CHAPTER 4

Pores, Parts, and Powers in Sixteenth-Century Commentaries on *Meteorologica* IV

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1 Introduction

Scholarship of the last century has shown that *Meteorologica* IV has held an extraordinary position, both with respect to interpretations of Aristotle's natural philosophy in general and with respect to understandings of the development of early modern matter theory. *Meteorologica* IV is to a large extent thematically disconnected from the first three books of the *Meteorologica*, which are concerned with motions and transformations of the dual exhalations in the sublunary region.[1] These two exhalations – one like water (vaporous), the other like fire (hot and dry) – make up the proximate causes of weather phenomena; fires in the sky, including comets and meteors; optical apparitions, such as the rainbow, double suns, and haloes; formations of bodies of water; and subterranean alterations, namely earthquakes and the formation of fossils and metals.[2] In this last subject there is some continuity between the first three books and the fourth and final book, as the formation of metals is briefly discussed in the last chapter of book III. There, Aristotle explains that metals, by which he refers to homogeneous watery substances, result from the congelation and solidification of the vaporous exhalation that is enclosed within the earth. Elsewhere fossils – that is, minerals dug up from the earth, rather than mined from an ore – form when the hot and dry exhalation acts as an efficient cause upon the underlying matter.[3] In like manner, book IV addresses the role of heat and the characteristics of underlying matter in the transformation and generation of homogeneous substances.

In particular, *Meteorologica* IV addresses the active powers of heat and cold and their roles in separating and uniting matter, specifically in the processes of concoction (*pepsis*) – which includes digestion and ripening – and

1 Wilson, *Structure and Method*, 9.

2 For *Meteorologica* I–III, see Wilson, *Structure and Method*; Taub, *Ancient Meteorology*, 77–115; Solmsen, *Aristotle's System*, 393–439; Gilbert, *Die meteorologischen Theorien*, 176–205.

3 Aristotle, *Meteorologica*, 3.6.378a17–b5; Eichholz, "Aristotle's Theory," 141–146.

of putrefaction (*sepsis*).[4] These processes are prominent in the generation and dissolution of living bodies, their parts, and their residues. They parallel artificial transformations, being analogous to the cooking heat employed in the culinary arts.[5] Ingemar Düring's description of *Meteorologica* IV as a "Chemical Treatise" was therefore regarded as inadequate by David Furley, who instead saw book IV as more closely connected to the biological works.[6]

Subsequent chapters of *Meteorologica* IV discuss the primary passive qualities of matter, namely dryness and wetness, in addition to the secondary passive qualities of matter. These secondary passive qualities – including malleability, brittleness, combustibility, viscosity, and meltability – are properties, potentially, of the matter of living beings, minerals, and artificial products. The underlying elements, that is, the proportions of earth and water, the two elements most closely correlated to the passive qualities of dryness and wetness, partially explain these secondary qualities, although porousness is invoked as another factor to account for some qualities.[7] For example, materials made up of earth, and possessing pores too small to allow the entry of particles (*onkoi*) of water, become soft when wet.[8] Similarly, wood, wool, bone, and other combustible objects have pores containing little moisture, which fire can readily penetrate.[9] Empty pores also explain why some objects, like sponges, wax, and flesh, reduce in size when pressed.[10] Furthermore, viscosity can be accounted for as the result of interlocking parts that create chain-like structures that inhibit flow.[11]

In 1915, Ingeborg Hammer-Jensen argued that the references to pores and particles in *Meteorologica* IV contradicted Aristotle's attacks on Leucippus, Democritus, and Empedocles in *De generatione et corruption* I.8, in which Aristotle rejected as superfluous and incoherent the argument that pores should be seen as conduits for active powers.[12] Seeing a closer correspondence with the later Peripatos than to Aristotle's own teachings, Hammer-Jensen argued that book IV should thus be considered inauthentic.[13] While notable scholars, including David Ross, Werner Jaeger, and Léon Robin, have agreed with

4 For concoction, see Aristotle, *Meteorologica*, 4.2.379b10–380a9. For putrefaction and natural decay, see ibid., 4.1.379a2–379b9.

5 Lloyd, *Aristotelian Explorations*, 83–103.

6 Furley, "The Mechanics," 73–93; Düring, "Aristotle's Chemical Treatise."

7 For the prominence of earth and water for defining passive properties, see Aristotle, *Meteorologica*, 4.4.382a4–8.

8 Ibid., 4.8.385a28–30; 4.9.385b19–26.

9 Ibid., 4.9.387a17–23.

10 Ibid., 4.9.386b2–11.

11 Ibid., 4.9.387a11–15.

12 Aristotle, *De generatione et corruptione*, 1.8.324b25–326b28.

13 Hammer-Jensen, "Das sogenannte IV. Buch," 118–36.

Hammer-Jensen's determination, after much debate, the scholarly consensus has nevertheless coalesced around the acceptance of the work as genuine.[14] At any rate, book IV's consideration of material properties, its description of corpuscles and pores, its linking of the artificial and the natural, and its appeals to "artificially contrived" experiences, have given the book a distinct legacy in the Middle Ages and the early modern period, particularly in relation to medicine and alchemy, fields that combined theoretical and practical inquiries into matter and its composition.[15]

William Newman has shown that readings of *Meteorologica* IV were crucial to the development of experimental practices and corpuscular theories of matter developed by alchemists beginning with Pseudo-Geber's *Summa perfectionis*, written around the end of the thirteenth century, and continuing into the seventeenth century, when Daniel Sennert and others used the text as a support for atomistic theories of matter.[16] In addition to being widely read in alchemical circles, *Meteorologica* IV was a standard part of the curriculum of medieval and Renaissance universities.[17] Consequently, it was the subject of commentaries by many of the leading university professors. Renaissance commentators frequently addressed the matter theory of *Meteorologica* IV and its significance for alchemy.[18] Niccolò Cabeo's 1646 commentary perhaps best represents this alchemical strain within the commentary tradition; here he used all four books of the *Meteorologica* to serve as a textual foundation for an innovative interpretation of Aristotle. Cabeo believed that his interpretation supported Paracelsian principles, experimental practices, and corpuscular matter theory.[19]

While alchemical theory and practice influenced Renaissance readings of *Meteorologica* IV, during the sixteenth century book IV increasingly came to occupy a transitional place between natural philosophy and medicine.[20] Sixteenth-century Italian universities emphasized medicine, and their instruction in natural philosophy reflected this focus.[21] Many of the topics of *Meteorologica* IV were directly relevant to medicine, including its discussions of

14 Ross, *Aristotle*, 11; Werner, *Aristoteles*, 386; Robin, *Aristote*, 17. For more doubts about its authenticity, see Gottschalk, "Authorship," 67–79. For the acceptance of Aristotle's authorship, see the forceful argument at Furley, "Mechanics," 86; and, most recently, see Popa, "Scientific Method," 317, n. 17; Gill, "The Limits of Teleology," 336, n. 1.

15 For the "artificially contrived situations," see Lloyd, *Magic, Reason and Experience*, 209–210.

16 Newman, "Experimental Corpuscular Theory," 291–329; idem, *Atoms*, 21–153.

17 For example, see Denifle, *Chartularium*, 1:278; Malagola, *Statuti*, 274.

18 Martin, "Alchemy and the Renaissance," 245–262.

19 Idem, "With Aristotelians Like These," 135–161.

20 Idem, "Francisco Vallés," 1–30.

21 Bylebyl, "School of Padua," 338; Lines, "Natural Philosophy," 267–320; Giard, "Histoire," 139–69; Grendler, *Universities*, 268–269.

digestion, ripening (treating also of bodily fluids), and putrefaction. Book IV's matter theory had the potential to help explain the properties and characteristics of flesh, blood, semen, marrow, and other body parts that were subjects for medical instruction, in line with Furley's classification of book IV as being primarily concerned with organic matter. Accordingly, a number of sixteenth-century commentaries, such as those by Pietro Pomponazzi, Lodovico Boccadiferro, Francesco Vimercato, and Francisco Vallés, associated *Meteorologica* IV with medicine and discussed in depth its medical aspects.

In their commentaries on *Meteorologica* IV, Pomponazzi, Boccadiferro, Vimercato, and Vallés cast doubt on the need to use occult qualities to explain material properties. Rather, they emphasized that particles endowed with manifest qualities can account for matter's active and passive powers. In doing so, they undermined the concept of homeomerity, contending that seemingly homogeneous materials are in fact composed of different kinds of corpuscles. They held that the corpuscular structure of these seemingly homogeneous substances played a significant role in defining their passive characteristics. Invisible fibers and pores – and the structures they formed – were crucial to the transformation of material substances, given that they served as conduits for active powers, allowing for the completion of processes such as coagulation and putrefaction. Pomponazzi, and several of his early modern readers, recognized that Aristotle's use of pores and particles was potentially at odds with his dismissal of atomism in *De generatione et corruptione*.

For these early modern commentators, the matter theory of *Meteorologica* IV was directly relevant to medical theory. They held that book IV's references to particles and pores were key to understanding temperaments, complexions, and constitutions. They discussed how blood contains small fibers that play a role in physiological functioning and the determination of temperament. Furthermore, they understood that elemental or vaporous particles enter into the pores of living bodies and alter their composition and the qualities of their parts. Without admitting the existence of indivisible atoms or of void, they contended that small particles, endowed with active and passive powers, were agents and recipients of qualitative change. Thus, the corpuscular interpretation of *Meteorologica* IV was not restricted to alchemical circles but also echoed throughout exegeses of the book that were concerned with, and informed by, medical practice.

2 Pomponazzi's *Dubitationes* and Elemental Parts

In the first years of the 1520s, directly after the controversies over the immortality of the soul and the composition of *De incantationibus* and *De fato*, Pietro

Pomponazzi gave lectures on a number of topics that deviated from the traditional teaching duties of an ordinary professor at Bologna. His contract, which was the result of intensive negotiation and his threatening to depart if his conditions were not met, permitted him to lecture on whatever subject he wished.[22] Taking advantage of this freedom, he lectured on Aristotle's *De generatione et corruptione*, *De partibus animalium*, and the *Meteorologica*. His *Dubitationes in quartum Meteorologicorum* likely stem from lectures given in the years between 1522 and 1524,[23] although they were only printed posthumously in 1563, in the interim between the first and second printings of the *De incantationibus*.

The printer's dedication to Cardinal Ludovico Madruzzo offers few clues as to the motivation for publishing the *Dubitationes*, besides its contentions that Pomponazzi was one of the greatest philosophers of his time and that the work is most erudite.[24] Nevertheless, publishers, purchasers, and readers of this book most likely were well aware of his better-known and more controversial writings, especially after the 1556 release of his *Opera omnia*.[25] To a great degree, these lectures on *Meteorologica* IV followed the materialistic inclinations that were a hallmark both of Pomponazzi's psychological works and the *De incantationibus*.[26]

Avoiding recourse to the supernatural in the *De incantationibus*, Pomponazzi instead gave hypothetical physical explanations for a range of marvelous and seemingly miraculous phenomena and events. In order to explain many of these phenomena, he evoked the occult natural powers contained in herbs, animals, metals, and other substances; he referred to astral influences and to forces transmitted through invisible, but material, spirits and vapors. He thereby replaced a conceptualization of the demonic exertion of active powers on passive subjects with the natural dispensation of these same forces, following the contours of Renaissance theories of natural magic.[27] In the *Dubitationes*, Pomponazzi dedicated himself to explaining material transformations, whether marvelous or not. The causes of these transformations, however, are largely more pedestrian than the accounts of marvelous, preternatural phenomena found in the *De incantationibus*. In the *Dubitationes*, Pomponzzi's causal accounts are mainly in accordance with Aristotle's text and are linked to the elements and sensible qualities. Eschewing occult forces,

22 Podestà, "Di alcuni documenti," 176.

23 Lohr, *Latin Aristotle Commentaries*, 356–357; Nardi, *Studi*, 83–84.

24 Pomponazzi, *Dubitationes*, sig. *2r–v.

25 Doni, "Il 'De incantationibus,'" 183–230.

26 Graiff, "I prodigi," 331–361.

27 Pomponazzi, *De incantationibus*, 7–13. For Pomponazzi and his work's relation to natural magic, see Copenhaver, *Magic*, 273–284.

he circumscribed the active powers to include just heat and cold, emphasizing heat. Furthermore, just as in the text of *Meteorologica* IV, he paid close attention to the passive aspects of matter and the secondary qualities that result from the formations of elemental parts, in particular from the mixing and conglomerations of earth and water.

Despite the differences between the *De incantationibus* and the *Dubitationes*, there are strong parallels between the two works. For example, the *Meteorologica* is among the authoritative texts that Pomponazzi relied upon in the *De incantationibus*. In chapter ten, which contains a lengthy exploration of potential causes of the preternatural, he argued that necromancy could possibly be explained by apparitions similar to the faces of the dead said to be reflected onto the vapors in the night air. In support of this hypothesis, Pomponazzi cited Aristotle's discussion of haloes and rainbows, and Aristotle's statement that such optical reflections do not occur at midday but require dense misty air, composed of small parts of water that have yet to form drops. These were the conditions that Pomponazzi presumed to prevail in the foggy graveyards where necromancers saw what they believed were the faces of dead people, recently buried.[28] Elsewhere in the *De incantationibus*, Pomponazzi referred to pores as key to the transmission of imperceptible agents. In chapter four, he contended that it is more probable that vapors and spirits cause marvelous cures than unguents and plasters because the latter are bulkier and therefore do not so easily enter into the pores and the internal parts of the body as the imperceptible vapors do.[29]

In the *Dubitationes*, Pomponazzi speculated about the natural causes of marvelous phenomena, just as he had done in his early works. For example, in *Dubitatio* LXIIII, in a digression following his consideration of the powers of fire and Aristotle's alleged belief that salamanders live in fire, he speculated that it might also be possible to find a human impervious to combustion, even if placed completely in fire. To support this contention, he cited Plutarch's biography of Pyrrhus, the ancient king of Epirus, whose foot, we are told, would not burn even when engulfed in flames.[30] He went on, recounting seemingly unrelated marvelous phenomena, including his own eyewitness account of a spear

28 Pomponazzi, *De incantationibus*, 91–92; Aristotle, *Meteorologica*, 3.4.373a35–b31; 3.5.377a11–28. Pomponazzi made a similar assertion in *De immortalitate animae* where he contended that visions of the dead often occur in burial grounds where the air is very thick such that it easily receives idols; see Pomponazzi, *De immortalitate animae*, 208; Aristotle, *Meteorologica* 3.4.373b7–10.

29 Pomponazzi, *De incantationibus*, 33.

30 Pomponazzi, *Dubitationes*, 38v; Plutarch, *Life of Pyrrhus*, 3.5. For Aristotle's statement on salamanders living in fire, see Aristotle, *Historia animalium*, 5.19.552b14–16.

being launched and penetrating a knight's armor while itself remaining fully intact despite lacking an iron tip. Having aroused the curiosity of numerous Mantuans, this spear was sold for the lofty sum of 300 ducats. Pomponazzi concluded this section by stating that these marvels are not the result of "spells or evil demons, as many unskilled in natural matters believe."[31]

In other ways, the discourse of the *Dubitationes* appears removed, or at least distanced, from the frequent evocation of the powers of celestial bodies and occult forces found in the *De incantationibus*, where – just as Avicenna had – Pomponazzi linked the products of spontaneous generation to celestial bodies.[32] In the *Dubitationes*, by contrast, he focused on Aristotle's description in *Meteorologica* IV of how spontaneously generated animals were formed by the power of heat lingering in the remnants of putrefaction.[33] By deliberating over the role of heat in generation, Pomponazzi, for the most part, left behind the outsized role of astral powers found in his earlier work.[34] Rather, he theorized about the transformations of earthly matter in terms of mixtures of elements and their manifest qualities.

A recurring *quaestio* among medieval and Renaissance commentators on *Meteorologica* IV was that regarding the *forma mixti* arrived at through the mixture of these elements.[35] In short, the query asks how a new substantial form can arise during the generation of mixture and what happens to the forms and qualities of the ingredients of the mixture. Are the ingredients' forms and qualities destroyed, or do they remain, in a refracted, potential, or blunted manner? Closely related to these questions is the question of whence the new supervening form arises. Does it emerge from the underlying matter, or does it come from outside of the mixture, transmitted by celestial bodies or imposed by God? Although Pomponazzzi did not directly address the *forma mixti* in the *Dubitationes*, his speculations on the accidental qualities of mixtures show that he was to some extent concerned with this question. His glancing treatment of it, like so many of the work's discussions, ends in an indeterminate fashion, even if the propositions of others are dismissed as unsatisfactory. Here, as in many of his lectures dating from this time, Pomponazzi commenced from, and proceeded through, doubt.[36]

31 Pomponazzi, *Dubitationes*, 38v: "Ideo non omnia talia fiunt incantatione, aut malorum daemonum adiuvamine, ut multi imperiti physicarum rerum credunt."

32 Idem, *De incantationibus*, 79; Nardi, *Studi*, 305–19.

33 Aristotle, *Meteorologica*, 4.1.379b6–9; 4.11.389b5–9.

34 Pomponazzi, *Dubitationes*, 35r.

35 Haas, "Mixture," 21–46; Maier, *An der Grenze*, 9–140.

36 Perfetti, "Docebo," 439–466.

Pomponazzi focused on the roles of the prime qualities, and in particular, on the two active qualities – heat and cold – that are necessary for altering, corrupting, and preparing for the introduction of a new *forma mixti*. In *Meteorologica* IV, Aristotle described the power of heat and cold to cause generation by ruling over or mastering the underlying matter.[37] In concoction, internal natural heat acts as the efficient cause. This heat fosters the realization of the end or the perfection of that substance.[38] For Pomponazzi, heat is the key qualitative instrument for bringing about a new *forma mixti*. Yet, in his view, by its essence, heat does not create substantial forms, as it merely prepares the matter through non-essential powers that "divides, separates, rarefies, and unites accidently."[39] The heat, directed by a natural agent that possesses a final cause, arranges the underlying matter "in order that the form of the mixture is introduced." Thus, for Pomponazzi, the other qualities are not part of the active process but are linked to matter, not form:

> I say therefore that heat alone introduces the substantial form into a mixture; moreover, wetness and dryness do not introduce the substantial form, but behave as matter. In the same way, cold does not introduce the substantial form into a mixture but behaves as matter.[40]

Heat's qualities prepare the matter defined by the other prime qualities so they may receive a new substantial form.

In its activity as directive agent in this process of introducing substantial form, nature is overwhelmingly sublunary. Here, Pomponazzi doubted the role of astral influences. In the passage of the *Dubitationes* that most closely resembles an inquiry into the classical problem of the *forma mixti*, Pomponazzi – "for the sake of exercise" – referred to an argument that he "used as a student at Padua," and presented to his teacher, whom he identified as Antonio Trapolino.[41] Pomponazzi supposed, following the Thomistic solution, that only one substantial form actually exists in a new mixture. The forms of the components of the mixture remain only virtually, while the new

37 Aristotle, *Meteorologica*, 4.1.379a1–2.

38 Ibid., 4.2.379b18–32.

39 Pomponazzi, *Dubitationes*, 6v: "Dico, ut prius, quod absolute inquantum est calor, dividit, segregat, & rarefacit, & per accidens congregat."

40 Ibid.: "Dico ergo, quod sola caliditas est, quae inducit formam substantialem in mixto: humiditas autem & siccitas non inducunt formam substantialem, sed habent se ut materia. Sic nec frigiditas inducit formam substantialem in mixto; sed habet se ut materia."

41 Ibid., 7v: "Exercitationis autem causa, adducam ego argumentum quo scolasticus adhuc Patavii usus sum, et adduxi viro percelebri Antonio Trapolino praeceptori meo."

form is introduced to the newly generated substance.[42] Pomponazzi presented Trapolino with the macabre proposition of a man hypothetically thrown into extremely cold water and dying as a result. The question arising from this grim hypothesis was as follows: "therefore, whence is [the new form of the dead man] generated?"[43] It cannot be from heat, because freezing water surrounds the corpse. In Pomponazzi's recounting, Trapolino responded, following Averroes, that through the influence of the heavens, heat from the sun and other stars are impressed on the air, which in turn produces the new *forma mixti*.[44]

Pomponazzi, however, rejected Trapolino's solution, noting that many mixtures are generated deep in water or below ground where there is no air that could convey celestial heat, and, evoking a renal complaint with which he himself was afflicted, that "stones and sand are generated in the kidneys, and [that] worms are generated in man and in other animals, where there is no air."[45] Ending the *Dubitatio* in a state of suspended judgment, he seemingly rejected both the role of celestial influences in the generation of intestinal worms, and the Thomistic view that a new form replaces the qualities of the components of a mixture. This is consistent with his earlier definition, where he stated that "mixture comes to be from heat, for heat mixes the four elements with each other and collects them so that they remain at the same time in the mixture."[46] Thus, in Pomponazzi's definition, the elements remain, seemingly intact. For the dead man submerged, as for Pomponazzi's kidney stones, the heat that introduced the new forms must therefore derive from the accidental qualities of the components that remain. Pomponazzi later clarified this view in a discussion of the spontaneous generation from putrefied matter, where,

42 Maier, *An der Grenze*, 36–40. While it is well known that Pomponazzi studied with the Thomistically inclined Pietro Trapolino at Padua (see Nardi, *Studi*, 104–21), the identity of Antonio Trapolino is mysterious. Eugenio Garin maintained that Antonio Trapolino did not exist (Garin, *La filosofia*, 2:57). Yet, an Antonius Trapolinus is listed as becoming extraordinary professor of jurisprudence at Padua in 1525, the year of Pomponazzi's death and thus well after his student days; see Facciolati, *Fasti gymnasii patavini*, 130.

43 Pomponazzi, *Dubitationes*, 7v: "Tunc accipio hominem, qui exponatur aeri frigidissimo; vel proijciatur in aquam frigidissimam, & moriatur illo frigore; tunc … ibi generatur nova forma mixti: quaero ergo unde generetur?"

44 Ibid.: "Respondebat praeceptor meus tenendo opinionem Comment. in 12. Met. 18. quod virtute influentiarum coeli influentis calorem solis & aliorum astrorum in aerem fit hoc, & est quaedam caliditas impressa in aer, quae producit hunc calorem, quo demum generatur forma mixti." Averroes, *Metaphysicorum*, 305r.

45 Pomponazzi, *Dubitationes*, 7v: "Item in renibus generantur lapides & arenae, & vermes generantur in homine, & in aliis animalibus, ubi non est aer." On Pomponazzi's own kidney stones, see Nardi, *Studi*, 205–206.

46 Pomponazzi, *Dubitationes*, 2v: "mixtio fit a calido, calor enim miscet quatuor elementa inter se, & ea congregat, ut simul maneant in mixto."

comparing the views of Albertus Magnus and Averroes, he wrote that these animals "sometimes come through the heat in the separated parts of matter, and sometimes through an extrinsic and ambient heat," that is, the "celestial heat [that] is spread throughout the orb."[47]

The discussion in the *Dubitationes* is characterized by the same hesitancy found in the *De incantationibus* to attribute causes to the supernatural. Nature, in the *Dubitationes*, remains largely sublunary; the causes of generation and corruption are the operations of the prime qualities; and their effects are consistent in both artificial and natural entities. His explanation of the powers, characteristics, and qualities of diverse mixtures depends on the existence of parts within them that retain these powers, most often powers similar, if not identical, to the prime qualities of the elements. For example, in his explanation of why strong wine desiccates even though it is itself wet, he maintains that Cretan and Falernian wines have a large amount of spirit and fiery parts within them. Similar accounts apply to the properties of coriander and vinegar. As for the "specific occult property," which played such a strong role in natural magic, Pomponazzi dismissively characterized it as the "universal refuge of all physicians and physicists."[48] Rather, it is in these fiery parts (*partes*) than we find a mundane explanation of the seemingly miraculous. Animals can be nourished and have sensation buried in the snow, "since in the midst there are hot, fiery parts."[49] Animals can be spontaneously generated in stones, because stones are generated from the double exhalation, which contains wet parts susceptible to putrefaction, as is confirmed by both Aristotle's authority and alchemists' extractions of oil and water. Additionally, these parts have corresponding pores. For example, salamanders' supposed ability to live within fire is the result of "such narrow pores within them that fire is not capable of penetrating them and consuming their humidity."[50] Presumably, Pyrrhus' foot could also withstand burning owing to a similar physical structure.

Pomponazzi concluded *Dubitatio* LXII by linking the artificial and the natural. He wrote that "those who are good philosophers can make some things through art that do not dissolve by fire," by using the lessons of the

47 Ibid., 35r: "quoniam aliquando fit per calorem in separatis partibus materiae; aliquando etiam per calorem extrinsecum, & ambientem"; "nam calor coelestis disseminatus est per totum orbem; calor autem est instrumentum productivum genitorum ex putredine."

48 Ibid., 36r: "Tertia responsio quam ponunt omnes medici, est, quod non quia calidum neque quia frigidum & humidum aut siccum; sed quia habet talem proprietatem specificam occultam, & est fuga communis omnium medicorum & physicorum."

49 Ibid., 38r: "quoniam in medio sunt partes calidae, igneae."

50 Ibid., 38v: "quoniam pori in ea sunt tam stricti, quod ignis non potest penetrare illos, & consumere humiditatem illorum."

imperishable salamander's pores.[51] Accordingly, references to the parts, with their qualities, and to pores, which block or convey them, apply to both the artificial and the natural, the living and the dead, as he referred specifically to "artificial mixtures, such as medicinal compounds," in addition to the work of goldsmiths.[52] Yet, most of the examples cited by Pomponazzi are products of nature. Oil becomes white because its water separates, leaving behind "airy parts" that coagulate and thicken.[53] Just as snow contains hot and fiery parts, hail contains air, which makes it foamy and white, and earthy parts, which are evident as residue left behind once the hail has melted.[54] Semen contains airy and potent parts that render it white and foamy immediately upon emission, while their absence renders the remnant fluid and cold. According to Pomponazzi, physicians believed that those who possess a long "rod" (*virga*) are thereby impeded from fatherhood, as the foamy parts of the semen fly off before the complete, potent seed can arrive in the womb.[55]

Pomponazzi's discussion of blood focuses similarly on its decomposition into various kinds of parts. He wrote that blood, taken from the vein, thickens not from the cold but because its hot and foamy parts evaporate, leaving behind its earthy parts.[56] Additional evidence that blood is composed of various parts derives from Aristotle's statement in *Meteorologica* 4.10 that "blood that contains fibers is mostly composed of earth."[57] This sentence had created confusion among medieval commentators. Some manuscripts of Henry Aristippus's twelfth-century *translatio vetus* interpreted Aristotle's *is* (ἴς) as meaning *via*, or path, instead of the more accurate *fibra*.[58] Consequently, in his commentary on the *Meteorologica*, Albertus Magnus, understanding the *viae* to be pores, made the obscure pronouncement that blood that "has many paths of pores, is more earthy than other kinds."[59] Although William of Moerbeke's thirteenth-century

51 Ibid.: "Unde qui boni essent philosophi, possent facere arte aliquas res, quae non dissolverentur igne."

52 Ibid., 2v–3r: "Item in corporibus sive commixtionibus artificialibus ut medicamentis compositis."

53 Ibid., 43r.

54 Ibid., 45v.

55 Ibid., 3r. For similar discussions of the various parts of semen contained in a jar or exposed to the cold, see ibid., 44v; 49r.

56 Ibid., 43v: "dico quod si sanguis sit extractus ex vena, tunc evanescunt partes calidae & spumosae."

57 Aristotle, *Meteorologica*, 4.10.389a20–21. For a general history of fibers in blood, see Haak, "Blood," 295–305.

58 Aristoteles Latinus, *Meteorologica liber quartus*, 10/1, 23.

59 Albertus Magnus, *Meteora*, 320: "Ille *vero sanguis*, qui *habet vias* pororum multas, *magis* est *terreus* quam alius." The italicized words, following Hossfeld's editing, mark Aristotle's words found in the text on which Albertus was expounding.

translatio nova left the word transliterated as *inas*, the continuator of Thomas Aquinas's commentary, perhaps informed by Albertus's reading, nevertheless described blood that has an earthy character as having "paths, that is, pores."[60] Following the translations of Pietro Alcionio (1487–1527) and Theodore Gaza (ca. 1398–1475/76), in the *Dubitationes*, Pomponazzi contended that these fibers cause a thickening of blood, as the foamy parts are led off.[61]

In his lectures on *De partibus animalium*, given in 1523, the same year in which he lectured on the *Meteorologica*, Pomponazzi discussed in greater depth the fibers within the blood, defining them "as hairs dispersed throughout the blood" or "corpuscles of blood."[62] Blood that contains these fibers will thicken and congeal, "since the fibers are of an earthy nature."[63] By contrast, watery blood contains no fiber. The resulting temperament of animals, such as humans and bulls, which have fibrous corpuscles in the blood, is ferocious compared to that of the weak, timid deer and gazelles, whose blood lacks these fibers. In Pomponazzi's account, diverse particles can explain different characteristics in blood. The qualities of venous blood arise "from the mixing with bodies and subtle parts that are invisible and spirituous and that enter and mix with the substance of blood" and thereby provide heat and fluidity.[64] In his view, these particles are analogous to "certain corpuscles" in warm water that render it hot even as it remains water, which is, by nature, cold.[65] Consequently, venous blood, while it appears homogeneous, is really made up of a variety of parts, some subtle and fiery, others larger and earthy.[66] According to

60 The continuator's comments are found at [Ps.-] Thomas Aquinas, *Expositio*, 680–681: "quae habent vias, idest poros." For the continuator and the authorship of the commentary, see Dondaine, "Le commentaire," 81–152. For William of Moerbeke's translation, see: Aristoteles Latinus, *Meteorologica*, 10/2.2, 131: "Sanguis quidem habens inas, magis terre."

61 Pomponazzi, *Dubitationes*, 49r: "Sed ad illud de sanguine occurrit dicendum, quod textus Aristotelis de sanguine habente fibras, non dicit quod congelatur; Theodorus enim legit, inspissatur, vel ingrossatur, sic etiam Alcyonius."

62 Pomponazzi, *Expositio*, 215: "Sunt enim sicut capilli dispersi per sanguinem"; "Nam istae fibrae sunt corpuscula sanguinis." For the fibers of blood, see Perfetti, *Aristotle's Zoology*, 55–58.

63 Pomponazzi, *Expositio*, 216: "Ratio autem istius est quoniam fibrae sunt naturae terreae, ideo ingrossant et congelantur."

64 Ibid., 178: "Nam quando sanguis in venis ex admixtione corporum et partium subtilium quae sunt invisibiles et spirituosae, quae intrant et miscentur substantiae sanguinis et subiectum et substantiam sanguinis calefaciunt et frigiditatem expellunt et eum efficiunt liquefactibilem."

65 Ibid.: "Nam aqua, quantum ad id quod est aqua, est frigida; tamen quia calefit, seu quaedam corpuscula, ideo redditur calida, et recedente caliditate, remanet ipsa aqua."

66 Ibid., 204: "Talis enim massa est diversarum partium. Unde, licet talis massa videatur homogenea, tamen secundum naturam non est ita: sunt enim partes subtiles et igneae et partes grossae et terrestres."

Pomponazzi, this model can explain the qualities of many other substances, including *materia medica*. Rose, rhubarb, and coriander contain diverse particles that are indistinguishable through the senses but generate different effects on the body. Both rose and rhubarb, for example, are composed of both subtle parts that have a laxative effect, and thicker parts that constipate.[67]

Just as the motions, associations, separations, and unions of these various parts explain the qualities and transformations of mixtures, the structures of substances are crucial to their susceptibility to change. Famously and controversially, in *Meteorologica* IV, Aristotle employed pores to explain some secondary passive qualities. Pomponazzi both unreservedly adopted these pores while also questioning the degree to which the promotion of these pores is consistent with the arguments made in *De generatione et corruptione* and in *De caelo*, where Aristotle denounced Democritus' reliance on pores.[68] In *Dubitatio* XCII, Pomponazzi discussed the roles of heat and cold in solidifying and melting substances. Here, he attempted to explain how that which is solidified by heat cannot be melted by heat, and that which is solidified by cold cannot be melted by cold. Anything, therefore, that is solidified by both must be completely incapable of melting. He contended that while heat solidifies *per se*, cold can do so *per accidens*, describing the process as such. First, heat extracts moisture from the body and enlarges it, but leaves some moisture in the body's pores. Then, cold constricts the pores, rendering the body more unified and stronger. Finally, the heat can no longer dissolve the small amount of remaining moisture because the closed pores do not allow it to enter within the body. Anticipating an objection to this explanation, Pomponazzi wrote:

> But then you will say: So, Aristotle Democritizes, although in *De caelo* III and *De generatione* [*et corruptione*] I, he condemns that opinion of Democritus that action occurs through entering through pores. Indeed, Democritus posits that indivisible bodies (*corpora atoma*) enter and exit through pores. I would say that the Philosopher agrees with Democritus, since he concedes there are pores, but he disagrees, since Democritus wants it to happen through indivisibles. Aristotle, however, wants a divisible body that is cold to enter through the pores and in this manner new coldness is generated and acts more powerfully, since it can be better applied in acting on its recipient.[69]

67 Ibid.

68 Aristotle, *De generatione et corruptione*, 1.8.324b25–326b28; *De caelo*, 3.8.307b12–18.

69 Pomponazzi, *Dubitationes*, 43v–44r: "Sed tunc dicetis. Ergo Aristoteles Democrizat quum tamen tertio coeli & primo de generatione damnet hanc opinionem Democriti, quod actio fiat per introitum per poros. Posuit enim Democritus, quod corpora atoma intrent & exeant per poros. Ego dicerem, quod philosophus assentitur Democrito in hoc,

Thus, Pomponazzi deemed that Aristotle used pores to explain how active powers transform substances, while rejecting the atomistic premise of indivisibility.

Pomponazzi later expanded upon this assessment of the closeness of the doctrine of *Meteorologica* IV with Democritean views. In his explanation of what makes substances capable of being burnt, Aristotle had written that those that have long pores that run lengthwise are more susceptible to fire.[70] Here again, Pomponazzi presented the potential objection that "Aristotle Democritizes," because he describes action as taking place through pores. Pomponazzi conceded that Aristotle understands the pores as fomenting combustion, "since the fiery corpuscles enter better and are better attached."[71] Yet, Aristotle's views differ from those of Democritus only in the fact that these corpuscles are not indivisible, and that since they are of a small size they are not the principal agents of combustion but only assist in the application of the agent on the passive body.

While noting the differences between Aristotle and Democritus, Pomponazzi conceded that pores play a significant role in determining which living bodies are affected by the powers of the hot and cold. For example, human bodies that have a cold complexion withstand the cold better and do not become sick as often as those with hot complexion, because their narrow pores do not allow the cold to enter.[72] Indeed, he posited that "all animals are full of pores," and "breath" (*halitus*) enters not only through the mouth and nose, but "through pores throughout the entire body."[73] Small bits of air, entering through these pores, are the cause of bodily corruption and putrefaction. Nor should we be surprised, he contended, that even a small amount of air causes corruption, citing numerous examples from experience: even a small bit of air that enters into a bottle of wine turns it bad; spice dealers place fruit under oil to prevent air from affecting their wares; and, chestnuts and the bark of cassia putrefy

quoniam concedit poros; dissentitur vero, quoniam Democritus vult ut fiat per indivisibilia; Aristoteles autem vult ut corpus divisibile quod est frigidum, intret per poros, & ita generetur ibi nova frigiditas & plus agit, quoniam melius applicari potest in actione suo passo." On the significance of this passage, see Lüthy, "Aristotelian Watchdog," 546.

70 Aristotle, *Meteorologica*, 4.9.387a19–21.

71 Pomponazzi, *Dubitationes*, 47v: "Videtur ibidem Aristoteles Democrizare, nam incidit in questionem Democriti. Qui voluit quod actio fiat per poros. Respondeo nolle Aristotelem actionem fieri principaliter per poros; sed quod per poros fiat melior applicatio rei combustibilis; quoniam corpuscula ignea melius intrant, & melius applicantur."

72 Ibid., 46r.

73 Ibid., 15r: "Omnia animalia sunt porosa. In illis enim quae respirant, ingreditur halitus per os & nares, & etiam per poros totius corporis."

when heated, as air penetrates their pores.[74] Pores help explain the process of the aging of fruit, as mature fruit possess many pores, while the pores of unripe fruit are constricted and block air from entering.[75] Although pores may not be the principal conduit for action on passive matter, they nevertheless remained, for Pomponazzi, a useful *explanans* for a variety of transformations of matter. Instead of invoking occult powers and astral forces, in the *Dubitationes*, many marvels of the natural world like amphibians impervious to fire, as well as banalities like rotting nuts, are best explained through the ingredients or parts of mixtures, and structures, such as pores, that allow hot and cold parts to act on passive matter. The parts, powers, and pores of *Meteorologica* IV offered an alternative to the natural magic that characterized much of the *De incantationibus*.

3 Commentaries after Pomponazzi: Boccadiferro, Vimercato, and Vallés

Even though the *Dubitationes* went unpublished until well after Pomponazzi's death, it is more than possible that they had an influence through the diffusion of manuscripts or through the lectures themselves. In the following years, three commentators on *Meteorologica* IV in particular, Lodovico Boccadiferro (1482–1545), Francesco Vimercato (1512–1571), and Francisco Vallés (1524–1580), interpreted book IV in the light of medical theory, just as Pomponazzi had.[76] Furthermore, along with Nifo and Pomponazzi, these three commentators were frequently cited in later commentaries of the sixteenth and seventeenth centuries. These successors to Pomponazzi maintained his views about the persistence of elemental parts and the role of pores in facilitating corporeal alterations.

Lodovico Boccadiferro likely followed Pomponazzi's lectures in the 1510s, and later became extraordinary professor and then ordinary professor, at Bologna when Pomponazzi gave lectures there on the *Meteorologica*.[77] His own lectures, probably given in 1538, followed and expanded on Pomponazzi's views. While Pomponazzi's discussion merely suggested, without stating outright, that the substances to which Aristotle and others referred as homeomerous are in fact composed of various parts that differ from each other, Boccadiferro explicitly

74 Ibid., 15r.
75 Ibid., 31v.
76 Martin, "Francisco Vallés," 1–30.
77 Lohr, *Latin Aristotle Commentaries*, 57–65.

defended this position. In his discussion on putrefaction, he questioned how truly homeomerous mixtures could putrefy, because putrefaction requires difference. The solution, he contended, is to be found in the fact that, "there is no truly homogeneous mixture, because although they appear to sight to be homogeneous, nevertheless in truth they are not homogeneous, because they always have some difference in their parts."[78] Wood, for example, resolves into parts of earth and smoke; gold, lead, rocks, and other substances that appear to be homogeneous are not only made up of different parts but are also susceptible to putrefaction, although only over a "long interval of time."[79] Boccadiferro did not deny the existence of substantial forms. Yet, his conception of them for these seemingly homogeneous bodies is closely linked to prime qualities. For example, in his discussion of why wine turns into vinegar, he maintained that the substantial form of wine has a hot temperament, while its matter has a cold temperament. When the substantial form is corrupted, only the cold temperament of matter dominates, and the resulting vinegar is cold, corresponding to its composition that consists of more cold than hot parts.[80]

Boccadiferro's judgment about the impossibility of a truly homeomerous mixture applied to substances within living bodies, in particular to milk and blood, both liquids prone to coagulate. Their capacity to solidify derives from their earthy parts. Whey, milk's watery part, combines with a more solid part associated with cheese that provides the nutriments. Blood has earthy parts that Boccadiferro associated with the fibers that Aristotle referred to at *Meteorologica* 4.10, and that Pomponazzi had also discussed. Boccadiferro too associated these fibers with earthy parts, describing them as hairs, threads, or gristles, and he took them to account both for blood's tendency to coagulate and for the diverse thicknesses of blood among different species of animals. These fibers create blood that is hot, not in the same way as a flame ignites, but rather in its ability to affect the senses. According to Boccadiferro, heated iron affects the senses more greatly than a lit torch. Analogously, the fibers in the blood convey the heat generated by the heart. For this reason, animals that lack fibers in the blood, like the easily frightened deer referred to in *De partibus animalium*, are rendered cold, timid, and weak. For Boccadiferro, these fibers confirm that no mixtures are truly homeomerous as, despite being earthy, they act as vehicles for the heat that defines living animals.[81]

78 Boccadiferro, *Lectiones*, 50: "nullum potest dari mixtum vere homogeneum, quia licet visu videantur esse homogenea, tamen in re non sunt vere homogenea, quia semper habent aliquam differentiam in partibus eorum."

79 Ibid.: "in longo temporis spatio."

80 Ibid., 238.

81 Ibid., 180–182.

In subsequent generations, other scholars modified conceptions of the homeomerous in ways similar to Pomponazzi and Boccadiferro. Francesco Vimercato studied at Bologna, Pavia, and Padua, before moving on to Paris around the year 1540.[82] Based on his teachings at the Collège Royal, his commentary on all four books of the *Meteorologica*, first printed in 1556, distinguished between living and inanimate mixtures. The concept of a "perfect mixture" was for him relative. Metals, stones, and similar inanimate substances are composed of a "more perfect mixture" but are not "completely perfect," being called so only because they have a form distinct from the elements, even though they pale in comparison to the "most perfect" parts of plants and animals.[83] According to Vimercato's reading of *Meteorologica* IV, Aristotle did not concern himself here with the first causes, namely the soul and the heavens, but rather with the actions of the hot and the cold.[84] For Vimercato, as for Pomponazzi, heat was the primary agent that prepares new mixtures, as its power alone prepares passive bodies to be unified after breaking them down into corpuscles. He wrote that heat "divides bodies, which are mixed into the most minute parts (*in minutissimas partes*) by concocting, so that they are rendered most fit for mixture."[85]

Vimercato's distinction between animate and inanimate homeomerous parts, however, is not consistently applied. Just like his predecessors, he held that milk and blood have constitutions composed of differing parts. Blood serum has more watery parts; the caseous, or cheesy, in milk constitute the more earthy parts, in addition to there being a fatty part that corresponds to butter. He concluded, therefore, that "milk is not unified and homogeneous (*similare*)."[86] Blood is composed of both earth and watery parts, the

82 Gilbert, "Francesco Vimercato," 188–189; Del Soldato, "Francesco Vimercato's *De placitis*," 117–120.

83 Vimercato, *In quartum librum Meteorologicorum*, 2: "Perfectiori autem admixtione constant lapides & metalla, quanquam ea omnino perfecta non constent, cum metalla ex aqua una, & lapides ex terra videantur esse: quoniam tamen formam quamdam habent ab elementis diversam, perfecte mixta nuncupantur. Omnium perfectissimae animalium & stirpium sunt partes."

84 Ibid., 11: "Princeps autem causa natura est, seu anima, aut etiam coelum, quae his facultatibus, ut instrumentis, utuntur. Aristotelis hoc in loco institutum non est, causas omnes ortus atque interitus explicare, sed quae sint caloris & frigoris, humoris & siccitatis facultates & opera."

85 Ibid., 12: "Atque hoc quidem caloris solius vi fieri, qui & quae sunt eiusdem generis, alienis secretis, in unum cogit, & corpora, quae miscentur, in minutissimas partes concoquendo dividit, ita ut mixtioni aptissima reddantur."

86 Ibid., 79: "Ac primam quidem crassam esse, e qua caseus conficitur, alteram pinguem, e qua butyrum, tertiam aquam videlicet, serum. Praeterea lac non esse unum & similare."

earthy part being fibers that allow the blood to take on "an earthy, thick, and hot constitution."[87] Noting that Galen said that milk, oil, and wine are anhomeomerous – since they have some parts that are earthy and others that are watery – Vimercato suggested that all "homogeneous substances are in fact completely heterogeneous" because of the elements that remain in them.[88] The idea of a complete mixture or corruption of the elements in a new mixture is therefore untenable.

Just as Vimercato's understanding of the constitution of blood differs little from those of Pomponazzi and Boccadiferro, his discussion of pores allows for them a role in action and passion. In his discussion of why salt and niter are "breakable" (*fictile*), he rejected Olympiodorus' solution to the apparent contradiction between *Meteorologica* IV and *De generatione et corruptione* II.8 that the word *poros* merely refers to parts that are "more suitable for undergoing change."[89] Rather, Vimercato contended, the pores are conduits, and even if action does not result directly from them, "nevertheless they contribute much to the dissolution of bodies and the reception of action."[90] Instead of seeing these pores as necessary for the reception of active powers, they merely facilitate this reception. In discussing Aristotle's statement that substances with pores suitable to the acceptance of fire are capable of being burnt, Vimercato dismissed the parallel suggestions made by Democritus and Plato that the shape of fire particles – proposed respectively as round and pyramidal – was in any way a determinant of which substances will burn.[91] Yet the pores, and the diversity of parts, help explain why some substances burn. In Vimercato's view, when air or a spirit is closed within a body, the earthy parts, having a fiery potency, can change into fire when fire is present. The pores must extend straight in order to provide sufficient respiration for ignition. If the pore is

87 Ibid., 80: "Haec sanguis est constitutio, & ideo lacti persimilis … in sanguine altera pars est veluti liquor sanguinis, sero lactis proportione respondens, altera veluti lutum & faex, quae caseo respondet. Cum autem hac duplici parte constet sanguis, terreus magis est, qui fibras habet … ab his fibris terream accipit, & crassam, calidamque constitutionem."

88 Ibid., 111: "Nam quod Galenus ait, lac, oleum, vinum, dissimilaria esse, quia partem aliam terrestrem habeant, aliam aqueam…. Ac si partes terreas & aqueas dici deberent, similares profecto omnes dissimilares essent, quandoquidem ex elementis, quae diversa sunt, constant." Galen, *De elementis*, 2.2 (1:495–7K).

89 Vimercato, *In quartum librum Meteorologicorum*, 82: "quod Olympiodorus assert, meatus hoc in loco proprie non accipi, sed partes significare, quae ad patiendum magis sunt aptae." For Olympiodorus' reading of the pores, see Viano, *La matière*, 159–163.

90 Vimercato, *In quartum librum Meteorologicorum*, 82: "quanquam meatuum merito actio non fiat, ut alii fuerant opinati, multum tamen rei solutionem, & actionem accipiendam conducunt."

91 Plato, *Timaeus*, 56b; Aristotle, *De caelo*, 3.4.303a13–14; ibid., 3.7.306a26–307b5.

bent, the fire will not ignite; or, if it does, it will be quickly snuffed out.[92] For Vimercato, the constitution (*constitutio*) of substances is in part elemental, depending on the relative proportions of air or moisture that resides within the pores. Yet it is also structural, as shape, despite his protestations, helps ensure that the fire can ignite and remain lit. Moreover, these porous bodies have parts that are distinct from the rest of the body and appear to have not been fully mixed, as only the earthy parts burn.

In his translation and commentary, Vimercato used the word *constitutio* for *dioresis*, whereas William of Moerbeke rendered it as *determinatio*.[93] Renaissance medical theorists used the word *constitutio* in a manner similar to *complexio* or *temperamentum*, applying it to human bodies, the seasons, and medicaments. While Vimercato's terminology resonated with medical theory, the commentary on *Meteorologica* IV by Francisco Vallés explicitly makes the connection between the contents of that book and the temperament of natural bodies.

Even though Vallés lived his entire life in Spain, his fame was widespread, and his writings were well known among Italians. A late edition of his commentary on *Meteorologica* IV was printed in Padua in 1591, decades after its first publication in 1558. Vallés interpreted *Meteorologica* IV as a medical work, importing Galenic vocabulary to clarify Aristotle.[94] The concept of temperament was key to his understanding of the instrumental powers of the hot and cold and their action on passive matter. He wrote that both Galen and Aristotle accepted that active and passive faculties "depend on temperament."[95] Heat and cold, in turn, are not just the causes of the elements but are the faculties responsible for generation and corruption. All substances and their passive qualities arise "by the motions of heat or cold" acting on the wet and dry matter.[96]

Significantly, Vallés considered the main topic of *Meteorologica* IV to be the passive qualities of mixtures and the ways they obtain their capacity to change. Like Pomponazzi, Boccadiferro, and Vimercato, Vallés undermined the notion of homeomerity. He contended that "a given thing (*res*), however

92 Vimercato, *In quartum librum Meteorologicorum*, 102.

93 Aristoteles Latinus, *Meteorologica*, 10/2.2, 105.

94 Martin, "Francisco Vallés," 1–30. For Vallés and the Spanish context of Renaissance debates about matter and form, see Navarro-Brotons, "Matter and Form," 99–116.

95 Vallés, *In quartum Meteorologicorum*, 6r: "Illud unum evidenter se scire Gal. profitetur, quod ex Arist. accipiendum est, facultates tam agendi quam patiendi ex temperamento pendere."

96 Ibid.: "Itaque ortus, aut corruptiones rerum naturales (ut aliae omnes mixtorum passiones, de quibus loquuturi sumus) fiunt calore & frigore moventibus, aut illorum altero; humido & sicco motis; […]."

much it appears simple to the senses, consists of diverse particles, some fiery, some watery, some airy, and some earthy."[97] Using this framework, Vallés contended that putrefaction occurs when the parts that are naturally hot become cold, or those that are naturally cold become hot, leading to the dissolution of the substance. Vallés maintained that the secondary passive qualities, such as friability, fusibility, density, and color, arose out of what he called a "mode of substance" (*modus substantiae*), a concept he traced to Galen.

What Vallés meant by the term "mode of substance" is not readily evident as there was something circular in his definition: "Galen, by the name modes of substance, was accustomed to understanding and accustomed to calling accidents that derive from the mode of substance."[98] The term, however, has a long tradition of usage, in both logical and medical writings. Pietro d'Abano (ca. 1250–1317) appropriated the term from scholastic dialectical discourse, and applied it to complexion, so that it meant a disposition that was inseparable from a substance, without being its essence or substantial form.[99] Vallés' contemporary, Giambattista Da Monte (1498–1551), defined "modes of substance" as natural passive powers, listing the tactile qualities of subtleness, thickness, softness, hardness, smoothness, and roughness.[100] Vallés appeared to adopt both Pietro's definition and that of Da Monte, meaning that these tactile qualities (*modi substantiae*) derive from a singular mode that is similar to complexion or temperament. The mode of substance derives from the proportion of earth and water in the body, and their respective dryness and wetness, that provides the corporeal nature or structure (*corporatura*).[101] The pores as described in *Meteorologica* IV, and the part they play in the corporeal structure, help explain Vallés' modes of substance. Density and rarity respectively result from large or narrow pores.[102] Moreover, bodies made of earth and water "do not become completely compact *per se* but are full of invisible pores."[103] Vallés' pores are not voids, but rather contain subtle matter that allows particles to enter into substances, affecting and transforming them.[104] Vallés was by no

97 Ibid., 14r: "Scire licet … rem quamcunque, quantumvis sensui appareat simplex, constare ex particulis diversis, aliis igneis, aliis aqueis, aeris aliis, ac aliis terreis."

98 Ibid., 34v: "Galenus nomine modi substantiae solet intelligere, soletque appellare accidentia, quae consequuntur modum substantiae."

99 Chandelier, "Nature humaine," 483–484; Klemm, "Medical Perspective," 292–295.

100 Da Monte, *In primam fen*, 174r–v.

101 Vallés, *In quartum Meteorologicorum*, 34v–35r; see also his discussion of modes of substance in relation to temperaments in idem, *Controversiae*, 371–375. For Vallés and modes of substance, see Blank, "Reductionism," 166–168.

102 Vallés, *In quartum Meteorologicorum*, 42r.

103 Ibid., 55r: "Verum haec non fiunt per se tota compacta, sed plena ocultis [sic] poris."

104 Ibid., 57r–v; 58v; 62v.

means an atomist, but his account of *Meteorologica* IV indicated a corporeal structure resulting from the mode of substance and attributed to the presence of hidden particles and pores a significant role in explaining the characteristics of bodies, which he viewed to be made up of diverse, invisible particles.

4 The Medical Tradition

Vallés' commentary was explicitly concerned with medicine, but even those of his Italian contemporaries who taught philosophy, were well aware of *Meteorologica* IV's relation to medicine. During the same years, a number of medical theorists showed themselves to be similarly concerned with passive qualities and the transformations of substances. Avicenna's *Canon*, due to its prominence in the medical curriculum, played an important role in shaping conceptions of elements, mixtures, and complexions. Avicenna's view, as transmitted in the twelfth-century Latin translation by Gerard of Cremona, emphasized that the elements are "the parts of the human body and of others, which can in no way be divided into bodies of different forms."[105] Similarly, his definition of complexion maintained that it arises when "parts [of the elements] are reduced into such small size" that there can be a great degree of contact between them.[106] Late-medieval commentators on the *Canon*, well known to sixteenth-century commentators on *Meteorologica* IV, considered these Avicennian definitions in reference to *minima*. For example, Jacobo da Forlì (ca. 1360–1414) defined mixture as "substantial transformation entailing such a division to *minima*."[107] Like Jacobo, the Sienese physician Ugo Benzi (ca. 1360–1439) adopted the Avicennian position that elements remain intact in mixture. He argued that, if this were not the case, there was no possibility of the occurrence of burning – defined by him as the separation of the thick parts from the subtle ones by the power of heat.[108] A century later, Giambattista Da Monte, a former student of Pomponazzi and professor of medicine at

105 Avicenna, *Canon*, 1.1.2.1, 7v: "Elementa sunt corpora et sunt partes primae corporis humani et aliorum quae in corpora diversarum formarum dividi minime possunt"; Siraisi, *Avicenna*, 242. For the *fortuna* of Gerard's translation in the Renaissance, see Hasse, *Success*, 96–133.

106 Avicenna, *Canon*, 1.1.3.1, 8r: "Complexio est qualitas, quae ex actione ad invicem & passione contrariarum qualitatum in elementis inventarum, quorum partes ad tantam parvitatem redactae sunt, ut cuiusque earum plurimum contingat plurimum alterius provenit."

107 Jacobo da Forlì, *In primum Canonem*, 9v: "Mixtio enim importare videtur substantialem transmutationem connotando divisionem talem ad minima."

108 Ugo Benzi, *In primam fen*, 5r: "cum adustio fit vi caloris subtilis a grosso separatio ita ut subtile sublimetur et grossus descendat."

Padua who frequently cited *Meteorologica* IV, felt it necessary to distinguish Avicenna's definition of elements – as first parts of the body – from the atoms of Democritus and Leucippus, by arguing that indivisible atoms do not contribute to a true alteration of substance.[109] While Da Monte sided against Democritus, he nevertheless considered Avicenna's *minima* to be bodies, describing the formation of mixtures through the division of the ingredients into very small parts that allow for the maximum degree of contact.[110]

The views of Santorio Santorio (1561–1636) emerged from the context of medical and philosophical readings of Aristotle's *Meteorologica* IV, reconciling it with medical conceptions of temperament and elements as found in the *Canon*, while undermining the distinctions between mixture and juxtaposition, and the concept of homeomerity. Santorio's acceptance that corporeal structure underlies all other categories of passive properties, as presented in the 1603 *Methodus vitandorum errorum*, is based on his interpretation of Aristotle's *Physics*. In reference to a passage in *Physics* VIII.7, which he admits that many interpreters have seen as a presentation of the views of others, Santorio contended that Aristotle endorsed the idea that "density and rarity are the principles of all passive qualities," such as heaviness, hardness, heat, and their opposites.[111] Santorio wrote that "if Aristotle is to be believed," rarity and density are prior to the other qualities, including heat and cold, because "just as homeomerous parts in varied ways are arranged because of the alteration of the position and motion of the parts, varied potentials for being cooled or heated arise."[112]

Santorio's evocations of pores that enable the possibility of matter undergoing alteration have no foundation in the text of *Physics* but resonate with sixteenth-century interpretations of *Meteorologica* IV. He knew this tradition, as is evident from his citations of Pomponazzi's *Dubitationes* in his commentaries on Galen and Avicenna.[113] Santorio's use of corpuscular theory emerged

109 Da Monte, *In primam fen*, 24v.

110 Ibid., 56r–57r.

111 Aristotle, *Physics*, 8.7.260b7–15. For a list of scholars who, unlike Santorio, interpreted this passage, not as Aristotle's own view, but as Aristotle's presentation of his opponent's view that density and rarity explain all passive qualities, see Blyth, *Aristotle's Ever-Turning World*, 205–206. Blyth notes that, in contrast to most interpreters, Simplicius – like Santorio – understood the passage to be Aristotle's view.

112 Santorio, *Methodus*, 157v–r.: "licet iis omnibus antecellant raritates, & densitates, quae si Aristoteli credendum est, sunt principia omnium passionum; nam pro ut similares partes vario modo figurantur ob mutationem situs, & meatus partium, variae consurgunt potentiae refrigerandi, vel calefaciendi." For a corpuscularian reading of this passage, see Bigotti, "A Previously Unknown," 29–42.

113 Santorio, *In artem medicinalem*, 109; idem, *In primam fen*, col. 171–172.

not just out of a medical context accustomed to investigating the role of small particles in contagion, as Fracastoro did, but also in a setting in which textual philosophical investigations mixed with theoretical analyses of temperament. In this context, Aristotelians were willing to confront apparent discrepancies in Aristotle's presentations of matter theory by contemplating, as had Pomponazzi, that at times, perhaps "Aristotle Democritizes."

5 Conclusion

By the middle of the seventeenth century, *Meteorologica* IV was regarded by commentators as an authoritative text for a corpuscular theory pertinent to medicine. Niccolò Cabeo, for example, a Jesuit scholar who used his commentary on the *Meteorologica* to reconcile Aristotelianism with corpuscular matter theory and alchemy, also considered the relevance of the work to medicine. He maintained that the pores that Aristotle used to explain secondary passive qualities should not be thought of as small rooms (*camerae*) of air, as some think, but rather as variations within the corporeal substance due to its being composed of qualitatively different particles. Echoing sixteenth-century commentators, from Boccadiferro to Vallés, he wrote that "bodies, however homogeneous they seem to the senses, are not truly homogeneous, and they are not of the same nature (*ratio*) with respect to the whole substance but consist of harder particles and some softer ones."[114] Thus, so-called pores are particles that are affected more easily or differently from the harder particles. Cabeo employed these pores, as well as his conviction that bodily fluids and airs are not truly homogeneous, to explain diseases. He maintained that these fluids and airs are composed of different kinds of ingredients, some of which he defined as spirits, which have active (*activae*) and animated (*vividae*) parts. Putrefaction occurs when a confluence of active spirits enclosed within the body are unable to escape. Their motion agitates body parts, creating an internal war. He applied this explanation to the etiology of putrid fevers, holding that such fevers result in the depths of winter when extreme cold blocks the skin's pores and the active spirits are unable to flow out of the body.[115]

While Cabeo used the *Meteorologica* to reframe Aristotelianism as an experimental and alchemical natural philosophy and to give insight into issues related

114 Cabeo, *Commentaria*, 4:372: "Sed solum dico corpora, quantumvis ad sensum sint homogenea, non esse vere homogenea, nec in tota substantia eiusdem rationis, sed constare ex particulis durioribus, & ex aliis tenerioribus."

115 Ibid., 4:93.

to medicine, others saw Aristotle's use of particles and pores to explain the characteristics and transformations of organic tissues in *Meteorologica* IV as a key to understanding the development of, and changes within, the Aristotelian corpus. The Italian polymath and polemicist Scipione Chiaramonti (1565–1652) – author on a variety of topics including an investigation into melancholy, a local history of Cesena, a treatise on forms of government, and attacks on Tycho Brahe – offered in his commentary on *Meteorologica* IV, printed posthumously in 1654, a potential solution to the objection that Aristotle's employment of pores and particles in that book contradicted his dismissals of similar explanations in *De generatione et corruptione*. He cited, without endorsement, the argument of unnamed scholars who believed that since Aristotle's views had changed or had even progressed over time, *Meteorologica* IV must reflect the historical development of his thought. Furthermore, some of the solutions presented in Aristotle's works should not be understood as absolute; nor should there be any expectation of finding universal consistency in the Aristotelian corpus.[116]

Chiaramonti's comments resonate with modern debates over the possible spuriousness of *Meteorologica* IV. But his attempts to remove any doubts about the work's origins reveal also the thoughts of some of his contemporaries and immediate predecessors. Indeed, Joachim Jungius (1587–1657) in 1642 endorsed the first of Chiaramonti's proposed solutions, maintaining that *Meteorologica* IV promoted a syndiacritical natural philosophy, which could be reconciled with Paracelsian alchemy and opposed Aristotle's earlier polemics against Democritus and Empedocles. For Jungius, a champion of induction who promoted a natural philosophy based on experimentation, the pores and particles of *Meteorologica* IV represent the real, mature thought of Aristotle. The attacks in the *De caelo* and *De generatione et corruptione* were to be considered either as dialectical exercises set down for the sake of his students, or as arguments that were outright corrected in his later works.[117]

The views of both Chiaramonti and Jungius were informed not just by their investigations into nature but also by their deep knowledge of the sixteenth-century commentary tradition on *Meteorologica* IV. Indeed, Chiaramonti's comment on the possibility of explaining the pores through

116 Chiaramonti, *In quartum metheorum*, 315: "Praeterea obijcit rationi ex pororum angustia adductae, repugnat enim illis, quae Democrito obijcit in primo de Generatione. Aliqui forsan sese extricabunt respondendo progressum Aristotelis hunc, & alios etiam nonnullos esse probabiles unde non mirum si ab integra universitate excedant."

117 Jungius, *Disputationes*, 389; Newman, "Experimental Corpuscular Theory," 327–328; for Jungius's methodology, see Clucas, "*Scientia*," 53–70.

speculations on the development over time of Aristotle's thought, is in response to Pietro Pomponazzi's depiction of passages of *Meteorologica* IV as inconsistent with other books of Aristotle's natural philosophy. In addition to Pomponazzi's commentary, Chiaramonti frequently cited the commentaries of Vallés and Vimercato. Jungius, in turn, had studied in Padua with the philosopher Cesare Cremonini (1550–1631) and the physician Santorio Santorio; he engaged deeply with the writings of Jacopo Zabarella (1533–1589); and his library contained commentaries on *Meteorologica* IV by Vimercato, Zabarella, and the Coimbrans.[118] The *natio germanica* at Padua added Pomponazzi's commentary to its library in 1598 and again in 1611; Vallés' commentary was donated to them in 1603.[119] Jungius gave examples from book IV to show that Aristotle's *onkoi* and pores could, in his view, be considered as evidence of a profession, if not of atomism, then at least of corpuscularism.[120] Moreover, he maintained that the syndiacritical philosophy undermines Aristotle's earlier account of truly homogeneous substances, because simple bodies are said in *Meteorologica* IV to be composed of a variety of particulate components. Specifically, Aristotle's account of milk and blood demonstrates that he believed simple natural substances made in the human body were not truly homeomerous – a view shared by Jungius's teacher Cremonini.[121] For Cremonini, milk is composed of watery, earthy, and fatty particles, which are visible respectively in whey, cheese, and butter. According to Jungius, blood contains watery serum in addition to fibers, revealing that in Aristotle's teaching, blood contains what Jungius called "hypostatical parts."[122]

Jungius's view of the syndiacritical character of *Meteorologica* IV ties in with the traditions of alchemical atomism of the late Renaissance, exemplified

118 Di Liscia, "*Operosum negotium*," 215–255; Meinel, *Die Bibliothek*, 117, 192, 195.

119 Favaro, ed., *Atti della nazione germanica*, 2:131, 2:206, 2:332.

120 Jungius, *Disputationes*, 393: "Quid multa? Cap. 8 adeo aperte in castra syndiacritorum transit, ut etiam vocabulo *ipsis* proprio utatur, dum 'ea, quae humoris absentia concrevere, ab humore liquefieri' scribit, 'nisi ita coierint … ut meatus molibus,' hoc est particulis sive corpusculis, 'aquae minores sint relicti.'" His reference is to Aristotle, *Meteorologica*, 4.8.385a29–30.

121 Cremonini, *Lectiones*, 762: "lac est quasi corpus etherogeneum habens partes crassiores, et terrestres, ex quibus fit caseus, et alias fluividas, ex quibus est serum"; Cremonini, *Lectiones*, 768: "Respondo similiter, quod lac est corpus quasi eterogeneum; habet enim diversas partes, caseum qui habet multum terrenae portionis, et serum quod est propemodum acqua [sic]."

122 Jungius, *Disputationes*, 391: "Porro lib. IV Meteor. Cap. 7 'in sanguine tum ichora sive serum tum fibras' ut hypostaticas scilicet partes 'contineri' docet."

by Andreas Libavius (ca. 1555–1616) and Daniel Sennert.[123] Yet, his examples point to a second arena for the emergence of Aristotelian corpuscularism, namely the intersection of natural philosophy and medicine. From the time of Pomponazzi, sixteenth-century commentaries on *Meteorologica* IV raised doubts about the homogeneity of organic fluids, understood pores to be conduits for small parts that act upon passive matter, endorsed corporeal structure as an explanation for passive qualities, and even saw Aristotle as embracing Democritean frameworks.[124]

123 Newman, *Atoms*, 66–83.

124 Lüthy, "Aristotelian Watchdog," 542–561.