Laura Bassi appeared through the years, the first of which was Giovanni Fantuzzi's eulogy in 1778. These sketches are characterized by their brevity and failure to explain how Bassi was able to contribute to the scientific activities of the town.[33] Some authors have, however, been more successful in assessing Bassi's scientific interests: Marta Cavazza in *Settecento inquieto* (1990) discusses the Cartesian influences found in the theses Bassi had to defend to order to obtain her degree. These theses reflected the interests of Bassi's teacher, Gaetano Tacconi, and not of the author herself, who was a Newtonian as early as 1732. Bassi's Newtonianism was made clear in her first lecture at the university in December 1732, when she stated that the philosopher's duty was to deduce the laws that governed nature from phenomena that could be observed experimentally. The Cartesians deduced such laws from rationally evident principles. Cavazza, however, does not analyze Bassi's output after 1733.[34] The author of Bassi's biographical sketch in the *Dizionario biografico degli italiani* (1965) takes into consideration only Bassi's published scientific works and assigns them some value; however, this author then proceeds to define her scientific interests as amateurish.[35] Alberto Elena in his article on Laura Bassi (1991) stresses Bassi's early involvement with Newtonian physics and mentions her scientific collaboration with her husband later in her life but fails to analyze this collaboration. Since Elena does not go beyond the printed sources of Bassi's correspondence with several scientists and has not considered the works of these

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1753: On the Exit of Water from the Holes of One Container; April 25, 1754: On the Evacuation of Water through Various Openings; April 25, 1755: On Hydrodynamics; April 26, 1756: On a Problem in Hydrodynamics; April 28, 1757: algebraic dissertation; April 20, 1758: On Analytical Problems; April 26, 1759: On Different Fluids Exiting from One Opening; April 24, 1760: hydrodynamics dissertation; May 2, 1761: Some Experiments on Electricity; April 29, 1762: On Iceland Glass [used for refraction experiments]; April 28, 1763: On a Way to Correct in Telescopes the Inconvenience Derived from the Different Refractions of Rays, Which Unite at Different Points in the Axis Depending on Their Color; May 2, 1764: On the Phenomena of Liquids in Capillary Tubes of Various Materials; June 14, 1765: On Experiments and Observations in Hydrometry and Hydrostatics; May 1, 1766: Some Hydrometric Experiments Dealing with Genette's Observations; May 7, 1767: On the Speed of a Water Jet in a Container; May 8, 1768: On Electricity; May 6, 1769: On a Series of Experiments to Improve the Art of Dyeing; May 17, 1770: On Electricity; June 7, 1771: On *vindex* Electricity; May 7, 1772: On an Experiment Proposed by Villanova Spagnolo; May 14, 1773: On the Repulsion of Fescues on the Surface of Water Produced by a Drop of Spruce Juice; April 28, 1774: On Electricity, Especially on Some Experiments by Halles; May 11, 1775: On Fire and the Facility of Various Fluids to Receive It; May 2, 1776: The Relation of Flame to Fixed Air [carbon dioxide]; June 5, 1777: On the Property of Various Bodies That Retain Heat More Than Others While Also Retaining Electricity; see Archivio dell'Accademia di Scienze di Bologna (hereafter, AASB), *Catalogo dei lavori dell'Antica Accademia raccolti sotto i singoli autori*, a cura di Domenico Piani, 15–17.

[33] For Italian sources on Bassi, see note 12 above; and G. L. Masetti-Zannini, "Laura Bassi (1711–1778), testimonianze e carteggi inediti," *Strenna storica bolognese*, 21 (1979): 221–41. For biographical sketches on Bassi in English sources, see Mozans, *Woman in Science*, 202–10; Mary Ritter Beard, *On Understanding Women* (New York, 1968), 442–44; Kate Campbell Hurd-Mead, *A History of Women in Medicine from the Earliest Times to the Beginning of the Nineteenth Century* (1938; rpt. edn., Boston, 1973), 500–10; Ogilvy, *Women in Science*, 36–37; Alic, *Hypatia's Heritage*, 117, 135–36, 205; Schiebinger, *Mind Has No Sex*, 14–17. For a French biographical sketch, see Alphonse Rebière, *Les femmes dans les sciences: Notes recueilles* (Paris, 1897), 28–31.

[34] Cavazza, *Settecento inquieto*, 249–56.

[35] s.v. "Laura Bassi Verati," *DBI*, 7: 145–47.

scientists, he also fails to detect her participation in several of the scientific debates then current.[36] The printed and manuscript sources and the scientific debates that went on when Bassi was scientifically active will demonstrate how she was able to contribute to the scientific life of Bologna and, eventually, of Italy.

BASSI'S INTELLECTUAL INDEPENDENCE FROM HER TEACHER appeared soon after she received her degree, when Tacconi insisted that she present her second set of theses in Ethics, needed to receive a lectureship at the university. Bassi objected to the theses in Ethics, an objection perhaps motivated by the fact that this choice would indicate a shift away from natural philosophy on her part. Pressure from Cardinal Lambertini forced Tacconi to back down, and, as Jacopo Beccari described to a friend, "the disciple [Bassi] was freed from a persecution by morals."[37] The twelve theses Bassi actually defended after Lambertini's intercession were all scientific and dealt with the nature of water as a natural element and as part of the universe. Influenced by physician and mathematician Domenico Guglielmini, of the universities of Bologna and Padua, these theses appear to represent a middle ground between Tacconi's Cartesian and Bassi's Newtonian sympathies. In the theses, as in Guglielmini's *Della natura dei fiumi* (1697), liquids were described as conglomerates of minute, perfectly smooth spheres.[38] A set of twenty-four theses found among Bassi's papers dating from 1732 and never published have a strong Newtonian influence throughout; in them, the physics section began with Newton's three laws of motion and continued in a similar vein.[39]

The argument over the theses in Ethics and other intellectual differences apparently caused Bassi and Tacconi to drift apart, in spite of her attempts at reconciliation.[40] She may have believed she was entitled to some intellectual independence from her teacher—an independence Tacconi might have been willing to accept from male students but not from a female, who had only been educated in science as a favor on his part.

After the split with her teacher, Bassi went through a period of about three years in which scientific studies and research did not play as prominent a role in her life as they would in later years, despite her continued interest in experimental natural philosophy and her facility, according to Beccari, for mathematics and physics.[41] Her activity seems to have been constrained by her gender, her education, and perhaps by her own and others' understanding of what her role

[36] Alberto Elena, "*In lode della filosofessa di Bologna*: An Introduction to Laura Bassi," *Isis*, 82 (1991): 510–19.

[37] BCAB, Letter no. 34 of G. Zanotti to Riva, Bologna, June 22, 1732, in B. 382: *Lettere di Giampietro Zanotti*; BCAB, Letter no. 1730 of Beccari to friend, s.d., in *Jacopo Bartolomeo Beccari: Lettere a diversi*, Collez. Aut. VI, 1710–39.

[38] Bassi, *Theses: De aqua corpore*; Maffioli, "Guglielmini vs. Papin," 84–87.

[39] Bassi, Laura, *Due cartoni*, Cartone II: opuscoli e stampe riguardanti Laura Bassi, no. 3: Tesi di fisica, metafisica e logica.

[40] See BCAB, Letter no. 223 of G. Zanotti to E. Manfredi, Bologna, November 19, 1732, in B. 163: *Lettere famigliari*; Tacconi to Senator Aldovrandi, December 15, 1732 in Cenerelli, ed., *Lettere inedite*, 183–84.

[41] For Bassi's support of experimental natural philosophy, see Cavazza, *Settecente inquieto*, 254. Beccari was the professor who questioned Bassi during the defense of the first set of theses; see BCAB, Letters no. 1730, 1734, 1736, 1737 of Beccari to friend, s.d., Collez. Aut. VI, 1710–39.

might entail. During that period, Bassi gave a few lessons at the university at the administration's request, but mostly she participated in yearly disputations on anatomical lessons given by other lecturers. These lessons took the form of a debate in which a thesis presented by the lecturer was attacked by assigned university lecturers present at his lesson.[42] Bassi also began to learn Greek and to write poetry; the poetry was undertaken partly as a social activity, mostly at the request of local aristocrats.[43] Her initial attempts to take mathematics lessons and to obtain access to books in the Vatican's *Index Librorum Prohibitorum* led nowhere until 1735, when she was twenty-four years old.[44] According to Monsignor Leprotti, the pope's physician, males involved in the sciences were usually granted access to the Index's books when they reached twenty-four years of age. The natural philosophy books in the Index—the works of Galileo, Descartes, Kepler, Copernicus, Fontanelle, and others—were essential reading for anyone interested in pursuing physics beyond the amateur level.[45]

It appears that Bassi, like the men, was granted access to the Index's books by 1735, since it was only then that she began a three-year study of mathematics with Gabriele Manfredi, one of the pioneers of infinitesimal calculus in Italy and a man she knew well from as early as 1732.[46] The fact that Bassi waited until 1735 to take mathematics lessons, which she presumably could have taken at any time after 1732, seems to indicate that those lessons would only have been worthwhile, or even possible, for someone like her, interested in pursuing physics seriously, if she could also study some of the most important works written on the subject and contained in the Index's list. Therefore, what may seem to be hesitation was probably a waiting period on her part. No doubt Bassi knew as early as 1732 the path she wished to follow.

The approval Bassi received from the Vatican was not usually given to women scholars. According to Leprotti, Clelia Borromeo, who held a scientific and literary salon in Milan, had been denied access to the books. Bassi's friend

[42] In June 1733, Bassi was assigned to debate a Doctor Azzoguidi when he lectured on the nature of poisons and their antidotes. According to G. Bianchi, who attended the lecture, Bassi succeeded admirably in destroying Azzoguidi's thesis. See BGR, G. Bianchi to Leprotti, June 17, 1733, Ms. 963 alla data; BCAB, Alessando Macchiavelli, "Delle donne bolognesi nella letterature e disegno illustri," B. 1331, May 26, 1741, p. 130; Nota di "requisiti" of Laura Bassi, 1739, in Melli, "Epistolario di Laura Bassi Verati," 37; BCAB, Bassi, Laura, *Due cartoni*, Cartone I, fasc. 1, i: serie delle funzioni pubbliche annuali; BCAB, Maria Macchiavelli, "De rebus praeclare gestus a clarissimo philosopho doctore collegiate Laura Maria Catherina Bassi," B. 3912, 59–61.

[43] BGR, Bianchi to Leprotti, February 17, 1733, in Sc.Ms. 963. For some of Bassi's poems, see BCAB, B. 1330: "Miscellanea di scritti dell'illustrissima et Eccellentissima Signora di Filosofia Dottoressa Collegiata Laura Maria Catterina Bassi o riguardanti la medesima," 108. See a list of her poetic publications in E. Colombo, "Catalogo delle edizioni di Lelio e Petronio Della Volpe possedute dalla Biblioteca dell'Archiginnasio," *L'Archiginnasio*, 75 (1980): 213, 218, 241, 261, 268, 273. It is obvious from her letter to G. Zanotti that Bassi felt socially obliged to write most of her poetry. Such writing had its advantages, however, as it kept Bassi in the good graces of the senatorial aristocracy of the town; see Bassi to G. Zanotti, February 9, 1737, in Melli, "Epistolario di Laura Bassi Verati," 82.

[44] BGR, Bianchi to Leprotti, February 17, 1733, Sc.Ms. 963.

[45] BGR, Leprotti to Bianchi, Rome, March 23, 1733, in Fondo: *Gambetti*, Posizione: Leprotti; A. Rupert Hall, "La matematica, Newton e la letteratura," in Renzo Cremante and Walter Tega, eds., *Scienza e letteratura nella cultura italiana del settecento* (Bologna, 1984), 44.

[46] BGR, Bassi to Bianchi, April 26, 1738, in Fondo: *Gambetti*, Posizione: Bassi; for the spread of infinitesimal calculus in Italy and Manfredi's role in it, see Luigi Pepe, "Il calcolo infinitesimale in Italia agli inizi del secolo XVIII," *Bollettino di storia delle scienze matematiche*, 1 (dicembre 1981): 56–60.

Francesca Manzoni, a serious scholar, albeit not in the sciences, was also denied access to them, in spite of being thirty years old at the time of applying. Perhaps Cardinal Lambertini again interceded on Bassi's behalf.[47] It is important to stress that Bassi's willingness to pursue three years of higher mathematics after she had been made a paid lecturer at the university is a measure of her commitment to contribute to physics beyond the amateur level.

Bassi now could settle down to her studies, careful observations, and experimentations—methods that, as her first lesson at the university expounded, were essential for the pursuit of natural philosophy.[48] Scientific pursuit also required the exchange of ideas and material and often involved working with collaborators, as was the practice in the Academy of Sciences of Bologna.[49] Gossip, however, plagued Bassi's meetings with men of science. These meetings took place at Bassi's home and allowed her and her scientific collaborators to exchange ideas and investigate Newton's experiments on light and colors. Some members of Bolognese society evidently thought that hosting these meetings was not appropriate behavior for a young single woman; they claimed that Bassi was probably using the meetings as an excuse to have assignations with men.[50] It was the type of gossip a woman had to avoid if she desired a good working relationship with the Vatican. Consequently, in 1738, Bassi decided to take a step that she hoped would allow her to pursue her scientific activities and, at the same time, put an end to the gossip. This step was marriage. In a letter dated April 26, 1738, Bassi explained to Bianchi the reasons for her marriage. According to her, marriage had not been a priority. But,

> my domestic circumstances have induced me to change my mind and make this decision. As I am sure you are someone who can judge matters as they are, you will be incapable of condemning the marriage, and you will not view it as a reason for detaching myself from the studies I am under obligation to profess, which I had hoped quietly to pursue in this life; therefore, I have chosen a person who walks my path in the arts and who, through long experience, I was certain would not impede me from following mine.[51]

The marriage to Giuseppe Veratti put an end to the gossip and made it easier for Bassi to attend meetings at the academy (along with her husband, although Veratti made no objection to her attending alone, as she did in 1746 while he was away).[52] The marriage did not have obvious, immediate benefits for Bassi's

[47] For Borromeo, see BGR, Leprotti to Bianchi, March 4, 1733, in Fondo: *Gambetti*, Posizione: Leprotti. Manzoni's works were of a literary nature. Manzoni's letters also confirm that Bassi had received access to the Index's books years earlier and easily enough. See Manzoni to Bassi, March 6, 1740, May 18, 1740, and July 13, 1741, in Cenerelli, ed., *Lettere inedite*, 88–90, 93–94.

[48] BCAB, Bassi, Laura, *Due cartoni*, Cartone I, fasc. 2, ff. 62–67.

[49] See Cavazza, *Settecento inquieto*, 217–53; Walter Tega, "*Mens agitat molem*: l'Accademia delle Scienze di Bologna (1711–1804)," in Cremante and Tega, *Scienza e letteratura*, 65–132.

[50] For the nature of the gossip, see BGR, Bassi to Bianchi, April 26, 1738, and May 14, 1738, in Fondo: *Gambetti*, Posizione: Bassi; and BCAB, Bianchi to Bassi, Letters no. 2261, May 1738, and no. 2262, June 3, 1738, in *Lettere no. 75 di Giovanni Bianchi*, Collez. Aut. VIII, 2254–2328; Fantuzzi, *Notizie*, 2: 384–91.

[51] BGR, Bassi to Bianchi, April 26, 1738, Fondo: *Gambetti*, Posizione: Bassi.

[52] For a biography of Veratti, see Fantuzzi, *Notizie*, 9: 193. Giampietro Zanotti's letters, which are usually a good source of the gossip surrounding Bassi's activities before her marriage, do not refer to any afterward; see Zanotti's letters to Riva, BCAB, B. 382. For her attendance at the academy, see BCAB, Bassi to unknown, November 26, 1774, *Lettere di Laura Bassi*, Collez. Aut. poz. 238443; Bassi

scientific career, however; she presented no dissertations at the academy until the spring of 1746. Although we know from one of her letters to Flaminio Scarselli, the Bologna Senate's representative in Rome, and from other members of the academy, that she had been active scientifically, some of her experiments had not yet been completed due to their difficulty and her lack of time.[53]

AFTER HER MARRIAGE, Bassi made several attempts to give regular lessons at the university so that, as she told Scarselli, she could justify her salary. By 1739, the university administration had increased her salary by 160 lire and stated that she could teach regular classes at the institution, yet these classes did not materialize.[54] Attempts to regularize her situation at the university were also made by several cardinal legates—the pope's representatives in Bologna—and by her former mathematics teacher, Gabriele Manfredi, but without success. During the period of Cardinal Legate Alberoni (1741–1743), times for regular lessons had been arranged—a fact also confirmed by the *Atti* of the Assunteria di Studio of November 1741. The lessons did not take place, however, because of the uninvited arrival of Spanish troops (1742–1744), which disrupted the government, caused havoc in the surrounding countryside, and forced the closure of the university, followed by a series of illnesses that affected both Bassi and the cardinal at the end of his legation. In 1749, again under pressure from a new cardinal legate and because of a shortage of anatomy teachers, the Assunteria decided that Bassi could lecture on anatomy, which was not her field of expertise; this last attempt, like all the preceding ones, led nowhere.[55]

The intercession of several cardinal legates on Bassi's behalf may not have endeared her to the senators, who controlled the Assunteria di Studio, and ultimately may have hindered rather than helped her efforts. There was a constant struggle for power between the senatorial oligarchy, which had always controlled the local government, and the central government in Rome, represented in Bologna by the cardinal legate. In this struggle, the senators were losing ground throughout the eighteenth century. Obstacles to Bassi's public teaching on the administration's part should be viewed in this context and not be attributed

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to Scarselli, November 27, 1745, in Melli, "Epistolario di Laura Bassi Verati," 115; Bassi to her husband in BCAB, Letters no. 1617–19, in *Lettere e minute di Laura Bassi*, Collez. Aut. VI, 1614–28; and Biblioteca Nazionale di Firenze (hereafter, BNF), letter of October 1746, Fondo: *Gonelli*, cart. 40, no. 257; for Veratti's letters to Bassi, see Cenerelli, ed., *Lettere inedite*, 151–57.

[53] See AASB, *Catalogo dei lavori dell'Antica Accademia*, 15–17; Bassi to Scarselli, April 21, 1745, in Melli, "Epistolario di Laura Bassi Verati," 103–04; "De aeris compressione," *Commentarii*, vol. 2, pt. 1ª, 1745, 347–53; T. Laghi, "De rubentibus lignorum ceneribus," *Commentarii*, vol. 2, pt. 3ª, 1745, 392–402.

[54] See Bassi to Scarselli, May 12, 1745, in Melli, "Epistolario di Laura Bassi Verati," 105–06; ASB, Fondo: *Assunteria di Studio*, serie: Atti, anni 1735–45, vol. 23: Acts of December 5, 1739, and December 11, 1739, f. 44.

[55] The troops entered the Papal Estates because of the War of Austrian Succession; see Venturi, *Settecento riformatore*, 103–05; Bassi to Scarselli, May 12, 1745, in Melli, "Epistolario di Laura Bassi Verati," 105–06; ASB, Fondo: *Assunteria di Studio*, serie: Atti, anni 1735–45, vol. 23: Act of November 15, 1741, f. 67; serie: Atti, vol. 24: Acts of January 22, 1749, f. 2, February 7, 1749, f. 2v, February 16, 1750, f. 17, April 7, 1750, f. 21v, April 14, 1750, f. 23v.

solely to misogyny.[56] This is not to say that Bassi did not have allies within the senatorial class or did not attempt to form alliances with them, since she was well aware that her fate was in the hands of these few men. Senator Filippo Aldrovandi had intervened in the dispute between her and her first teacher, Tacconi; he was one of the senators in favor of granting her a lectureship and was godfather to one of her children, as was Senator Pepoli.[57] Bassi and her family were also on friendly terms with Scarselli, who had been a professor of literature at the university and a member of the Academy of Sciences before he became secretary to the Senate's ambassador in Rome. The friendship continued after Scarselli's departure for Rome in 1742 and was to prove very useful to Bassi.[58]

At the same time Bassi was struggling to give regular lessons at the university, she began to give private lessons at home. At first, she taught mathematics, a course that apparently did not succeed. In 1749, Bassi switched to teaching experimental physics. This course became so popular that what began as a private enterprise aimed at young people starting off at the university soon grew into a course attended by grown men interested in physics.[59] The teaching of physics at the Institute of Sciences, unlike that at the university, was supposedly based on experimental work as well as on theory. However, as this teaching was the responsibility of the head of the physics section or, in his absence, his assistant, the type of physics taught there depended on their interests.[60] From 1734 to 1770, Domenico Galeazzi was professor of physics at the institute and Paolo Balbi was his assistant. In 1770, Balbi took over Galeazzi's position, and Bassi's husband Veratti became his assistant. All of these men were medical scholars, and, although they presented dissertations in physics, particularly Veratti, who had several on electricity, their dissertations were generally physiological in nature, and their teaching of physics tended to be applied to physiology.[61] This focus provided an opportunity for Bassi, who had studied advanced mathematics, had done experiments in optics, hydrometry, electricity, and on Boyle's law, to offer a course in experimental physics, which was not readily available at the institute.

Some records of Bassi's teaching are left by her students at the Collegio Montalto and by Dr. John Morgan, a physician from Philadelphia who visited Laura Bassi in 1764, when she was teaching Newton's theory of light through a

[56] For the power struggle between the Senate and the central government, see Dal Pane, *Economica e Società a Bologna*, 415–20.

[57] For Aldrovandi's intercessions, see Cenerelli, ed., *Lettere inedite*, 183–84; Melli, "Epistolario di Laura Bassi Verati," 79; BCAB, Letter no. 219 of G. Zanotti to E. Manfredi, August 30, 1732, in B. 163: *Lettere famigliari*. For the role of senators as godfathers, see AAB, *Libro dei Battezzati della metropolitana di Bologna*: anno 1738: Die 7 mensis decembris 1738, the baptism of Joannes Maria Franciscus Nicolaus; anno 1745: Die 17 mensis martis 1745, the baptism of Catherina Maria Teresa, p. 58.

[58] See Scarselli to Bassi, in Cenerelli, ed., *Lettere inedite*, 104–25; BCAB, *Lettere di Flaminio Scarselli a Laura Bassi*, Ms. Scarselli, I, 3–17.

[59] See Bassi to Scarselli, June 14, 1755, in Melli, "Epistolario di Laura Bassi Verati," 148–49.

[60] ASB, Fondo: *Assunteria di Istituto*, serie: Diversorum, Busta 9, fasc. 1: "Le costituzioni dell'Instituto delle Scienze," December 12, 1711, cap. V, nos. 3 and 6, cap. VI, no. 1.

[61] For Balbi's, Galeazzi's, and Veratti's dissertations, see Rosen, "Academy of Sciences," 170–71, 207–25; Walter Tega, ed., *Anatomie Accademiche*, Vol. 1: *I Commentari dell'Accademia delle Scienze* (Bologna, 1986), 372; Melli, "Epistolario di Laura Bassi Verati," 180; Susana Gomez, "The Bologna Stone and the Nature of Light: The Science Academy of Bologna," *Nuncius*, 6, fasc. 2 (1991): 16–17.

series of experiments. According to her college students, Bassi first taught the theory and then demonstrated it with experiments.[62] Morgan tells us that Bassi,

> who was employed at our coming in giving lectures upon light & colours shewing the 4 primary original colours, which she said were red, yellow, blue and green, the purple, orange & violet being compounded of these . . . , made several curious experiments upon Phosphori [the Bologna Stone—barium sulfate[63]] & to shew the reflection of Bodies—i.e.—ye attract'n of ye rays of light by ye Body it passes thro'—as in a slit or small hole or perforation thro' a Board with a ray of light let into a dark room from ye sun; thro' a perforation in a window shutt'r, by means of a speculum made to pass thro' the first mentioned hole. This rec'd at ab't a foot distance on a piece of paper, at a sort of focal point, shows how ye ray is attracted by ye sides of the slit so as to shew a separation of the col'rs & a Dilation of them into a kind of fimbria . . . After this she discoursed very learnedly on Electricity and other philosophical subjects . . . and when I left her, [I] was greatly pleased at her affability. She spoke in french.[64]

Bassi continued to teach on the nature of light and later added instruction on the nature of fire when she became professor of experimental physics at the Institute of Sciences.[65]

Historians have failed to grasp how important these private lessons were to Bassi and to Bologna. Teaching at home, Bassi was not constrained by the university's curriculum, which remained essentially Aristotelian even though modern philosophies were available, as Bassi's theses illustrated.[66] She could use her lectures to spread Newtonian philosophy and, as will be discussed below, the Franklinian system of electricity. Bassi kept abreast of the latest debates in natural philosophy, repeated many of the experiments herself, and most likely passed them on, at least to those students who wanted to pursue natural philosophy. Her young cousin Lazzaro Spallanzani had come to Bologna to study law but as a result of Bassi's teaching switched to the sciences, to which he made major contributions while she was still alive.[67]

Teaching at home was commonly done in Italy and had been officially recognized by the Bologna Senate in 1665. Home lessons were used, as in Bassi's case, to impart new ideas and innovative methods to natural philosophy stu-

[62] BCAB, B. 2727: "Pubblica Accademia di lettere avutasi nel Collegio Montalto."

[63] The Bologna Stone, after calcination and being exposed to light, would shine in the dark; several experiments were done with the stone to explain Newton's theory of light. Her friend and supporter Jacopo Beccari had worked on the Bologna Stone and other materials to explain *phosphori*, which in his definition were materials that retained even a minimum of luminosity when moved quickly from the light into the dark. See Dissertation no. 33 in Tega, *Anatomie Accademiche*, 1: 156; Gomez, "Bologna Stone," 3–32.

[64] Morgan, *Journal*, 98–99.

[65] In *Diario Bolognese Ecclesiastico e civile l'anno 1777* (Bologna, 1777), 142, 154.

[66] For an overview of the university curricula in natural philosophy, see Gabriele Baroncini, "La filosofia naturale nel studio bolognese (1650–1750): Preliminari di una ricerca," in Cremante and Tega, *Scienza e letteratura*, 271–92; Brandon Dooley, "Social Control and the Italian Universities from Renaissance to Illuminismo," *Journal of Modern History*, 61 (June 1989): 205–39.

[67] For Spallanzani's contributions to medicine, see Erwin H. Ackernecht, *A Short History of Medicine*, rev. edn. (Baltimore, Md., 1982), 136–37. For his relationship with Bassi, see BCAB, Introduction to Spallanzani's *De lapidibus ad aqua resilietibus dissertatio*, in Bassi, Laura, *Due cartoni*, Cartone II: opuscoli e stampe riguardanti Laura Bassi, no. 9; Lazzaro Spallanzani, *Le opere di Lazzaro Spallanzani*, Vol. 1 (Milano, 1934), xi–xii.

dents.[68] Bassi's private lessons were recognized by the members of the Assunteria di Studio, which increased her university salary because of them.[69] The success of Bassi's private lessons ensured her nomination as lecturer in experimental physics at the Collegio Montalto. The nomination did not alter the venue for her teaching, since the college had no institutional facilities of its own, and students had to attend classes either at the home of the lecturer or at the university. The nomination, however, did increase the number of students attending her course and her income: lecturers were paid approximately 54 *scudi*, or 378 lire, per year. There is evidence that Bassi sought this position: in a letter to Scarselli, she asked how best to approach Alessandro Albani, the cardinal protector of the college.[70]

In 1776, the senators, who also controlled the administration of the Institute of Sciences, finally rewarded Bassi's many years of private lessons by naming her professor of experimental physics at the institution. She had requested admission to the professoriate of the institute since 1773. Her initial intent may have been to be assistant to her husband, who had been responsible for the chair of physics there since 1772, after Balbi, the holder of the position, had become ill. In the usual course of things, Veratti would have been made professor after Balbi's death in 1776, since he had been Balbi's assistant; apparently, however, Veratti had been unable to teach both the experimental and theoretical aspects of physics, which were his responsibility. Without doubt, Veratti would have had trouble handling the mathematical aspect of physics. He did not have the mathematical training his wife had, and his dissertations presented no mathematical solutions to physical problems; they leaned toward physics applied to physiology. In spite of Bassi's qualifications in mathematics, the administration decided to split up the physics section for the first time, thereby giving Bassi the experimental physics section with Veratti as her assistant. The physical mathematics section, which dealt mostly with mechanics, was assigned to S. Canterzani, the institute's secretary, with G. Bonaccorsi as his assistant. Another factor in the splitting of the physics section was a dispute between the Verattis and Bonaccorsi, who complained that the couple was impeding his access to the laboratories.[71]

For the first time after many years of struggles with the senatorial administration of both the university and the institute, Bassi was allowed to teach in public on a regular basis, but this good fortune came only two years before her death. The one advantage offered by the institute was its equipment resources.[72] In

[68] Cavazza, *Settecento inquieto*, 100.

[69] ASB, Fondo: *Senato*, serie: Vacchetoni, Registro 71, f. 95, December 14, 1759; Registro 79, f. 45, May 10, 1776; Simeoni, *Storia dell'Università di Bologna*, 95.

[70] The author Cagni is not specific about whether the amount paid was on a yearly basis; see Cagni, "Il Pontefico Collegio 'Montalto,'" 24, 34; see also Bassi to Scarselli, July 16, 1755, in Melli, "Epistolario di Laura Bassi Verati," 150–55; see back of Pio Fantoni's letter to Bassi, Rome, July 19, 1766, in BCAB, B. 2024: *Lettere autografe*.

[71] It is arguable how qualified Bonaccorsi was to act as assistant to Canterzani in the mathematical-physics section: most of his dissertations, of which he published none, tended, even more than Veratti's, to be concerned with the biological sciences rather than physics, which indicates that the splitting of the section was done to bring peace to the department; see Rosen, "Academy of Sciences," 263–85; "De professoribus Instituti," in *Commentarii*, vol. 7: 1783, p. 6; ASB, Fondo: *Assunteria di Istituto*, serie: Diversorum, Busta 15, no. 42, letters dated April 25, 1776, and May 6, 1776.

[72] For the facilities in the physics section, see Urbinati, "Physica," 123–83.

terms of what Bassi taught and the people she probably reached, it made little difference whether the teaching was done at home or at the institute.

LAURA BASSI WAS FAR MORE SUCCESSFUL dealing with Rome, where she indeed had powerful patrons, especially after Cardinal Lambertini became Pope Benedict XIV in 1740. In Rome, she also had Flaminio Scarselli, a family friend, and Monsignor Leprotti, who was an intellectual within the church. In the early 1700s, while in Bologna, Leprotti had been part of the Accademia degli Inquieti, the institution that predated the Academy of Sciences. Leprotti kept up his contacts with Bologna's scientific circles, had met Bassi while she was still Tacconi's student and been favorably impressed. Through his correspondence with Giovanni Bianchi, he continued to hear glowing reports on Bassi's abilities.[73] These contacts were to prove extremely useful in 1745 when Pope Benedict decided to create the group of Benedettini Academics within the Academy of Sciences out of funds controlled by the papacy. The new members were to be the heads of the scientific sections at the institute, their assistants, the institute's president, and its secretary, for a total of fourteen Benedettini. The other ten members, also from the Academy of Sciences, were to be selected by those fourteen, of whom Veratti was not one, and then the list was to be sent to the pope for approval.[74] When Bassi learned, probably from Beccari, who was the head of the chemistry section, that her name was not among the ten chosen members, she decided to appeal through Scarselli to the pope. Bassi suggested that an extra Benedettino Academic be created so that none of the scientists already selected could accuse her of taking his place. Bassi also offered an explanation of why she had not given dissertations at the academy's meetings: some scholars had deliberately attempted to stop her from participating in the life of the academy. Scarselli's advice was to find someone in Bologna who would mention her as a possible candidate to the cardinal legate, and then her name would appear in the list of Benedettini Academics when it went to the pope. This did not happen, and efforts on behalf of her selection shifted to the Vatican. Scarselli, Monsignor Malvezzi, the master of chamber, and Monsignor Leprotti all suggested to Benedict XIV that Bassi's name be added to the list of Benedettini Academics as an extra member, and the pope promptly complied.[75]

Attempts followed on the part of some new members to limit her role among

[73] Cavazza, *Settecento inquieto*, 72–73; Marta Cavazza, "Giandomenico Cassini e la progettazione dell'Istituto delle Scienze di Bologna," in Cremante and Tega, *Scienza e letteratura*, 26. For Bianchi's letters to Leprotti, see BGR, Sc.Ms. 963 alla data: *Lettere autografe*; for Leprotti to Bianchi, see BGR, March 4, 1733, in Fondo: *Gambetti*, Posizione: Leprotti; Mario Rosa, *Riformatori e ribelli nel 700 religioso italiano* (Bari, 1969), 72.

[74] Rosen, "Academy of Sciences," 75.

[75] Beccari appears also to have nominated Veratti, his ex-student, to a Benedettina position. See Beccari's letters dating from 1745 to his cousin Scarselli in Rome, Biblioteca Universitaria di Bologna (hereafter, BUB), Ms. 243; Fantuzzi, *Notizie*, 9: 193; Bassi's petition for a membership and her letters to Scarselli of April 21, 1745, May 12, 1745, June 5, 1745, June 19, 1745, in Melli, "Epistolario di Laura Bassi Verati," 103–09; Scarselli's answers, April 23, 1745, in Cenerelli, ed., *Lettere inedite*, 108–10; and BCAB, Letters no. 5, Rome, May 25, 1745, no. 6, June 12, 1745, no. 7, June 26, 1745, Ms. Scarselli, I, 3–17.

the Benedettini. In a letter to Scarselli dated November 21, 1745, Bassi reported that, during a meeting neither she nor her husband could attend, some academics tried to deny her voting rights in the new academy—a right she had held in the Academy of Sciences since 1732. Scarselli then contacted Galeazzi, the head of physics at the time, with the suggestion that if the Benedettini had any doubts about Bassi's voting rights, they were to contact the pope for clarification on that point. In a letter to Bassi, Scarselli voiced his opinion of the whole affair: "Monsignor Leprotti and I were surprised, not to say nauseated, by the extravagant difficulties the institute attempted to create without any reasonable foundation."[76]

Her appointment as Benedettina Academic was of pivotal importance in her career as a scientist. It meant that Bassi could collaborate with her husband and others. Moreover, from then on, she had full access to all the academy's facilities, and her output of dissertations rose to the level of other Benedettini. She also received 100 lire for being a member of the academy, plus reimbursement for materials used while carrying out experiments at the institute.[77]

It is important to look at some of Bassi's supporters, without whom she would have been unable to play a role in the intellectual life of the town. Among the laymen was Jacopo Beccari, a former professor of physics and then chemistry at the institute and a scientist of international renown.[78] Beccari, along with Gabriele Manfredi, had been Bassi's examiner during her first public debate. From his 1732 letters, one can surmise that Beccari had been impressed with Bassi's abilities. In a language free of misogynist statements, the scientist hoped that Bassi would be allowed to continue on her chosen path.[79] He also supported Maria Gaetana Agnesi after she had been named lecturer in mathematics at the university by the Bologna Senate. Beccari had begged Agnesi to come to Bologna and teach.[80] Later on, Bassi, Beccari, and Veratti collaborated in several experiments at the academy, one when Father Giambattista Beccaria—the foremost defender of the Franklinian system in Italy—visited the institute for several months. Bassi always considered Beccari a friend and teacher.[81]

Bassi's patrons included highly placed prelates, such as Giulio Alberoni, who helped Bassi in her struggles with the Senate. Cardinal Alberoni came from a humble background: his father was a gardener; his mother, a weaver. He was able to study because of a benefactor. His rise to the highest ranks of the church had

[76] Bassi to Scarselli, November 25, 1745, and December 11, 1745, in Melli, "Epistolario di Laura Bassi Verati," 115–17; BCAB, Letter no. 9 to Bassi, December 4, 1745, in Ms. Scarselli, I, 3–17.

[77] ASB, Fondo: *Assunteria di Istituto*, serie: Diversorum, Busta 9, fasc. 18, Accademia Benedettina: Dissertazioni degli Accademici Benedettini, 1757–1776. For Bassi's dissertations, see note 32 above; for those of other academics, see Rosen, "Academy of Sciences," 222–65.

[78] Beccari had been made a member of the Royal Society of London for his extensive work on phosphorescence. See Rosen, "Academy of Sciences," 109–11; Maria Boas Hall, "La scienza italiana vista dalla Royal Society," in Cremante and Tega, *Scienza e letteratura*, 52.

[79] BCAB, see Letters no. 1730, 1734, 1736, 1737 of Beccari to friend, s.d., in Collez. Aut. VI, 1710–39.

[80] Tilche, *Maria Gaetana Agnesi*, 90–91.

[81] Giambattista Beccaria, *Elettricismo atmosferico: Lettere di Giambattista Beccaria* (Bologna, 1758), 28–30; Biblioteca Apostolica Vaticana (hereafter, BAV), Laura Bassi to Father Beccaria (1766), in *Lettere di Laura Bassi Verati a Giambattista Beccaria*, Autografi: *Patteta*, cart. 45.

been achieved through his ability and determination.[82] Cardinal Alessandro Albani, cardinal protector of the Collegio Montalto, who nominated Bassi as lecturer to the college, was, in addition, librarian at the Vatican. He had been responsible together with his brother for modernizing the teaching at the college; in this, they had the help of Cardinal Lambertini while he was archbishop of Bologna.[83]

Bassi's most important patron was Lambertini, the Bolognese noble who later became Pope Benedict XIV. Lambertini was an intellectual with several publications to his name; he was also a self-made man who achieved his position through work and intelligence, not as a representative of a great family, as former popes had been. Lambertini was responsible for university reforms during his papacy. He founded several academies in Rome and reformed its university as well. In Bologna, besides the foundation of the Benedettina Academy, he donated instruments and materials to the institute, established a chair of surgery, and opened a school of obstetrics to train midwives. Lambertini also lifted the restriction on works defending the Copernican system, including Galileo's works. It is an indication of the intellectual turmoil the Italian Catholic church was going through in the eighteenth century that Lambertini was considered a moderate during that period compared to some of the prelates surrounding him, men such as Leprotti, Ruggero Boscovich, and Cardinal Querini, the Vatican Library's prefect. These men would have preferred to move faster and farther in the church's reforms of society, the sciences, and education. The fact that Bassi was determined to work for her money only served to endear her to Lambertini and others like him, who were very critical of lecturers who did not.[84] There is no doubt that Bassi would have achieved very little without Lambertini's support; however, she was not the only woman he helped attain academic positions or degrees. Agnesi was made lecturer in mathematics at the university through his efforts. Cristina Roccati received a degree in mathematics and philosophy from the same university in 1751. Also during Lambertini's lifetime, Faustina Pignatelli, Emilie du Châtelet, and Anne Marie du Bocage were made members of the Bologna Academy of Sciences, and Anna Morandi Manzolini was made a member of the institute's Accademia Clementina.[85] A combination of reformist currents within the church and the personal intervention of a few enlightened clergymen opened opportunities for talented women like Bassi.

[82] See Bruno Pirazzoli, "La formazione filosofica del Card. Giulio Alberoni," *Archivio storico per le Province Parmense*, quarta serie, 39 (1987): 321–55.

[83] Cagni, "Il Pontefico Collegio 'Montalto,'" 81–100.

[84] For reforms in the church, see Venturi, *Settecento riformatore*, 102–03; Rosa, "Benedetto XIV," 393–409; Rosa, *Riformatori e ribelli*, 50–85; Giuseppe Alberigo, "Cattolicità e Ecumenicità nel settecento," in G. Benzoni and M. Pegrari, eds., *Cultura, religione e politica nell'età di Angelo Maria Querini* (Brescia, 1982), 9–21. For the reforms that pertained to Lambertini and Bologna, see Viviana Lanzarini, "Il museo ostetrico di Giovanni Galli," in *I laboratori storici e i musei dell'Università di Bologna: I luoghi del conoscere* (Bologna, 1988), 105–13; W. Tega, "Introduzione," in Tega, *Anatomie Accademiche*, 1: 28–32; "Benedetto XIV e la scienza fisica: Nella Bologna del settecento nasce un papa Galileiano-Newtoniano," *Bologna Incontri*, 17 (giugno 1986): 26–30.

[85] For Agnesi, see Tilche, *Maria Gaetana Agnesi*, 90–91; for Morandi Manzolini, see V. Ottani and G. Giuliani-Piccari, "L'opera di Anna Morandi Manzolini nella ceroplastica anatomica bolognese," in *Alma Mater Studiorum*, 82–83; for Roccati, see *Alma Mater Studiorum*, 207; for Pignatelli, du Châtelet, and du Bocage, see Anne Marie du Bocage, *Recueil des oeuvres de Madame du Bocage*, Vol. 3 (Lyons, 1764), 180.

BASED ON THE DISSERTATIONS SHE PRESENTED YEARLY at the academy, Bassi's scientific output primarily concerned the physical sciences. With her training in mathematics, she was able to handle the classical sciences such as mechanics—which included hydraulics—and optics, as well as the Baconian sciences of electricity, magnetism, and heat.[86] When Bassi participated in any experiments in the biological sciences, it was usually to assist her husband or friends, such as in 1747 when Veratti was engaged at the academy's request in repeating Giovanni Francesco Pivati's experiments on the effectiveness of electric therapy.

The results of these experiments along with others were published as a book in 1748. In it, Veratti claimed, as did others, that the electrification of glass tubes containing medicinal substances allowed these substances to pass through the glass into the atmosphere. He also found that electricity by itself helped cure diseases such as arthritis. In the section dealing with the physical properties of electricity, Veratti criticized Abbé Nollet's double flux theory, which, according to Veratti, reduced electrical attraction and repulsion to a simple case of electricity "running from a body to another." To Veratti, the "electrical virtue, like attraction, was universally scattered and diffused in all corporeal nature," and the electric fluid, like light, had the property to be attracted by some bodies and rejected by others.[87] The book was discussed at the Royal Society of London and was attacked by Joseph Priestley, Benjamin Franklin, and others who did not accept the notion that electricity might induce porosity in glass.[88] Nollet, whose theory had been rejected by Veratti, made a special trip to Italy in 1749 to ascertain the Italian claims.

It is from Nollet's ensuing correspondence with the Bologna Academy, from Bassi's correspondence with friends in defense of the reputation of the Bologna scientists involved in the dispute, and from one of her dissertations published in 1791 (first presented to the academy in 1747) that we learn of her collaboration with her husband in some of the experiments.[89] Bassi's apparent contribution to Veratti's work received no mention in his book. If Bassi had not been made a member of the Benedettina Academy responsible for her own experiments, we could not have distinguished her contributions to Veratti's scientific research

[86] Thomas S. Kuhn, "Mathematical versus Experimental Traditions in the Development of Physical Science," in Kuhn, *The Essential Tension: Selected Studies in Scientific Tradition and Change* (Chicago, 1977), 31–65.

[87] In his book, Veratti defined electricity sometimes as a "force," other times as "matter," or "virtue," and still other times as a "fluid." See Giuseppe Veratti, *Osservazioni fisico-mediche intorno alla elettricità* (Bologna, 1748), 1–141; for the physical properties of electricity, see in particular 127–28, 140–41; J. L. Heilbron, *Electricity in the 17th and 18th Centuries: A Study of Early Modern Physics* (Berkeley, Calif., 1979), 354; Joseph Priestley, *The History and Present State of Electricity*, Vol. 1 (1769; rpt. edn., New York, 1966), 179–88.

[88] I. Bernard Cohen, *Franklin and Newton: An Inquiry into Speculative Newtonian Experimental Science* . . . (Philadelphia, 1956), 477; Priestley, *History and Present State of Electricity*, 1: 179–88.

[89] "De immixto fluidis aere," *Commentarii*, vol. 7, 1791, 44–47; for the dispute, see BCAB, Letter no. 34 of Abbé Nollet to Francesco Maria Zanotti, July 3, 1749; attached to Letter no. 39 to Zanotti: Extrait d'une relation lue à l'Académie des Sciences de Paris par M. l'Abbé Nollet; Letter no. 45 of Nollet to Zanotti, Montpellier, March 21, 1750, all in *Lettere di diversi a Francesco Maria Zanotti*. For Bassi's correspondence with Scarselli, see November 12, 1749, in Melli, "Epistolario di Laura Bassi Verati," 140–41; Scarselli's Letters no. 15, Rome, November 5, 1749, and no. 16, Rome, November 19, 1749, to Bassi in BCAB, Ms. Scarselli, I, 3–17. For Nollet's version of the events, see Bibliothèque Municipale de Soissons, Ms. 150: Abbé Nollet, *Journal du Voyage de Piemont et D'Italie en 1749*, 110–16.

from his. Bassi's initially acrimonious relationship with Abbé Nollet improved with time and was useful to her years later. In 1753, he sent her special converging lenses she needed to correct for aberrations in telescopes. The results of her subsequent experiments appeared as dissertations in 1762 and 1763 titled, respectively, "On Iceland Glass" and "On a Way to Correct in Telescopes the Inconvenience Derived from the Different Refractions of Rays, Which Unite at Different Points in the Axis Depending on Their Color." Since these dissertations were never published, and they have been lost, we do not know if she succeeded in making an achromatic lens. In the 1760s, Nollet also suggested several demonstrations in electricity that Bassi could present to her students to illustrate its principles.[90]

After Bassi and her husband acquired a machine to produce electricity at home, they were able to assist young scientists in a disputation with Tommaso Laghi about Albert Haller's theory, presented in 1752, on the irritability of muscles and the sensitivity of nerves. In 1756, Laghi, an established member of the academy and university, attacked Haller's theory, a topic of particular interest to Veratti. Laghi, in turn, was criticized by several scientists in Italy, among them MarcAntonio Caldani and Felice Fontana, who set out to prove Laghi wrong but who had trouble gaining access to the machine and material necessary to carry out experiments to confirm Haller's thesis. The experiments were done at Veratti and Bassi's home. In a letter to Haller, Caldani acknowledged the couple's kindness and their most valued assistance in doing the experiments. Laghi's, Caldani's, and Fontana's experiments, along with later experiments by Veratti on the same topic, laid the groundwork for further work in the same academy by Luigi Galvani, who eventually arrived at the concept of animal electricity.[91] Bassi never presented dissertations on irritability; however, when Madame du Bocage visited the academy in 1757, Bassi conducted several experiments on irritability for the benefit of du Bocage, a neophyte in natural philosophy. Bassi's dissertations to the academy at the time were on mathematics.[92]

In 1769, Bassi participated in a debate outside her usual area of interest. It had been occasioned by the book of her ex-student and cousin, Lazzaro Spallanzani, *Podromo di un'opera sopra la riproduzione in animali*, published in 1768. Spallanzani had maintained that snails were able to grow back a new head if the original had been cut off. The scientist had assumed that when he removed the snail's head, he had also removed its brain or ganglia. Some disputed Spallanzani's results and

[90] Ruggero Boscovich's dissertation in which he reported the invention of achromatic objectives, which abolished the need for objectives with long focal lengths in telescopes, was published in the Bologna *Commentarii* in 1767. It had been presented at the academy by the end of 1763, several months after Bassi had presented her dissertation on the subject. See Dissertation 148 in Tega, *Anatomie Accademiche*, 1: 242; for Nollet's letters to Bassi, see Cenerelli, ed., *Lettere inedite*, 95–102; and Abbé Nollet, *Lettres sur l'electricité: Dans lesquelles on trouvera les principaux phenomenes qui ont été découvert depuis 1760* (Paris, 1770), 274–95.

[91] Haller's theory stated that in the body there were irritable or non-sensitive parts, which contracted when touched (muscles), and that there were also sensitive, or non-irritable parts, which once touched transmitted the impression to the mind (nerves). Laghi believed that the movement of an organism was the effect of "spirits that flowed along the nerves"; see Tega, "Introduzione," in *Anatomie Accademiche*, 2: 23–25, 32–35; BUB, MarcAntonio Caldani, "Sull'insensitività ed irritabilità di alcune parti degli animali: Lettera scritta ad Albert Haller, 25 novembre 1756," 323–25.

[92] For Bassi's dissertations in 1757, see note 32; du Bocage, *Recueil des oeuvres*, 180.

objected, correctly, that in those that survived, the ganglia had remained, and what the snail reproduced was only part of its head.[93]

The controversy on the reproduction of the snail's head lasted several years, and Spallanzani, whose reputation was already considerable at the time, won out, in spite of his errors.[94] During the first years of the debate, Spallanzani had asked several scientists, including Bassi, to repeat the experiments. In the spring and summer of 1769, and again in the spring of 1770, Bassi conducted the experiments according to Spallanzani's instructions and on the snails provided by him, and Spallanzani checked the results in person. Nothing is known of Bassi's results, despite Spallanzani's assurance that they would be published.[95] When he published the various scientists' results on the reproduction of the snail's head in 1783, Bassi's findings were not among them.[96] The reason for this omission was not stated. Perhaps she had not completed the experiments to his satisfaction; perhaps Spallanzani felt that by 1783, four years after her death, it was not important to include her name; or perhaps Bassi had arrived at a conclusion that Spallanzani did not desire.

OF THE THIRTY-ONE DISSERTATIONS Bassi presented to the Academy of Sciences, ten dealt with fluid mechanics. By showing an interest in fluids, Bassi was following in the footsteps of other Bolognese scientists, such as Domenico Guglielmini. Water was of particular concern to the region's inhabitants, some of whom sought to ensure that the plain was properly drained and others that the water from the rivers arrived in the town by means of canals, since much of Bolognese industry (paper, hemp, or silk) was water propelled at the time. Through the study of fluid mechanics, the academy could prove itself useful to the town.[97] One of Bassi's published works, or *opuscula*, fit into this category.

The *opusculum*, published in 1757, tested the laws concerning the flow of liquids through openings. Bassi used Guglielmini's and Bernardino Zendrini's method, which calculated the quantity and average velocity of water exiting a hole and extended it to apply to two or more holes of known dimensions and positions under water. Once these solutions were found, and after considerable simplification, Bassi was able to derive an equation that could be used to determine the position and size of another hole of similar shape under water. Her method of finding a practical solution to a complicated problem was considered interesting and elegant by one of her contemporaries, as was her approach to solving a problem in classical mechanics that appeared in the same volume.[98] In this second

[93] Moreover, in the book, Spallanzani stated that salamanders and earthworms were also able to grow back certain parts of their bodies after ablation. But the debate centered on the snail's ability to reproduce its head; see Spallanzani, *Le opere*, 120–211, 211 n.

[94] Spallanzani, *Le opere*, 211 n.

[95] Bassi to Spallanzani, April 30, 1760, in Melli, "Epistolario di Laura Bassi Verati," 66. Spallanzani to Bassi, April 24, 1769–March 10, 1770, and Spallanzani to Charles Bonnet, in Biagi, ed., *Epistolario di Lazzaro Spallanzani*, 177, 180–86, 196–97, 201–03, 232–33.

[96] Spallanzani, *Le opere*, 211–78.

[97] Cavazza, *Settecento inquieto*, 187–88, 204–06; Dal Pane, *Economica e Società a Bologna*, 72–73, 98.

[98] Laurae Bassiae, "De problemate quodam hydrometrico," *Commentarii*, vol. 4, 1757, 61–73;

opusculum, Bassi used differential calculus to determine the motion of the center of mass of two or more bodies moving along any curved paths in a plane. If the two bodies had uniform rectilinear motion, rather than curvilinear motion, the problem was reduced to Lemma XXIII, Book I of Newton's *Principia Mathematica*. This work by Bassi was part of a trend in dissertations in the academy's journal, the *Commentarii*, which concentrated on classical mechanics and avoided the metaphysical and empirical assumptions about the nature of matter that had tended to characterize such analyses previously.[99]

Two further works by Bassi appeared in the *Commentarii* in the form of summaries, one in 1745 and another in 1791. The first dealt with deviations from Boyle's law, which states that the product of the volume of a gas and the pressure it exerts on a container, at constant temperature, is a constant.[100] Doubts had appeared as to the general validity of the law. Domenico Galeazzi in 1732, while testing deviations in the Amontonian thermometer, which was based on Boyle's law, found that its deviations were caused by variations in the elasticity of the air.[101] Bassi not only repeated the experiments in which the elasticity of the air was studied at different pressures and temperatures but also made new investigations using air taken in days that varied from being very humid to being dry. While she found that the relationship between volume and pressure established by Boyle's law was approached on dry days, it broke down on humid days. On humid days, Bassi could not contract the air to half the volume by doubling the pressure; this led her to ask whether it was possible that "humours" in the air affected its elasticity and therefore the results. Eventually, she concluded that the relationship between volume and pressure established by Boyle's law was not universally applicable. This was well before scientists had a detailed understanding of the behavior of vapor under pressure.[102] The experiments were considered important enough to her Bolognese contemporaries that the institute's secretary published a summary of her results before the experiments were finished. A eulogy on her death pronounced them her most important contribution to physics.[103]

The 1791 publication appeared thirteen years after her death, when physicists, according to the secretary of the institute, Canterzani, were attempting to formulate mathematically forces of attraction at the smallest distances, such as

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BAV, Pio Fantoni to Giovanni Amaduzzi, April 22, 1778, in *Lettere a Giovanni Amaduzzi*, Vat. Lat. 9036, ff. 114–15.

[99] Laurae Bassiae, "De problemate quodam mechanico," *Commentarii*, vol. 4, 1757, 74–79. For the debate on *vis viva* as it affected the European scientific community in the first half of the eighteenth century, see Carolyn Iltis, "Leibnizian-Newtonian Debates: Natural Philosophy and Social Psychology," *British Journal for the History of Science*, 6, no. 24 (1973): 343–77; as it affected the Academy of Sciences of Bologna, see Luigi Neri, "Mechanica," in Tega, *Anatomie Accademiche*, 2: 175–78.

[100] Opusculum no. 36 in Tega, *Anatomie Accademiche*, 1: 158.

[101] Leon N. Cooper, *An Introduction to the Meaning and Structure of Physics* (New York, 1968), 334–35.

[102] Vapor does not follow Boyle's law as it approaches the critical point where it becomes saturated and begins to liquefy. "De aeris compressione," *Commentarii*, vol. 2, pt. 1ª, 1745, 347–53; A. W. Smith and J. M. Cooper, *Elements of Physics* (New York, 1964), 406; s.v. "Laura Bassi Verati," *DBI*, 7: 146.

[103] "De aeris compressione," 347–48; see the *Elogio* in BCAB, B. 2727: "Pubblica Accademia di lettere avutasi nel Collegio Montalto."

those that caused the raising and lowering of fluids in capillary tubes.[104] Bassi's dissertation, which was presented in 1747, had been motivated by Alexis Clairaut's *Théorie de la figure de la terre* (1743), in which he analyzed the capillary phenomena in terms of attractive forces acting between the molecules of a capillary tube and the molecules of a fluid.[105] Bassi's experiments concerned the action of air dissolved in various liquids that were contained in different shaped vessels, including capillary tubes, once the air pressure was removed. Finding that air bubbles appeared more intensely in capillaries, she assumed that this phenomenon was a result of the greater attraction exercised by the glass surface on the air and liquids. She did not find this idea contradictory, since in electric phenomena as well, pointed and angled objects showed a greater force of attraction.[106]

Her work is interesting on several levels: first of all, it illustrates well Bassi's Newtonian tendencies; secondly, it demonstrates her knowledge of recent debates in the physical sciences; thirdly, the work reveals Bassi's early experiments in electricity and her awareness that pointed objects attracted electricity, a discovery made at approximately the same time, if not earlier than, Benjamin Franklin's explanation of the phenomenon. Fourthly, the publication of the paper after Bassi's death indicates that the academy then possessed her dissertations in manuscript form, although most of them have since been lost.[107]

In the *Commentarii*, there is evidence of further scientific activity by Bassi, sometimes in collaboration with her husband. In 1747, Laghi, in his dissertation concerning the reddish ashes produced by the burning of two types of deciduous woods, mentioned that similar experiments had been carried out earlier by Bassi.[108] From 1756 to 1761, Bassi and Veratti also helped Gregorio Casali with two sets of experiments. The first dealt with the force released by gunpowder. Casali believed that the force was dependent on the elasticity of the air. Bassi, Veratti, and Beccari, who shared his views, not only advised Casali on what experiments might be attempted but also assisted him.[109] Before 1761, both Veratti and Bassi again assisted Casali in gathering data from a series of experiments dealing with the shattering of glass.[110]

Unpublished dissertations, summaries, and *opuscula* are evidence of Bassi's extensive activities at the academy, yet they represent only a fraction of the activities she described in her correspondence. Evidently, those activities did not translate into extensive publications. Fantuzzi in his eulogy wrote that such paucity of publications was due to domestic cares, pregnancies, and her constant

[104] The mathematical formulation that attempted to find molecular parallels to Newton's gravitation was published by Laplace in his *Exposition du système du monde* (1796); see Louis L. Bucciarelli and Nancy Dworsky, *Sophie Germain: An Essay in the History of the Theory of Elasticity* (Dordrecht, 1980), 68–69. For Canterzani's statements, see "De immixto fluidis aere," *Commentarii*, vol. 7, 1791, 47.

[105] The academy was very familiar with Clairaut's works. The author was mentioned in several of the academy members' publications. See Tega, *Anatomie Accademiche*, 1: 186, 312, 325, 362, 422; Bucciarelli and Dworsky, *Sophie Germain*, 134 n–135 n.

[106] "De immixto fluidis aere," 44–47.

[107] "De immixto fluidis aere," 44–47; Cohen, *Franklin and Newton*, 436; Priestley, *History and Present State of Electricity*, 1: 206–07.

[108] T. Laghi, "De rubentibus lignorum cineribus," *Commentarii*, vol. 2, pt. 3ª, 1747, 392–402.

[109] G. Casali, "De ictu pulveris pyrii," *Commentarii*, vol. 5, pt. 2ª, 1766, 362–63, 371.

[110] G. Casali, "De quorumdam vitrorum fracturis," *Commentarii*, vol. 5, pt. 2ª, 184.

occupation with the course she taught in experimental physics.[111] While this course may have hindered her writing (it was given regularly after 1749), Fantuzzi's statements may also simply be indicative of what was expected of women. Bassi was scientifically active and published papers while her children were still young. Domestic cares probably had little effect on her; throughout her married life, Bassi always had female servants at her disposal and lived with her mother until the latter's death.[112]

In a letter to Abbot Giovanni Amaduzzi, Veratti provides us with the best clue to Bassi's low number of publications: "Her few publications can be found in the Acts of our academy; many other *opuscula* exist pertaining to several subjects in physics, which she recited in the public or private sessions of the academy but did not publish because on that point she was very difficult. I will communicate them to my friends in due time, letting them decide if they are worthy of being inserted in the Acts of the academy."[113] Possibly Bassi was a perfectionist who not only lacked time but also had reservations about the quality and importance of her dissertations and so was reluctant to have them published. Since we know from the posthumous publication of one of her *opuscula* that the academy kept her dissertations, it also appears that Veratti's friends did not believe most of them were worthy of publication after her death. Even had she wanted to publish her five *opuscula* on electricity, which were presented after 1766, she would have been unable to do so; the journal of the academy was not published between 1766 and 1783.[114] In fact, the number of her publications, two *opuscula* and two summaries, was about average for members of the academy. Of the seventy-five authors who appeared in the *Commentarii* during its existence, fifty-five had less than four *opuscula* to their name. Galvani, the most famous scientist at the academy, had only three of his dissertations published. As the journal did not appear often enough to include all the dissertations, many were left out, especially those on electricity, including all of Bassi's contributions.[115] Consequently, information about her work on electricity and the debates with which she was involved are known to us only through the correspondence she maintained with the scientists involved and through the works of the scientists themselves.

Bassi appears to have become interested in the physical properties of electricity as early as 1746, when she and Veratti acquired their electric machine. She

[111] Fantuzzi, *Notizie*, 2: 390.

[112] Bassi's publications appeared in 1745 and 1757; the children's dates of birth were: Giovanni in December 1738, Caterina Maria in December 1739, Caterina Maria Anna in January 1742, Ciro in February 1744, Caterina Maria Teresa in March 1745, Giacomo in July 1749, Flaminio in March 1751, Paolo in January 1753; see AAB, *Libro dei battezzati della metropolitana di Bologna*, for 1738, p. 264, 1740, p. 1, 1742, p. 8, 1744, p. 28, 1745, p. 58, 1749, p. 160, 1751, p. 74, 1753, p. 16. In 1755, only five of those children were still alive: four sons and one daughter. At the time of her death in 1778, only four sons remained. See AAB, *Status animarum*, per la Parrocchia di San Barbaziano, casa Sacchi, from 1739–56, and from 1776–78; Bassi to Scarselli, June 14, 1755, in Melli, "Epistolario di Laura Bassi Verati," 146–47; Bassi's epitaph at the Church of Corpus Christi in Bologna, x cal. martiis an. MDCCLXXVIII, placed by Veratti and sons.

[113] Rubiconia Accademia dei Filopatridi di Savignano sul Rubicone (hereafter, RAFSR), Veratti to Amaduzzi, March 28, 1778, in *Lettere a Giovanni Cristofaro Amaduzzi*, vol. 1, no. 16, p. 47.

[114] See *Commentarii*, vol. 5, pt. 1ª e 2ª, 1766, and vol. 6, 1783.

[115] The institute's secretaries, F. M. Zanotti and S. Canterzani, tended to favor physics publications with a mathematical bent to them. See Urbinati, "Physica," 503–04; Tega, *Anatomie Accademiche*, 1: 503–04.

presented no dissertations on the subject until 1760. In 1756, however, Bassi met Father Beccaria, from the University of Turin, while he was visiting Bologna. She corresponded with him until her death, and he seems to have increased her interest in electricity. Beccaria, who had written in 1753 *Dell'elettricismo artificiale e naturale*, to "the applause of the learned," supported Franklin's theory, which expounded the idea of conservation of charge and rejected Nollet's notion of a double fluid. Franklin's supporters viewed electricity as one fluid, whose particles were able to act at a distance, run through conductors, and be arrested by insulators; they also believed that like charges repel and unlike charges attract each other. Franklin and others had understood some of electricity's fundamental properties, and they were instrumental in laying the foundation for the laws of the electrostatic force exerted between charged point bodies that were set forth by Charles Coulomb in 1788.[116]

During his stay at Bologna, Beccaria (in collaboration with Bassi, Veratti, and Casali) engaged in a series of experiments on electricity at the academy. In his book *Elettricismo atmosferico*, Beccaria recorded an experiment suggested by Bassi that, according to him, supported the theory of the universal diffusion of the electric fluid.[117] Thanks to Beccaria, we have one of the few surviving records of an experiment in electricity suggested by Bassi.

It is from her correspondence with Beccaria and with Abbot Felice Fontana, one of her ex-students, that we know that Bassi was a supporter of the Franklinian system and that she continued to support it when many former Franklinians, such as Fontana and Carlo Barletti, had abandoned the field. In 1759, the Englishman Robert Symmer, through his experiments on the "contrary electricity" of black and white stockings, had resurrected the thesis of two distinct electric powers. Electricity did not consist of the afflux and efflux of those fluids as suggested by Nollet but the accumulation of one or the other of them in electrified bodies.[118] In a 1768 letter to Bassi, Fontana expressed his doubts about the Franklinian system of electricity, which he believed too general to explain certain effects.[119] This letter was indicative of the controversy that arose in the 1760s when the Franklinian system failed to explain why bodies deficient in electricity repel one another (minus-minus repulsion). The controversy recommended the Symmerian system to many and forced defenders of the Franklinian system, such as Beccaria, to justify it by repeating experiments. To refute Symmer, Beccaria coined the term *vindex* electricity, first mentioned in a 1767 letter to Franklin and illustrated by many experiments in his *Experimenta atque observationes*

[116] According to Heilbron, Franklin did not "discover" conservation of charge but was the "first to exploit the concept fruitfully." See Heilbron, *Electricity*, 330, 365; see also Tega, "Introduzione," *Anatomie Accademiche*, 30–31; Priestley, *History and Present State of Electricity*, 1: 308; Emilio Segrè, *Dalla caduta dei gravi alle onde elettro-magnetiche: Personaggi e scoperte nella Fisica classica* (Milano, 1983), 147, 151–52; David Halliday and Robert Resnick, *Physics*, 3d edn. (New York, 1978), 566–75.

[117] Beccaria, *Elettricismo atmosferico*, 28–30.

[118] Priestley, *History and Present State of Electricity*, 1: 303–33; Antonio Pace, *Benjamin Franklin and Italy* (Philadelphia, 1958), 22–25; Heilbron, *Electricity*, 431–34.

[119] BCAB, Fontana to Bassi, Letter no. 8024, Florence, June 10, 1768, in *Lettere di Felice Fontana*, Collez. Aut. XXIX, 7992–8054.

quibus electricitas vindex constituitur atque explicatur (1769), a defense of the one-fluid system.[120]

Bassi, who corresponded regularly with Beccaria, also contributed to the debate. By March 1769, having received Beccaria's latest work on *vindex* electricity and having already done some experiments on her own, Bassi communicated to him her reservations about this new double-fluid theory.[121] Bassi's participation in the controversy is also confirmed by an incomplete copy in her handwriting of a series of experiments done by Beccaria and repeated by her, along with her intention of doing new ones to disprove the double-fluid theory.[122] In 1771, Bassi presented to the academy a dissertation on *vindex* electricity, but it was never published. This work was nevertheless sufficiently developed to be sent to Abbot Fontana in 1775. From Fontana's reply, it is clear that Bassi was certain of the validity of Franklin's theory, since Fontana answered, "You have expressed in most ingenious and subtle terms of physics a defense of the Franklinian system."[123]

From Bassi's letter to Beccaria of March 26, 1769, we also know that she had discovered that glass conducted electricity when heated. Joseph Priestley had come to the same conclusion in 1767. It is not known whether she had been aware of his experiments.[124] Three years earlier, Bassi and her husband were testing the effect of electricity on various substances. Similar tests were also carried out by Beccaria and Priestley. In 1774, Bassi had decided to set up an "observatory" at the family's country house, where she hoped that she, Veratti, and Beccaria could spend time experimenting on atmospheric electricity. Bassi and Veratti were also interested in the effect of electricity on magnetism; they suggested correctly, like Franklin, that there was a close relationship between the two. Bassi gave no dissertation on magnetism. Yet, by 1774, she was interested in investigating variations of the magnetic needle.[125] Carried out during the period that preceded any significant quantification in electricity,[126] Bassi's experiments appear to have been up to the standards of most workers in the field. Following the methodology she had embraced in 1732, Bassi helped advance the understanding of electricity.

Laura Bassi's extensive commitment to physics is reflected in her correspondence, which after 1745, the year she was made a member of the Benedettina

[120] A. Pace, "Giambattista Beccaria," *DBI*, 7: 469–71; Pace, *Franklin and Italy*, 22–25; Heilbron, *Electricity*, 407–20, 446.

[121] BAV, Beccaria to Bassi, December 26, 1768, f. 74, April 19, 1769, f. 70, in Autografi: *Patteta*, cart. 48, *Lettere di P. Beccaria a Laura Bassi e Giuseppe Veratti*; BAV, Bassi to Beccaria, Letter no. 2, March 22, 1769, no. 3: April 26, 1769, in Autografi: *Patteta*, cart. 45.

[122] See the back of a letter by Spallanzani to Bassi, July 14, 1768, in BCAB, *Spallanzani, Lazzaro*, Collez. Aut. LXVI, 17923–963.

[123] In 1769, Volta explained the Symmerian effect as a case of electrical induction, although Beccaria did not accept it. See BCAB, Letter no. 8028 of Fontana, Florence, May 9, 1775, in Collez. Aut. XXIX, 7992–8054; Pace, *Franklin and Italy*, 24.

[124] Joseph Priestley was the discoverer of oxygen and the author of a book on electricity. BAV, Bassi to Beccaria, Letter no. 2, March 22, 1769, in Autografi: *Patteta*, cart. 45; Priestley, *History and Present State of Electricity*, 2: 201–06; Segrè, *Dalla caduta dei gravi*, 148.

[125] BAV, Bassi's Letters no. 1, s.d. (1766), and no. 5, April 9, 1774, in Autografi: *Patteta*, cart. 45; BAV, Beccaria to Bassi, s.d., f. 66, in Autografi: *Patteta*, cart. 48; Priestley, *History and Present State of Electricity*, 1: xxxv–xxxvi; Giuseppe Veratti, "Experimenta magnetica," *Commentarii*, vol. 6, 1783, 31–44; BCAB, Bassi to unknown, November 26, 1774, Collez. Aut. CV, no. 23843.

[126] Heilbron, *Electricity*, 449–89; Segrè, *Dalla caduta dei gravi*, 150.

Academy, became almost exclusively scientific.[127] That correspondence continued to expand and involve young men just starting out in the field of physics such as Marsilio Landriani and Alessandro Volta. The latter, who went on to become a major contributor to the field of electricity, wrote her several letters, after he had learned from Spallanzani of her interest in electricity. He mentioned experiments done with a gun containing either metallic air (hydrogen) or swamp air (methane), which needed deflogistic air (oxygen) and the flame of an electric spark to trigger an explosion. Bassi wanted to acquire some swamp air and attempt similar experiments, since in 1775 she had received Fontana's eudiometers, which measured the air salubrity, and had already given a dissertation on the effect of flame on fixed air (carbon dioxide).[128] This correspondence with Volta and Fontana as well as her dissertation indicate that Bassi was becoming involved in a debate concerning Lavoisier and his new oxygen theory and Priestley and the phlogiston theory. In Italy, Priestley was being defended by Fontana, and Lavoisier eventually by Spallanzani. Unfortunately, as Bassi's activities were brought to an end by her death in 1778, and her dissertation on fixed air was lost, we do not know where she stood in the controversy.[129]

On February 20, 1778, Laura Bassi died suddenly. Just the night before, she had attended a session of the Academy of Sciences.[130] Bassi was the product of a society with a long tradition of offering a high level of education to certain women of the aristocracy and professional elite. The rewards Bassi received for her education—a degree, lectureship, and membership in an academy—cannot be considered unique and were not considered so by those who conferred them. What made Bassi unique was that she made use of rewards that would normally have remained symbolic to carve out a position for herself in the scientific community of her town and to contribute to its intellectual life through her research and teaching. She would not have been able to contribute to this life as effectively if she had not actively engaged the support of the men who encouraged

[127] For Bassi's correspondence with Caldani and Nollet, see Cenerelli, ed., *Lettere inedite*, 56–62, 95–102; also Caldani to Bassi in BCAB, Letters no. 3668, 3672, 3674, 3676, 3685–3687, Collez. Aut. XII, 3666–3764. For Bassi's letters to Caldani, see Melli, "Epistolario di Laura Bassi Verati," 164, 168–69, 178; for her correspondence with Beccaria, see BAV, Autografi: *Patteta*, cart. 45; and for Beccaria's letters to her, see BAV, Autografi: *Patteta*, cart. 48; and BCAB, *Lettere di Giambattista Beccaria a Laura Bassi ed al marito*, Collez. Aut. VI, 1741–54. For Fontana's letters, see BCAB, Collez. Aut. XXIX, 7992–8054; several letters from men of science from the latter period of Bassi's life are scattered throughout the *Collezione Autografi* of BCAB, as are some of her answers.

[128] For Landriani's letter, see BCAB, July 7, 1777, in *Lettere di Landriani Marsilio a Laura Bassi*, Collez. Aut. XXXVII; for Volta's achievements in the field of electricity, see Heilbron, *Electricity*, 449–89; Segrè, *Dalla caduta dei gravi*, 159–60; Volta's letters to Bassi in Cenerelli, ed., *Lettere inedite*, 157–59; Bassi to Volta, September 20, 1777, in *Epistolario di Alessandro Volta*, Francesco Massardi, ed. (Bologna, 1949–55), 1: 187; Fontana to Bassi, Letter no. 8030, April 30, 1775, in BCAB, Collez. Aut. XXIX, 7992–8054.

[129] For the role of Italian natural philosophers in the chemical revolution, see Marco Beretta, "Gli scienziati italiani e la rivoluzione chimica," *Nuncius*, 4, fasc. 2 (1989): 119–45; for Fontana's role in the debate and his invention of the eudiometer, see Peter K. Knoefel, *Felice Fontana, Life and Work* (Trento, 1984), 163–90.

[130] Bassi's death certificate is found in ASB, Fondo: *Assunteria di Studio*, serie: Requisiti dei lettori, Busta 31, lettera B, vol. 2, no. 21, February 21, 1778; RAFSR, Veratti to Amaduzzi, March 28, 1778, in *Lettere a Giovanni C. Amaduzzi*, vol. 1, no. 16, p. 47.

a larger role for women in the academic and scientific world; she was fortunate enough to have encountered such men, Cardinal Lambertini for one, who occupied powerful positions in society and government.

Bassi's determination to teach privately if she could not teach publicly helped her with reformers such as Lambertini, Alberoni, and Albani and, ultimately, elicited recognition from those who had been reluctant to let her teach publicly: the Bologna senators. As a teacher, Bassi contributed to the spread of Newtonian physics and the Franklinian system of electricity in Bologna and in Italy. In her scientific activities, Bassi, unlike most women of the period, did not merely dabble in science but concentrated on narrow fields of physics, kept abreast of the latest developments, and successfully concluded many experiments, which were then presented as dissertations to the academy. Like most physicists of the past and present, she did not make key contributions to physics. Her level of professionalism, however, made her a pioneer female physicist, and as such she was an exceptional case for her time. Her role as a woman teacher of men of university age was also exceptional, and as a teacher her influence was long lasting. She contributed to the intellectual development of many men of science, particularly her cousin, Spallanzani, whose contributions to medicine had lasting importance.