

2. Aristotelian Meteorology in Renaissance Technical Literature

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1. Introduction

A comprehensive definition of medieval and Renaissance Aristotelianism has been notoriously difficult to pin down. The difficulty in part stems from the indeterminate nature of Aristotle's writings, which contain numerous ambiguities, difficulties, and unresolved questions in their thousands of pages that address a multitude of subjects, and in part from the varied applications and even transformations of his thought. Early Modern Aristotelians, like their medieval predecessors, at times contradicted or openly disagreed with Aristotle or attempted to build new philosophical constructions on the frameworks found in his works. For example, within the settings of medieval and Renaissance universities, Aristotle's natural philosophy formed the conceptual basis for a range of fields that his writings did not consider in depth. A salient example is medicine, which is addressed in depth only in the *Problemata*, whose authorship is questionable, yet Aristotelian logic, physics, and psychology helped defined many aspects of medieval and Renaissance medi-

cine¹. Moreover, fields such as alchemy, Christian theology, and judicial astrology, that he could not have actively contributed to because of their non-existence or undeveloped status during his life, borrowed and depended on Aristotelian concepts, leading to a broadening of the category of Aristotelianism far beyond what a conservative reading of the corpus could attribute to his philosophy².

Equally troubling for defining a clear boundary to Aristotelianism is the synthetic and eclectic approaches to his thought. The synthesis of Plato and Aristotle began in late antiquity and was consolidated among Arabic philosophers such as Avicenna³. The relation between and possible reconciliation of the two philosophers remained a subject of debate and controversy during

¹ C. SCHMITT, *Aristotle among the Physicians*, in *The Medical Renaissance of the Sixteenth Century*, a cura di A. WEAR, R. K. FRENCH E I. M. LONIE, Cambridge University Press, Cambridge 1985, pp. 1-15; I. MACLEAN, *Logic, Signs and Nature*, Cambridge University Press, Cambridge 2002; C. MARTIN, *Francisco Vallés and the Renaissance Reinterpretation of Aristotle's Meteorologica IV as a Medical Text*, «Early Science and Medicine», 7 (2002), pp. 1-30; C. MARTIN, *Lodovico Settala's Aristotelian Problemata Commentary and Late-Renaissance Hippocratic Medicine*, in *Early Modern Medicine and Natural Philosophy*, a cura di P. DISTELZWEIG, B. GOLDBERG E E. RAGLAND, Springer, Dordrecht 2016, pp. 19-42.

² For alchemy, see W. NEWMAN, *Atoms and Alchemy: Chymistry and the Experimental Origins of the Scientific Revolution*, University of Chicago Press, Chicago 2006, pp. 1-152. For astrology, see H.D. RUTKIN, *Astrology*, in *The Cambridge History of Science. Volume 3: Early Modern Science*, a cura di L. DASTON E K. PARK, Cambridge University Press, Cambridge 2006, pp. 541-561: 542-547. For Christianity and Aristotelianism, see C. MARTIN, *Subverting Aristotle: Religion, History, and Philosophy in Early Modern Science*, Johns Hopkins University Press, Baltimore 2014; E. GRANT E C. MARTIN, *Aristotle and Aristotelianism*, in *Science and Religion: A Historical Introduction*, 2nd ed., a cura di G. FERNGREN, Johns Hopkins University Press, Baltimore 2017, pp. 23-36.

³ P. HADOT, *The Harmony of Plotinus and Aristotle according to Porphyry*, in *Aristotle Transformed: The Ancient Commentators and their Influence*, a cura di R. SORABJI, Cornell University Press, Ithaca 1990, pp. 125-140; R. WISNOWSKY, *Avicenna and the Avicennian Tradition*, in *The Cambridge Companion to Arabic Philosophy*, a cura di P. ADAMSON E R. TAYLOR, Cambridge University Press, Cambridge 2005, pp. 92-136: 97-98.

the fifteenth and sixteenth centuries. The approach of some of the most famous Aristotelians of Renaissance universities was openly eclectic. Pietro Pomponazzi's *De incantationibus*, for example, cites positively the fact that many interpreters hold that Plato and Aristotle were likely in agreement about philosophical truth, amidst a panoply of citations of thinkers not usually associated with Peripateticism, such as Cicero, Augustine, Plutarch, Ficino, among others, and he defends seemingly Stoic views about determinism and moral virtue in *De immortalitate animae* and *De fato*⁴.

The success of Aristotle within the culture of universities spread expansively during the late Middle Ages and early Renaissance. By the beginning of the sixteenth century, vernacular translations, handbooks, and commentaries brought Aristotelian thought to a wide reading audience that deepened its understanding of philosophical principles and gained insight into some of the most heated philosophical controversies of the time, such as those regarding the fate of the human soul after death. Both outside and within universities Aristotle's *Meteorology* appealed in part for perceived usefulness in practical subjects. Commentaries in the work, both those written in the vernacular and those written in Latin, explicitly point to potential pragmatic applications of the subject matter.

2. The Commentary Tradition

The question of usefulness or utility of a given authoritative writing was standard in the introductory material of commentaries, as part of the *accessus ad auctores*. The *accessus ad auctores* were a group of formulaic questions that commentators derived

⁴ P. POMPONAZZI, *De naturalium effectuum causis sive De incantationibus*, Gratarolo, Basel 1556, p. 218. For Pomponazzi's recourse to Stoicism see J. KRAYE, *The Philosophy of the Italian Renaissance*, in *The Routledge Handbook of the Stoic Tradition*, a cura di J. SELLARS, Routledge, London 2016, pp. 133-144: 140-142.

from pre-existing interpretative techniques applied to religious and medical works. Before commenting on a text the commentator typically tried to determine the book's authorship, title, authenticity, order within the corpus, scope, and utility. These preliminary questions became standard introductory fare for Aristotelian commentaries in the sixth century A. D. and remained prevalent through the first half of the seventeenth century. Its roots came from exegetical approaches to a wide range of texts, not only philosophical but biblical as well.⁵ Following this tradition, commentaries on the *Meteorology* routinely addressed this question of its usefulness.

The usefulness of meteorology for many commentators on Aristotle depended on its applicability to practical and manual disciplines. For example, in his Latin commentary on the *Meteorology* first printed in 1523, Agostino Nifo, after explaining the nobility of meteorology, pointed to the subject's usefulness for deciding which regions are best suited for building cities based on their wetness or dryness and the likeliness of their succumbing to earthquakes. Similarly, he wrote that meteorology potentially assists agriculture, by providing knowledge of weather signs. Above all it is useful, in his view, to medicine by providing knowledge of airs and waters, which played a significant part in two of the Galenic six non-naturals⁶. Three decades after the first printing of Nifo's commentary, Francesco Vimercato, in his Latin commentary, added to Nifo's list, pointing to the arts of astrology, medicine, navigation, agriculture, economics, and even moral philosophy, which is bolstered by the consideration of the impermanence of mountains, rivers, seas, and populous cities and the consequent reflection on the fleeting nature of human life in general⁷.

⁵ J. MANSFELD, *Prolegomena: Questions to be Settled before the Study of an Author, or a Text* Brill, Leiden 1994, pp. 10-57. E.A. QUAIN, *The Medieval Accessus ad auctores*. «Traditio», 3 (1945), pp. 228-242.

⁶ A. NIFO, *In libris Aristotelis Meteorologicis commentaria*, Scoto, Venice 1540, fol. 2r.

⁷ F. VIMERCATO, *In quatuor libros Aristotelis Meteorologicorum commentarii*, Scoto, Venice, 1565, pp. 4.

Many vernacular treatments of Aristotle's *Meteorology* followed their Latin predecessors in listing the various uses of the work in their prefaces. Such a correspondence is not surprising for authors such as Francesco de' Vieri and Nicolò Vito di Gozze, who worked in universities and wrote in Latin as well as the vernacular. Indeed, the subject matter and the sophistication of their commentaries differ little from commentaries based on lectures given to university students. Thus, Gozze's *Discorsi sopra le Metheore d'Aristotele*, printed in 1584, repeats Nifo's list in what seems to be nearly a verbatim translation⁸. In his vernacular commentary on the *Meteorology*, first printed in 1573, de' Vieri, while noting the subject's usefulness for physicians, emphasized the civic and economic contributions of the field. There was a lengthy precedent for noting the connections between commercial activity and knowledge of the weather among the Tuscan mercantile class. As early as the beginning of the 1400s, a Florentine merchant recommended reading the vernacular paraphrase of Aristotle's *Meteorology* that circulated at that time as a means to render sea voyages more secure⁹. With a similar concern for family wealth, de' Vieri emphasized that the knowledge found in these three books of Aristotle can help the *paterfamilias* predict times of abundance and lack of grain, oil, and wine, allowing them to time markets, «così possono arricchire presto»¹⁰. Meteorology's utility, however, potentially extends beyond personal enrichment. Meteorology has a civic value in improving maritime activities that provide cities with commerce and protect them, or expand their power, through war¹¹.

⁸ N. GOZZE, *Discorsi sopra le Metheore d'Aristotele, ridotti in dialogo e divisi in quattro giornate*, Ziletti, Venice 1584, fol. 5v.

⁹ E. REFINI «Aristotile in parlare materno»: *Vernacular Readings of the Ethics in the Quattrocento*, «I Tatti Studies in the Italian Renaissance», 16 (2013), pp. 311-41: 316.

¹⁰ F. DE' VIERI, *Trattato delle meteore*, Marescotti, Florence 1573, fol. 4r. For this passage see M. SGARBI, *Aristotle and the People: Vernacular Philosophy in Renaissance Italy*, «Renaissance and Reform/Renaissance et Réforme», 39 (2016), pp. 59-109: 82-83.

¹¹ DE' VIERI, *Trattato*, fol. 4v.

These commentaries on the *Meteorology*, both in the vernacular or in Latin, point at these applications but for the most part do not detail the ways in which merchants, heads of households, architects, or generals can leverage this material for their advantage. In order to gain an understanding of the application of the book to these practices, we must look beyond the works that are explicitly Aristotelian and focus upon the technical writings that integrated natural philosophical insights with practical know-how. Technical literature was at the forefront of the process of vernacularization of knowledge since the late Middle Ages¹². During the sixteenth century, the production and consumption of technical writings, as well as a number of technical practices, functioned in what Pamela O. Long has described as a trading zone in which artisanal skills were refined and developed in light of humanist culture, which in turn was affected by the broadening desire to acquire practical expertise¹³. Thus, in a manner not unlike that of Renaissance Aristotelianism, authors adhering to this Vitruvian tradition that Long details, such as Leon Battista Alberti, mixed elite and more popular strata and wrote in both Latin and the vernacular. Authors of technical treatises combined philology, textual criticism, with their own experiences and observations as they mined natural philosophical texts and classical writings for relevant material. The result was often more eclectic than that found in the canonical texts of Renaissance Aristotelianism. Yet, despite the growing number of readers of Lucretius, Plato, Pliny, and Seneca, Aristotle still had no strong rival for his comprehensive account of the natural world. As a result, Aristotle's ideas dot these works as his authority entered into even more fields – architecture, navigation, military science, and mining – about which his writings were largely silent. Some authors who integrated their understanding of Aristotle's *Meteorology*

¹² W. CROSSGROVE, *The Vernacularization of Science, Medicine, and Technology in Late Medieval Europe: Broadening our Perspectives*, «Early Science and Medicine», 5 (2000), pp. 47-63.

¹³ P. LONG, *Artisan/Practitioners and the Rise of the New Sciences, 1400-1600*, Oregon State University Press, Corvallis, OR 2011.

into their technical accounts were the same ones who engaged with the pseudo-Aristotelian *Mechanical Problems* in vernacular writings geared toward engineers, architects, and military men. For example, Niccolò Tartaglia wrote that his consideration of weather signs was based in part on what he read in the *Meteorology*, as well as what he took from Nifo – presumably, from his *De verissimis signis temporum commentariolus*¹⁴. Tartaglia's treatment of these weather signs, advertised on the title page as «useful and no less necessary to mariners», are found printed together in his *La trāvagliata inventione*, which contains instructions on raising sunken ships using Archimedean techniques.

3. Technical Literature and Translation

Like Renaissance Aristotelianism, technical writings thrived by using translations of both medieval and ancient works. Moreover, translations of these technical writings from other vernacular languages into Italian were common. The Italian Renaissance literary market place was elastic both with respect to geography and chronology. For example, in the field of agriculture, one of the most influential texts available in Italian were translations, reprinted over twenty times, of Pietro de' Crescenzi's *Opus ruralium commodorum*, which was composed in the first years of the fourteenth century, and printed in Latin first, in 1471, and not longer after in the Italian vernacular. The work appealed to the learned pretensions of members of the newly established aristocracy of the sixteenth century that hoped to dignify rustic life with erudite considerations of farming and the countryside¹⁵.

¹⁴ N. TARTAGLIA, *Trattato, di segni delle mutationi dell'aria, ouer di tel[m]pi materia no[n] men utile, che necessaria, a nauiganti, & altri*, Bascarini, Venice 1551, sig. d4r; A. NIFO, *De verissimis temporum signis commentariolus*, Scoto, Venice 1540; M. SGARBI, *Aristotele per artigiani, ingegneri e architetti* in «Philosophical Readings», 8 (2016), pp. 67-78: 69-74.

¹⁵ G. E. FUSSELL, *The Classical Tradition in West European Farming*, Farleigh Dickinson University Press, Rutherford, NJ 1972, p. 99. For Crescenzi's im-

Pietro's discourse fulfilled Nifo's and others' expectations about the utility of meteorology for determining ideal terrains for construction, as he addressed the question of how to choose the best places for building houses and courtyards, based on an understanding of the effects of the winds, waters, and altitude. At times, the advice is overwhelmingly practical yet it still reflects the author's training in logic and the natural sciences, which he claimed to have studied at Bologna. Accordingly, his advice on choosing the best places for building is bolstered with the authorities of Albertus Magnus and Avicenna, who in effect, transmit Aristotle's thought, and in the case of Avicenna, integrate it with medical theory, as they are authorities for the dangers of vapors in causing putrefaction in living beings, including plants, and for the risks of excessively cold and hot air on human health¹⁶.

Vernacular translations of technical literature, however, were not only from Latin or of older works but include contemporary works translated from other European languages. A relevant example is the *Art of Navigation* written by the Spanish cosmographer Pedro de Medina and published in Venice by Giambattista Pedrezano in the Italian vernacular in 1555. Pedrezano by this time was experienced in producing vernacular translations related to cosmography. Eight years earlier, he printed a vernacular edition of Ptolemy's *Geography* translated by Pier Andrea Mattioli. In the dedication to *Art of Navigation*, Vincenzo Paletino explained the usefulness of this treatise¹⁷. The obvious benefit

portance in early modern Italy see: E. CASALI, *Le spie del cielo: Oroscopi, lunari e almanacchi nell'Italia moderna*, Einaudi, Torino 2003, pp. 122-24.

¹⁶ P. DE' CRESCENZI, *Opus ruralium commodorum*, Husner, Strasbourg, 1486, sig. a1r; P. DE' CRESCENZI, *De agricultura volgare*, [s.n.], Venice 1511, fol. 3r-v. For an analysis of the translation of this work see F. CAPPACCIONI, *Infiniti ingegni da' più non saputi: la prima traduzione italiana dei Ruralia Commoda di Pietro de' Crescenzi (Libro X)*, in *Science Translated: Latin and Vernacular Translations of Scientific Treatises in Medieval Europe*, a cura di M. GOYENS, P. DE LEEEMANS e A. SMETS, Leuven University Press, Leuven 2008, pp. 361-375.

¹⁷ For Pedrezano's publishing activities, see: C. L. C. E. WITCOMBE, *Copyright in the Renaissance: Prints and the Privilege in Sixteenth-Century Venice and Rome*, Brill, Leiden 2011, p. 247.

of defending the republic was wedded to an encomium to the art of navigation¹⁸. Unlike all other crafts, which imitate nature, navigation makes nature «obey human ingenuity», allowing humans to nearly transform themselves from a «terrestrial animal to an aquatic one, and even in a certain sense become of the air (*aereo*)»¹⁹. Paletino, who hailed from the Dalmatian island of Curzola and, by his own description, was experienced in naval matters, wrote that he translated this book because many of his friends who had been too busy with philosophy and theology had requested to learn more about this difficult art.

If indeed Paletino's philosophically trained friends read Medina's navigational treatise they would have been likely comforted by familiar concepts from their studies of cosmology and natural philosophy. Medina's work had been written in a period of struggle between Spanish pilots and cosmographers. Cosmographers such as Medina and Martín Cortés attempted to establish the principles of navigation on mathematics, while pilots sought to retain traditional methods of navigation²⁰. Accordingly, Medina's work contained not only astronomical tables useful for calculating latitude, but also a discussion of cosmology similar to what is found in Sacrobosco's *Sphere* or in more recent mathematically based cosmographies, such as Peter Apian's. These discussions distinguished this work from the almost entirely descriptive guides to navigation that had been available to Venetians, most notably Alvise Ca' da Mosto's 1490 manual²¹.

¹⁸ P. DE MEDINA, *L'arte del navigar*, Pedrezano, Venice 1555, sig. a iii v.

¹⁹ Ivi, sig. a iii r: «& quasi di animal terrestre farsi aquatico, anzi per un certo modo diventare aereo, ... percioche essendo fatte le altre arti à imitation della natura, questa sola li fa violenza, & la sforza ubbidire all'ingegno humano».

²⁰ M. PORTUONDA, *Secret Science: Spanish Cosmography and the New World*, University of Chicago Press, Chicago 2009, 52-54; A. SANDMAN, *Mirroring the World: Sea Charts, Navigation, and Territorial Claims in Sixteenth-Century Spain*, in *Merchants and Marvels: Commerce, Science, and Art in Early Modern Europe*, a cura di P. FINDLEN e P. SMITH, Routledge, New York 2002, pp. 83-108.

²¹ A. CA' DA MOSTO, *Questa e una opera necessaria a tutti li naviga[n]ti*, Rizo, Venice 1490.

Similarly, Medina's discussion of winds, a topic standard to navigational and cosmographical treatises as well as to Aristotelian commentaries on the *Meteorology*, corresponds to discussions found in natural philosophical works. He cited two medieval authors, Albertus Magnus, whose *Meteora* was frequently used as a guide to meteorology during the Renaissance, and Al-Ghazali, the author of, among many other works, a compendium, titled in Latin *Logica et philosophia*, printed in 1506, which briefly gives an account of winds and other weather phenomena. Medina's treatise reveals a bookish knowledge of the subject, as he begins by stating that determining the «nature of winds is very difficult», and that there is a diversity of opinions about the material and efficient causes of the wind²². As regard to the material cause, Medina noted that «some say it is air, others that it is water, others that it is a vapor from the earth»²³. This disagreement on the matter of wind was a prominent characteristic of scholastic quarrels and Renaissance polemic on meteorology as scholars weighed Aristotle's assertion that the wind is not moving air with the positions of Seneca and others who argued the contrary.

4. Architecture and Meteorology

The question of winds, a central subject of Aristotle's *Meteorology*, was not only prominent in navigational works but formed a growing concern of architectural authors who wrote about the topic in relation to the construction of healthy homes and cities. Their starting point was Vitruvius, who not only instructed on building and architectural style but also put forth a physical explanation of the wind. Vitruvius's *De architectura* circulated in numerous manuscripts during the Middle Ages²⁴. His read-

²² MEDINA, *L'arte del navigar*, fol. 26v.

²³ Ibid.

²⁴ C.H. KRINSKY, *Seventy-eight Vitruvius Manuscripts*, «Journal of the Warburg and Courtauld Institutes», 30 (1967), pp. 36-70.

ings gained wider currency during the fifteenth and sixteenth centuries when they were translated into German, Italian, and French, printed in numerous editions, and became a model for architectural treatises²⁵.

Renaissance architects' reading of Vitruvius was partially colored by Hippocratism, Aristotelianism, and considerations of experience. The authors of architectural treatises saw Vitruvius as a potential solution to contemporary problems of public health and epidemic disease²⁶. For example, Daniele Barbaro, who wrote three commentaries on Vitruvius in both Italian and Latin, added his own example of recent history to reinforce Vitruvius's judgment that the inhabitants of Mytilene are weakened by the southerly Auster, cough because of Coro, a northwesterly wind, but cured by the northerly Tramontana. According to Barbaro, the small city near Brescia, then part of the Venetian empire, called Orzinuovi, was rebuilt without any consideration of the wind, leaving its residents susceptible to disease²⁷. Indeed, the sixteenth-century chronicler of Orzinuovi, Domenico Codagli, recounted that a particularly severe plague struck the city from 1512 to 1513²⁸. Similarly, in reference to the

²⁵ I. ROWLAND, *Vitruvius in Print and in Vernacular Translation: Fra Giocondo, Bramante, Raphael and Cesare Cesariano*, in *Paper Palaces: The Rise of the Renaissance Architectural Treatise*, a cura di V. HART e P. HICK, Yale University Press, New Haven 1988; A. PAYNE, *The Architectural Treatise in the Italian Renaissance: Architectural Invention, Ornament, and Literary Culture*, Cambridge University Press, Cambridge 1999; L. A. CIAPPONI, *Vitruvius*, in *Catalogus translationum et commentariorum*, vol. 3, a cura di F. E. CRANZ, Catholic University of America Press, Washington D.C. 1976, pp. 399-409; M. M. D'EVELYN, *Venice and Vitruvius*, Yale University Press, New Haven 2012.

²⁶ A. NOVA, *The Role of the Winds in Architectural Theory from Vitruvius to Scamozzi*, in *Aeolian Winds and the Spirit in Renaissance Architecture*, a cura di B. KENDA, Routledge, London 2006, pp. 70-86; M. HARDY, «Study the Warm Winds and the Cold»: Hippocrates and the Renaissance Villa, in *Aeolian Winds and the Spirit in Renaissance Architecture*, a cura di B. KENDA, Routledge, London 2006, pp. 48-69.

²⁷ D. BARBARO, *I dieci libri dell'architettura tradutti et commentati*, Marcolini, Venice 1556, p. 33. D'EVELYN, *Venice and Vitruvius*, p. 55.

²⁸ D. CODAGLI, *L'istoria orceana*, Borella, Brescia 1592, pp. 130-33.

same passage from Vitruvius, Francesco di Giorgio Martini, an author of treatises on fortifications, reported that he had seen three thousand become ill in an hour near Massa Marittima as a result of southerly winds²⁹.

Much of Vitruvius's discussion of winds centers on the techniques for choosing proper building sites, one of the activities that the *Meteorology* potentially informed, according to its Renaissance commentators. Renaissance architectural treatises reflect similar concerns. Leon Battista Alberti, in his *De re aedificatoria*, which was released in the vernacular multiple times throughout the sixteenth century, discussed the various signs or *inditia* that can be used for identifying the healthiness of cities and palaces. The mentioned signs include the direction that trees grow, whether walls are full of holes, and the health of animals³⁰. Following Vitruvius, he wrote that the arts of augury, that is examining entrails, «should be the least despised», if they should conform to religious orthodoxy³¹. But above all he recommended repeated observation. Using a variety of sources, many of them ancient, he described the advantages and disadvantages of various locations: Locri and Croton have never been affected by the plague, few monsters are born in France, the lack of winds in Libya create varied formations of vapors, and the southerly wind does not blow in Ethiopia³².

Other fifteenth-century authors of architectural treatises created general rules for evaluating the salubriousness of building sites based on the frequency of particular winds. These rules were informed by Aristotle as well as Vitruvius. Filarete described a healthy and fertile location that he has seen that is protected from southerly and easterly winds³³. Francesco di Giorgio, fol-

²⁹ F. MARTINI, *Trattati di architettura, ingegneria e arte militare*, a cura di C. MALTESE, Il Polifilo, Milan 1967, p. 309.

³⁰ L.B. ALBERTI, *L'architettura [De re aedificatoria]*, a cura di G. ORLANDI, Il Polifilo, Milan 1966, pp. 43-45.

³¹ Ivi, 49.

³² Ivi, 46-47.

³³ FILARETE, *Trattato di architettura*, a cura di A. M. FENOLI E L. GRASSI, Il Polifilo, Milan 1972, p. 2:54.

lowing Aristotle's idea that all winds are made of the same substance, namely the hot and dry exhalation, contended that their differences are the result of the tracts of earths and climates they move through. For him, Auster is most dangerous, especially in areas, like most of Italy, that have thick air, whereas in places that the air is subtle, cities should be protected from Boreas, because they intensify the predominant quality of the air³⁴. Thus depending on the location, different winds are dangerous. He proposed, however, one universal rule, namely that winds that pass by nearby swamps are always malignant³⁵.

While Francesco di Giorgio in many instances followed Vitruvius, his account of the material properties of wind differs since Vitruvius did not follow Aristotle's contention that wind is the dry exhalation. Francesco di Giorgio was seemingly unaware of the difference. Vitruvius explicitly stated that «wind is a wave of flowing air». He held that winds are caused by heated moisture that arises and presses the exhalation or *spiritus* that rests above them, modelling this action on a device called the aeolipile, a device that heated water to create vapor that is ejected horizontally, used primarily as a way to heat fires³⁶. Like Francesco di Giorgio, Cesare Cesariano, one of the earliest commentators on and translators of Vitruvius, considered Aristotle's theory of the wind harmonious with Vitruvius's, recommending that the reader should supplement his reading of *De architectura* with the *Meteorology*³⁷.

In a later commentary, Daniele Barbaro eloquently described Vitruvius's argumentation: «From art to nature, from experience to reason, from small to great, he [Vitruvius] guided the evidence

³⁴ MARTINI, *Trattati*, pp. 307-8; ARISTOTLE, *Meteorologica*, 2.4.359b34-360a17.

³⁵ Ivi, 308.

³⁶ VITRUVIUS, *De architectura*, 1,6,2. For the influence of this theory in the early modern period see C. MARTIN, *The Aeolipile as Experimental Model in Early Modern Natural Philosophy*, «Perspectives on Science», 24 (2016), pp. 264-284.

³⁷ C. CESARIANO, *De architectura libri dece commentati*, Da Ponte, Como 1521, fol. 23r.

(*inditium*) of his assertions»³⁸. Nevertheless, he rejected Vitruvius's explanation of winds because of their lack of conformity to Aristotle. For Barbaro, Vitruvius's incorrect understanding of the wind did not limit the usefulness of his work because his qualitative considerations of the wind correspond to Hippocratic precepts. Well versed in Aristotle's writings on nature and rhetoric, Barbaro had studied at Padua where he later oversaw the construction of botanical gardens³⁹. From a noble Venetian family he became patriarch of Aquileia, just as his great-uncle, the humanist Ermolao Barbaro, had been decades before⁴⁰. His three commentaries on Vitruvius, two in the vernacular and one in Latin, all different, exhibit his Aristotelianism and concern with public administration and health. Barbaro doubted Vitruvius's explanation of winds that used the an aeolipile in order to demonstrate that winds are moving air. He wrote that Vitruvius, despite demonstrating the power of heat in the formation of winds, «did not clearly explain its effects». Barbaro, following Aristotelian lines, asserted that «the wind is the exhalation of the earth, which rises up into the air, and, having been crushed by the cold, which is in that [upper] part of the sky, strikes the air with violence»⁴¹.

For Barbaro, Vitruvius considered the winds in a general manner, while a more precise understanding is necessary to know the particular temperaments of local winds and sites. Thus, while largely Aristotelian in outlook, he held that observations and experience can improve and expand what is found in Aristotle's writings. Accordingly, he was aware of local conditions,

³⁸ D. BARBARO, *De architectura libri decem, cum commentariis*, De Franceschi, Venice 1567, p. 39.

³⁹ L. CELLAURO, *Daniele Barbaro and Vitruvius: The Architectural Theory of a Renaissance Humanist and Patron*, «Papers of the British School at Rome», 72 (2004), pp. 293-329.

⁴⁰ B. MITROVIC, 1998. *Paduan Aristotelianism and Daniele Barbaro's Commentary on Vitruvius' De Architectura*, «Sixteenth Century Journal», 29 (1998), 667-688.

⁴¹ D. BARBARO, *I dieci libri dell'architettura tradotti e commentati, riveduti e ampliati*, De Franceschi, Venice 1567, p. 55.

noting that the swampiness of Aquileia had rendered it almost inhabitable during the winter and writing that «Boreas is healthy in Venice, elsewhere harmful»⁴². Applying Vitruvius to Venice, he used the vocabulary peculiar to that city, writing its «piazze, public ways, streets, *androni*, and *calli* must be oriented so they are not struck by the winds»⁴³. Illustrating the importance of orientation with respect to winds, in a design of fortified town the winds are clearly marked⁴⁴.

In addition to wind, architects who sought solutions to urban infrastructure incorporated Aristotelian meteorology in their writings about water and remedies to flooding. For example, Andrea Bacci's 1576 work on water mixed medical concerns about the effects of various kinds of waters to explanations of the extraordinary recent floods in Rome. While not wishing to swear an oath of fidelity to Aristotle and recognizing a host of relevant ancient authorities, nevertheless he explained transformations of land into water with appeals to Aristotelian explanations of the cycles of rain, which he held to be the principle cause of the deluges. Accordingly, Pamela Long describes the work as «essentially a critical commentary on Aristotle»⁴⁵.

These concerns with winds, local climate, and city planning expanded in Vincenzo Scamozzi's *Dell'idea della architettura universale* (1615). Scamozzi studied mathematics with Christopher Clavius and used a broad range of humanist erudition as a demonstration of bravura that was characteristic of late sixteenth-century social climbers⁴⁶. Fitting with a desire to raise the status of architecture and of himself, he linked the field to

⁴² BARBARO, *I dieci libri dell'architettura*, 1556, p. 36; BARBARO, *De architectura* 1567, p. 28; D'EVELYN, *Venice and Vitruvius*, p. 198.

⁴³ BARBARO, *I dieci libri*, p. 39; D'EVELYN, *Venice and Vitruvius*, p. 139.

⁴⁴ BARBARO, *De architectura*, p. 34; D'EVELYN, *Venice and Vitruvius*, p. 56.

⁴⁵ P. LONG, *Hydraulic Engineering and the Study of Antiquity: Rome, 1557-70*, «Renaissance Quarterly», 61 (2008), pp. 1098-1138: 1109; A. BACCI, *Del Tevere*, Venice 1576, sig. [2v, p. 236.

⁴⁶ V. SCAMMOZZI, *Dell'idea della architettura universale*, Valentino, Venice 1615, p. 1:29; PAYNE, *The Architectural Treatise*, p. 1:216.

natural philosophy⁴⁷. «It is very necessary», he wrote, «that the architect be a meteorologist (*Metheorico*), [and] have the greatest understanding of the nature and quality of air»⁴⁸. In the section on air, he presented an Aristotelian explanation that depended on the prime qualities and its levity and cited Aristotle, Averroes, and Alexander of Aphrodisias, among others. Accordingly, for nearly every design, of both proposed and standing edifices, a wind rose indicates the building's orientation. Scamozzi's treatment of wind and air loosely follows Vitruvius's yet is adorned with a mass of cosmographical, historical, natural philosophical, and architectural details. His explanation of the wind holds that the winds «perpetually and continually» circle the earth «following the motion of the sun», as confirmed by the observations of navigators⁴⁹.

5. Conclusion

For a full understanding of Aristotelian meteorology in the vernacular, it is necessary to go beyond the treatises, commentaries, dialogues, translations, handbooks, and paraphrases that explicitly set out to interpret Aristotle but to look as well at the vast body of technical literature that incorporated and transformed Aristotelian thought, placing it into contexts distant from Aristotle's original ones and mixed among a panoply of authorities whose connections to Aristotelianism range from limited to extremely close, while at the same time bringing his ideas to vast and diverse sets of readers. Commentaries on the *Meteorology*, both in Latin and the vernacular, consistently maintain that the work is relevant to a range of practical and pragmatic concerns. Yet, within the commentaries themselves the connections between Aristotle's work and commercial, artisanal, mechanical, and military activity are rarely drawn out. The failure, however,

⁴⁷ PAYNE, *The Architectural Treatise*, p. 223.

⁴⁸ SCAMMOZZI, *Dell'idea*, p. 1-133.

⁴⁹ Ivi, 1:147. See also Ivi, 1:139.

of commentaries to link natural philosophy to practical concerns in an explicit way does not mean that their proclamations for relevance are misleading. Judging from their citations, authors of a broad range of technical literature maintained the usefulness of Aristotle's *Meteorology* for their field, as they applied and mixed his principles with writers of their own subjects and their own observations and experience. Offering critiques and amendments to Aristotle's writings was common to both commentators on Aristotle and to authors of technical treatises, who were less bound by the demands of textual interpretation. The technical literature's appropriation of the *Meteorology* suggests that the vernacularization of his ideas ranged far from those with a general interest in natural philosophy as it appealed to needs and interests of farmers, sailors, architects, and merchants.