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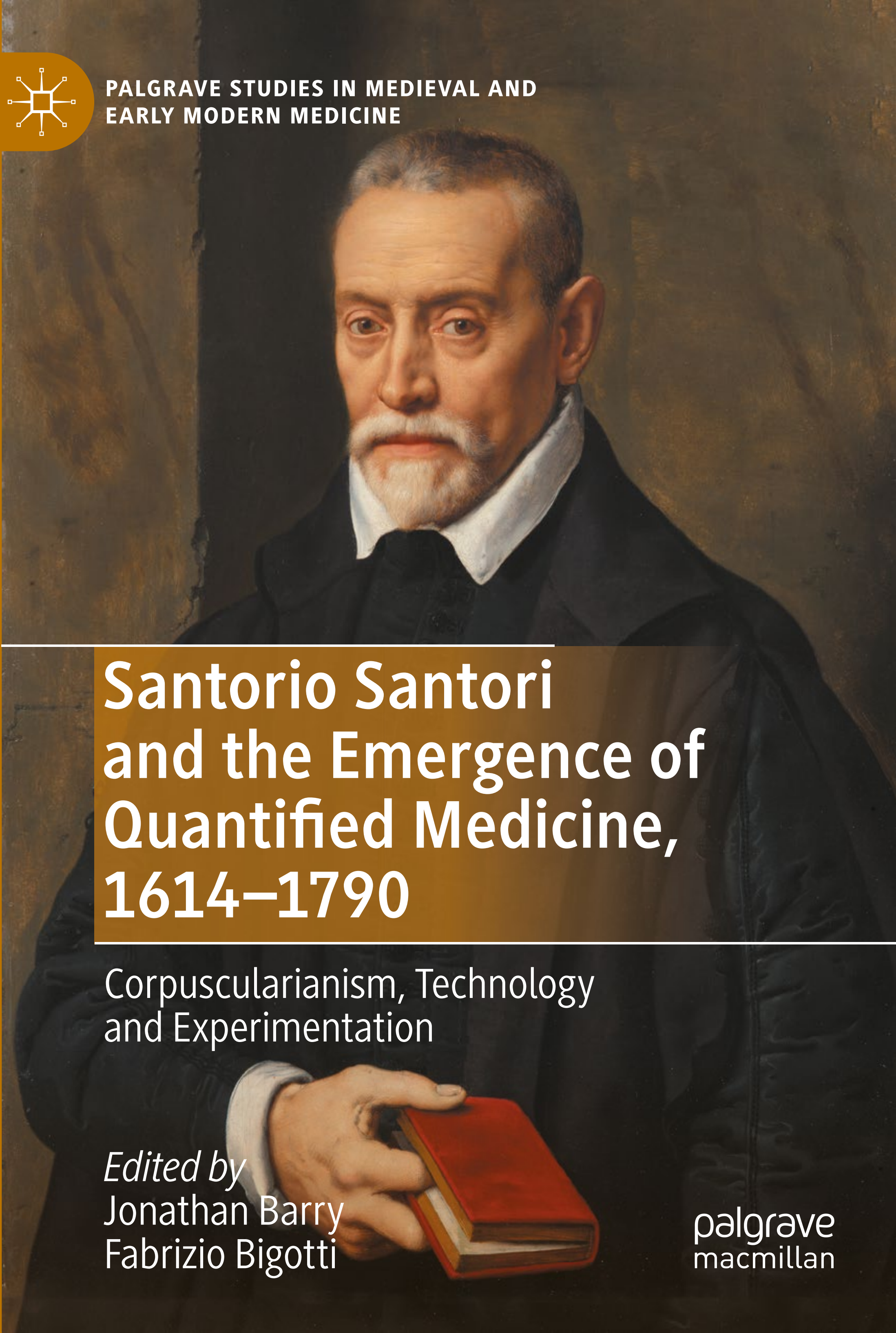

Santorio Santori and the Emergence of Quantified Medicine, 1614–1790

Corpuscularianism, Technology and Experimentation

Edited by
Jonathan Barry
Fabrizio Bigotti

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Preface

This book seeks to re-establish the centrality of Santorio Santori,[1] not only in the history of medicine but also in the history of science and technology, by showing how, through studying his work and legacy, we obtain a new and fuller perspective on the nature and development of corpuscularianism and early modern experimental philosophy. It does so by establishing not only Santorio's own contribution to both natural philosophy and experimentation but also his legacy over the following two centuries, in which his work was a fundamental reference point to many leading figures. This legacy, however, was never one of simple acceptance of Santorio's ideas and findings: just as he sought to follow Aristotle and Galen by adopting their methods rather than simply repeating their conclusions, so successive generations of scholars were inspired to conduct their own programmes of experimentation and theorising by following his lead, even if they often sought to explain his results through their own preferred natural philosophies. Yet, ironically, many of them did so applying versions of corpuscularian and mechanical philosophy which (though they probably did not know it) had been pioneered by Santorio himself, although his own corpuscularian and mechanical models of nature remained largely implicit in the construction of his instruments and experiments, or were expressed only briefly in his medical commentaries.

The reader may well wonder why, if Santorio was so important to early modern science and medicine, has he been so little known or studied in recent times? One answer might be the paradoxical one that Santorio was a victim of his own success. His name became indelibly associated with his *Medicina statica*, which was constantly reprinted, translated and commented on for the next two centuries. In particular his name became synonymous with the weighing chair he invented (the Sanctorian chair) and with the measurement of insensible perspiration for which it was designed (widely known as Sanctorian perspiration in the eighteenth century). Although these remained a living part of scientific and medical theory and practice until at least the time of Lavoisier, they were sidelined by new forms of science and medicine in the nineteenth century, and Santorio became seen as a 'dead end' in terms of the progress of science and medicine. Although Lucia Dacome and others have done much to re-establish the significance of medical statics in the early modern period, they have tended to present this as an aspect of medical thinking and practice tied closely to dietetics and the application of the six non-naturals to health regimes, rather than exploring the broader implications of Santorio's work, which this collection seeks to emphasise. The contributions cover different aspects and developments of Santorio's legacy throughout European medicine up to Lavoisier and explore the 'dissemination' of his 'seminal' ideas. They also demonstrate that Santorio's researches, both experimental and theoretical, extended well beyond medicine to cover theory of matter, optics, clinical practice, technology and even astronomy, fields in which his contributions served as a fountainhead of new ideas and pioneered new approaches.

Santorio has also suffered from the downplaying of medicine as a source of scientific development during the 'scientific revolution', and in particular as a source of mathematical, experimental and 'mechanical' models of nature (including the human body) during this period. Traditionally the focus has been on physics, and especially the development of a 'mechanical worldview' through development in astronomy associated with men like Galileo and Newton. More recently, this unilateral view has been rightly criticised and supplemented by a recognition of the importance of 'chymistry' (a term for pre-Lavoiserian chemistry developed by Newman and Principe in their pioneering work in this area), not least in the work of Boyle and Newton, which has in turn brought medicine back into the picture, given the strong links between chymistry and medicine. Historians have also identified the crucial role played by medical practitioners in the development of all the sciences, including natural history (e.g. Linnaeus), while even those natural philosophers not directly practising medicine, such as Descartes and Leibniz, have been shown to be centrally concerned with medical developments. Gradually this is filtering into general accounts of scientific change.

As a collection of studies on the development of corpuscularianism and technology, a clarification as to what we mean by the former term is required. We have taken corpuscularianism (from the Latin *corpusculum* meaning 'little body') as that set of theories that explain natural transformations as the result of the interaction of particles. Most notably, we have interpreted corpuscularianism as a 'theory of form' whereby corpuscles result from the action of an agent (*forma substantialis*) that divides the continuum of matter into portions (*corpuscula, particulae*) that are provided with the same specific quality and quantity. Resulting from the division of a homogeneous and continuous magnitude, corpuscles can always be further divided into smaller and smaller parts and for this reason they are substantially different from atoms and seeds. Thus, as distinct from both physical and geometrical atomism, corpuscularianism is a development of Aristotle's *minima naturalia* and it remained a subject of debate within Aristotelian natural philosophy (as well as among its opponents) until the late seventeenth century. In this sense, while corpuscularianism is often associated with the emergence of early modern mechanical philosophy, and especially with the work of Daniel Sennert (1572–1637), René Descartes (1596–1650) and Robert Boyle (1627–1691), corpuscularian theories can be found throughout Western philosophy. A new phase of corpuscularianism occurred in the early modern period (roughly from Galileo to Newton) when corpuscles were postulated as a necessary aspect of the mechanical model of the world and thus endowed with properties, such as shape, discrete quantity and weight. This represented a transition from the Aristotelian physics of qualities towards a rigorous atomism. But during this period many authors conflate together different aspects of the two traditions in ways that are peculiar to their approach to the continuum and the elemental composition of matter.

Although coming to full bloom in the seventeenth century, the trend towards the mathematisation of forms started in the late fourteenth century. In order to be responsive to mathematical treatment, matter ought to be particulate and divisible into *minima* of time, intensity, space, light, motion and so on. This 'mathematical minimism' opened up the possibility of reinterpreting the metaphysical concept of form, which was redefined as a structure or 'geometrical configuration' whereby forms are reduced to numerical entities and the emergence of new properties is seen as the result of a different spatial arrangement of the material substratum. Early attempts to develop this new idea, however, were tied up to the Aristotelian conception of place, which requires the existence of absolute directions, and thus retained the concept of form as an active principle able to guide the motion of corpuscles in an orderly manner. Such attempts are part of what has been defined as an ‘Aristotelian corpuscularianism’ predominantly linked to North Italian philosophers (especially in Padua), including Santorio. Compared to other Aristotelians, these thinkers, mainly physicians, upheld a more direct commitment to the physical existence of *minima* in their study of the combination of artificial substances to pursue a truly quantitative and chymical analysis of them. In many cases, however, they remained committed to the existence of substantial forms which they used to explain the emergence of new properties. Santorio’s own version of corpuscularianism and the adaptations and responses to this found in the other natural philosophers reveal the complexity of this process.

This volume explores one particular aspect of this new approach by detailing Santorio’s approach to medicine in the light of the theories he developed, the instruments he invented and the experimental practices he pioneered. It collects papers resulting from the international conference on ‘Humours, Mixtures and Corpuscles. A Medical Approach to Corpuscularianism in the Seventeenth Century’ that we organised in Pisa in May 2017 with support from the Wellcome Trust (Grant no. WT106580/Z/14/Z) and the Institutio Santoriana—Fondazione Comel. Bigotti’s contributions on Santorio himself, and the chapters on Obizzi, an early opponent (by Zurlini), and on Santorio’s views on plague (D’Alessio and Nutton), reveal both his continued commitment to a model of nature which underpinned a medicine delivered with certainty by the rational physician and the fundamental departures from traditional medical orthodoxy which his approach produced. The subsequent chapters of this volume explore these themes for such key figures as Sennert (Newman), Beeckman (Moreau), Descartes (Baldassarri), Leibniz (Blank) and Boyle (Ricciardo). It is clear that Santorio himself was read differently depending on the particular approach of each author and indeed our contributors (like their subjects) take rather different positions on the degree to which a corpuscularian approach presumed, for example, the rejection of substantial forms. With the establishment by the end of the century of forms of ‘mechanical philosophy’ such as Newtonianism and the associated iatromechanical model of the body/medicine, Santorio ceased, for a period, to be a direct source of inspiration for theories of matter as a whole. However, his mathematical approach to the study of the body and his version of the notion of ‘insensible perspiration’ remained very important to experimental traditions within medicine and natural philosophy, as is shown by the later chapters on Borelli (Zampieri), Baglivi (Tonetti), De Gorter (Verwaal) and

Linnaeus (Thomaz). The work of Lavoisier and Séguin (explored in the final chapter by Antonelli) also shows how Santorio's legacy could take on new life and meaning as a new form of chemistry was forged.

In addition to its substantive contributions, we also hope that this volume will contribute methodologically, both to the historiography that places medicine at the centre of broader scientific developments in the early modern period and to those approaches which stress the complexity of how both old and new models and practices were combined, recovering the significance of figures such as Santorio who may not fit neatly into paradigms of 'scientific revolution' as marked by dramatic changes of worldview, but nevertheless reveal that more incremental changes can nevertheless embody significant new approaches that underpin crucial features of our own understandings of nature, the body, and medicine.

Exeter, UK — Jonathan Barry
Würzburg, Germany — Fabrizio Bigotti

Note

1. We have chosen Santori as the most accurate rendering of his surname, as found in original documents letters, but he is often called Santorio Santorio or simply Sanctorius. However, we have used Santorio as the short form of his name in line with how Galileo's name is usually rendered in English forms of his titles (Galileo Galilei = Galileo).

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L. Gianfrancesco, P. Palmieri (eds.), *Disaster Narratives in Early Modern Naples. Politics, Communication and Culture*, 2018, pp. 187–204; "L'aria innocente. Geronimo Gatta e le sue fonti," in *Mediterranea-ricerche storiche*, a. XV, n. 44, dic. 2018, pp. 587–612; "Un allievo di Marco Aurelio Severino sulla peste di Napoli," *Medicina Historica*, vol. 4 (1).

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CHAPTER 1

Introduction

Fabrizio Bigotti and Jonathan Barry

Anatomists have in effect discovered many elegant things,
but the majority seems to be more curious than useful matters, and the
origin of diseases should be pursued not so much by hands but by
adopting a precise logic, which—except for Santorio amongst the earlier
[priores], *and Descartes amongst the most recent* [novissimi]—*I find*
in very few authors.
—G. W. Leibniz

Leibniz to Herman Conring (Hanover, 24 August 1677) in Gottfried Wilhelm (von) Leibniz, *Sämtliche Schriften und Briefe*, II.1 (Berlin: Academie Verlag, 2006), 563 (original quote with context): 'Quid enim est post studium pietatis cura sanitatis utilius. Nam in plerisque rebus nobis consulere possumus mediocri prudentia: at sanitatis conservationem fere casui committere coguntur homines,

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Few, concise remarks, rife with admiration. Leibniz's words bear witness to the influence that the Italian physician Santorio Santori (1561–1636) exerted on European medicine and natural philosophy. His works introduced quantification in the life sciences, his devices helped Giovanni Alfonso Borelli (1608–1679) to understand the vegetation of plants, Robert Boyle (1627–1691) to conceive his hydrostatic medicine, Giorgio Baglivi (1668–1707) to formulate his doctrine of fluids and solids, and Carl Linnaeus (1707–1778) his dietetics.[1] Santorio's masterwork, *Medicina statica* (Venice 1614), became the textbook for generations of physicians and a benchmark of experimental medicine. Praised by Herman Boerhaave (1668–1738) as the ultimate example of medical perfection, it set the groundwork for the studies of Archibald Pitcairne (1652–1713) on fevers, John Floyer (1649–1743) on asthma, James Keill (1673–1719) on digestion, Jean Bernoulli (1667–1748) on nutrition, Jean-Antoine Nollet (1700–1770) on electricity up to Lavoisier's and Séguin's researches on oxidation and metabolism.[2] In learned circles Santorio's authority was equally heralded to uphold the existence of atoms, to explain action at a distance as a stream of particles (*effluvia Sanctorii*) and to validate the belief in the resurrection of the dead.[3] And yet so pivotal a figure, likened to William Harvey for importance and to Descartes for clarity of method, is today little known, even by the most committed scholars.[4] While applying to all languages, the lack of studies is particularly conspicuous in the English-speaking world, where the only available monographs are translations of nineteenth-century Italian works, obsolete in their interpretative framework and full of misleading information.

1 A Tale of Oblivion and Rebirth

In part at least, Santorio himself was to blame for conveying such an image of obsolescence. At a quick glance, he might easily pass for the classic Renaissance Paduan physician, busy in providing students with commentaries to the canonical works of Hippocrates, Galen and Avicenna.

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in tanta verarum causarum ignorantia, quidquid etiam felicitas seculi jactetur. Quanquam enim multa elegantia detexerint Anatomici, pleraque tamen curiosa magis quam utilia videntur, et morborum origines non tam manibus quam accurata ratiocinandi methodo assequi licet. Quam si Sanctorium ex prioribus, Cartesium ex novissimis eximas, in paucis scriptoribus agnosco' (italics added).

Santorio himself once joked about the fact that the destiny of commentaries is to fall into oblivion,[5] a prediction that has so far proved correct. His fame instead rested on his *Medicina statica* and in particular on its dual emphasis on insensible perspiration and the weighing of the body by using the weighing chair he invented. Although, as we shall see, these inventions rested on his wider corpuscularian philosophy and his experimental methodology, they took on a life of their own, not always necessarily associated with Santorio's philosophical outlook, and eventually eclipsed the latter. Changes in medicine which appeared to render the medical statics obsolete left Santorio in obscurity, and although recent scholarship—particularly thanks to the contribution of Lucia Dacome[6]—has helped to recover the importance of his statics, such a recovery has not, generally at least, been accompanied by the same interest in Santorio's output as a whole.

Indeed, the context and content of Santorio's works seem so at odds with each other that they have been regarded as a trick history played at his expense.[7] This way of looking at his legacy began in the nineteenth century with Charles Daremberg (1817–1872), to whom Santorio was 'a more or less forgotten relic of the ancient physiology':

> […] we cannot share the enthusiasm of Baglivi, Boerhaave and many other 17th- and 18th-century physicians for the medical statics. I do not believe that for this work alone one would erect a marble statue to Sanctorius today, as was done after his death. Sanctorius is more or less forgotten: it is not even read anymore. The whole edifice of his *Ars statica* is based on the old physiology. […] One would be astonished to find so many ingenious instruments in a commentary which is, moreover, entirely scholastic, if one forgot that Sanctorius was above all a *physicist* and a *mechanic*, always in search of novelties; so that *medical statics* is less the result of a medical system than the application of studies directed towards the work of mechanics proper.[8]

Many have borrowed this interpretation acritically,[9] though others have more recently delved into Santorio's works and acknowledged the groundbreaking nature of his ideas.[10] In spite of this, the overall attention devoted to the Venetian physician has hitherto been patchy and very limited in scope. The historiographical reasons for this are not difficult to recount.

Particularly damaging to Santorio's legacy have been attempts to read his ideas as an embodiment of Galileo's. The attempt was consistent with a reading of history as a progression towards the final triumph of the scientific method, which had eventually replaced Santorio's rudimental trials with Lavoisier's precise chemistry. The life sciences sat at odds with the picture positivists were keen to sketch, and medicine in particular was regarded as an empirical pursuit led by outdated methods and theories. Thus, when the phenomenon of the 'insensible perspiration', to which Santorio's contributions had meanwhile been reduced, ceased to be a pressing concern for medical practice, Santorio was praised instead for having applied Galileo's methods to medicine.[11]

Not less problematic, in the least, is the contemporary attempt to counterbalance such an approach. If framing major scientific changes in terms of 'revolutions' does get away from *Whig history*, it sets the discussion of historical problems within a structuralist dichotomy (old/new, before/after, closed/open, etc.), which hinders any attempt to grapple with the complexity of historical sources. Worse still, in a Panglossian move that reduces everything to language and text, it advocates for the necessity of accommodating historical actors and empirical evidence to narratives and historiographic paradigms, thus requiring historians to locate events on the one side or the other of an imaginary threshold, which does not exist. As with all a priori approaches, it works best in challenging established accounts, but it is of little help when—as in this case—the task is that of evaluating the merits of historical figures that have been forgotten or whose contributions defy easy encapsulation. In this sense, the relevance of authors such as Santorio—but the same would apply to Daniel Sennert, as William Newman shows in his contribution—is that they are a constant reminder that there is 'no simple way' to deal with history. To approach early modern authors, texts must be studied closely and historical evidence used to enlarge and enrich our tentative characterisations of a period or a trend. Thus, in locating Santorio's legacy, we pose as reference the existence of a 'constellation of problems' that are shaped by both converging and diverging historical accounts, each in turn seen as the result of various actors, ideas, methods and aims admitting of different solutions, where the old and the new survive, commix and react, in a way that is impossible to distil into a unifying picture, be it a paradigm or an episteme.[12] Such an approach will lead to a better understanding of Santorio's intellectual legacy reversing the oblivion that has affected an author whose contributions are still reduced nowadays to the caricature of a man living on a weighing chair.[13]

This new approach ought to start necessarily from sketching afresh the main traits of Santorio's life, character and works. These, now enriched by substantial findings, will help us to reconstruct in turn the problems his research was moved by and the directions along which it developed.

2 Santorio's Life and Works

Sources for Santorio's life and personality are scarce and the most reliable ones are scattered throughout his works. The hitherto available biographical outlines depend on a patchy reading of Santorio's works and provide information that is either unreliable or—when it is—depends almost entirely on the biography published in 1750 by the physician Arcadio Capello, who had access to a series of original documents by Santorio's heirs living in Venice.[14] To the former group belong a series of documents written either as praises of Santorio's work and inventions or as part of large histories of the University of Padua,[15] while the latter is represented by a variety of nineteenth- as well as twentieth-century contributions.[16] Useful sources to reconstruct Santorio's intellectual profile can be found in Galileo's epistolary exchanges with his Venetian colleagues, in the official documents of the University of Padua, in the biographies of Sarpi written by Fulgenzio Micanzio (1570–1654) and Francesco Griselini (1717–1787), as well as in the *Iscrizioni Veneziane* by Emanuele Antonio Cigogna (1789–1868).[17] Important letters and documents, including Santorio's last will found in 1883,[18] were published by Modestino del Gaizo (1854–1921)[19] while a few others were discovered around 1960 by Maria Stella Ettari and Marco Procopio, in what has been so far the best monograph on Santorio.[20] A substantial number of documents and letters have finally resurfaced as a result of Fabrizio Bigotti's extensive research into European and American public and private archives, some of which will be used here. In the end, however, the most reliable details and character traits can be found in Santorio's works. In what follows, we have summarised the available data with the most recent discoveries and reshaped some of the conclusions previously reached by scholars.

2.1 Early Life, Travels and Setting in Venice (1561–1593)

The elder son of Antonio (c. 1520–1592/3) and the noblewoman Elisabetta Cordoni (or Cordonia), Santorio Santori was born in Capodistria—today Koper in Slovenia—on the borders of the Venetian dominion, on 29 March 1561.[21] He had two sisters, Diana[22] and Franceschina, and one brother, Isidoro (d. 1618).[23] The Santori family—also known as *Santorio*, *Santorii* or *De Sanctoriis*, Figs. 1.1 and 1.2—was originally from Spilimbergo in Friuli, where Santorio's grandfather, Isidoro, was a notary and a teacher at the local schools (1516–1518).[24]

Fig. 1.1 Santorio's Coat of Arms as portrayed on the engraving by Jacopo Piccini (1659)

Fig. 1.2 Santorio's Coat of Arms in the Atrium of Palazzo Belgramoni-Tacco (seventeenth century). Regional Museum, Koper (Capodistria)