Experience of the New World and Aristotelian Revisions of the Earth's Climates during the Renaissance

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Abstract

It is widely perceived that the discovery of the New World contributed to the eventual downfall of Aristotelian natural philosophy. This discovery demonstrated the unsound nature of Aristotle's view that there exists an uninhabitable "torrid zone" in the area between the Tropic of Capricorn and the Tropic of Cancer. It has been argued, among contemporary historians of science, that travels through this region of the earth created doubt in Aristotle's authority and thus led people away from the sterile and bookish natural philosophy taught by scholastics. In fact, during the first decades of the sixteenth century, commentators on Aristotle, such as Pietro Pomponazzi and Agostino Nifo, were informed, through sailors' reports, of travels in southern regions and, as a result, questioned the existence of a torrid zone. Renaissance Aristotelianism was flexible and capable of integrating new experiences into a larger theoretical framework; experiential evidence that the "torrid zones" did not exist was utilized by a number of scholars who taught Aristotelian natural philosophy in the years after Columbus' first crossing of the Atlantic Ocean.

Introduction

> Michiele Monaldi: *How did it happen that Aristotle was not capable of knowing that the entire earth is habitable?*
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> Nicolò Vito di Gozze: *The Philosopher could not have known this through natural reason; but we came to recognize all of this through experience.*
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> —di Gozze, 1584.[1]

That the scientific revolution chronologically followed upon the discovery of the New World is widely perceived as not coincidental. Columbus' voyages fundamentally shook many received notions among Europeans of the sixteenth century. Encounters with previously unknown peoples altered conceptions of the nature of mankind; and collections of New World flora and fauna sparked wonder, making ancient botanical and zoological writings incomplete if not obsolete.[2] It was not just that the explorations of the late-fifteenth and sixteenth centuries revealed anomalies to accepted frameworks of knowledge, but that the New World itself was one huge anomaly. In Kuhnian terms, the result of such an anomaly could not but cause a crisis in the accepted paradigm. According to Reijer Hooykaas, it was the exploration of the New World that led to greater emphasis on "the fact" among intellectuals, which paved the way for modern science.[3] Thus authorities, such as Aristotle and other ancients, ceased to be trusted, and doubt reigned, as evidenced by Montaigne and the renewal of Pyrrhonism, creating a vacuum of knowledge. The traditional story tells us that Bacon, Descartes, Galileo, and Boyle, among others, filled this void by rejecting Aristotle and in his place created an experimental philosophy that was confirmed by mathematics and eventually reached its apotheosis in the Newtonian synthesis.[4] Thus the discovery of the New World was preparatory for the scientific revolution.

By now, this story has been partially disassembled. The break between traditional natural philosophy and those that emerged in the seventeenth century was not clean; and that the revolution took one century, if not two, suggests that the scientific revolution was not a rapid overturning of the accepted order in the same way that the American, French, and Russian revolutions were.[5] Nevertheless, the belief that the emergence of modern science resulted from the rejection of Aristotle's thought as the absolute truth endures.[6] Even though a number of Aristotelian positions and concepts were rejected in the seventeenth century, the idea of authority is often misconstrued, so that Aristotelians are portrayed as defending the theories found in texts at all costs. To the contrary, Aristotelianism was extremely flexible, and the rejection of one or more tenets was not sufficient to send the entire edifice of scholastic learning tumbling down. This flexibility is especially evident for the field of meteorology because it was viewed as a conjectural science that dealt with intractable phenomena. Meteorological theories were seen as provisional and subject to reformulation. As a result, many Renaissance university professors who commented on Aristotle's *Meteorology* had no problem rejecting Aristotelian positions if experience contradicted them. For them, authority was evidence, not the final answer.

A case in point regards the effect that Columbus' voyages had in altering the conception of the size of the earth and its division into climatic zones. While Columbus did not prove that the earth was spherical, an idea already accepted since antiquity, exploration in the New World called into question the extent of the habitable area of the earth. Aristotle had addressed the earth's climates in *Meteorology* II.5, where he argued that the terrestrial globe should be divided into five belts or climates that wrapped around the world's circumference. Assuming that the

borders of the climates must reflect the astronomical division of the earth, Aristotle defined the borders by the two tropics and the Arctic and Antarctic circles. Two of these zones, thought to be habitable, were called *oikoumenai*; one lies in the north, between the Tropic of Cancer and the Arctic circle, and a corresponding region lies in the southern hemisphere. In between the tropics, lies a torrid zone, too hot for the streams and pastures necessary for human life;[7] and, in the extreme latitudes, both northern and southern, the cold prevents human habitation.

During the fifteenth and sixteenth centuries reports from sailors about habitations along the coast of Africa and in the New World made the torrid zone a potential target for anti-Aristotelians. The readiness of some, including Columbus himself, to reject traditional understandings of the size of the earth and the nature of its continents is portrayed in contrast to the supposed hardheadedness of Aristotelians who were trapped by theory and could not adjust their bookish views to observational evidence. Anthony Grafton points to the Jesuit scholar and traveler, Josè de Acosta, whose 1580 treatise on the New World, described his being so cold while traveling in the so-called torrid zone that he needed to put on more clothing. As a result, he wrote: "What could I do then but laugh at Aristotle's *Meteorology* and his philosophy? For in that place and that season, where everything, by his rules, should have scorched by the heat, I and my companions are cold."[8] De Acosta's rejection of Aristotle supports Grafton's claim that: "Between 1550 and 1650 Western thinkers ceased to believe that they could find all important truths in ancient books." De Acosta certainly was willing to challenge Aristotle's *Meteorology* on a number of points, but his treatment of ancient authority is not as dramatic as it might appear. He does not present Aristotle as generally risible for his fallibility, nor did he reject Aristotle wholesale, but called him merely incorrect, "the author of this view [regarding the torrid zones] is Aristotle, great explorer of nature, but who in this case wanders far from the truth."[9]

De Acosta, however, was not the first to reject the existence of torrid zones or antipodal habitations on the basis of experience. A few years earlier, Francisco Sanchez wrote a far more scathing indictment of Aristotelian theories of the earth in his skeptical work, *That Nothing is Known.* In his invective, Sanchez cited the common experience of travelers to New World to show that the theory of uninhabitable climatic zones was untenable and therefore Aristotelian science was incomplete and fallible:

> Yesterday you said in the light of your complete scientific knowledge - or rather, knowledge that was complete even long ages ago - that the entire earth was surrounded by the Ocean; and you divided it into three all-embracing parts, namely Asia, Africa, and Europe. But what are you to say today? A New World has been discovered - new realities - in New Spain or in the West and East Indies. Moreover, you used to say that the southern zone, situated below the equator, was uninhabitable on account of heat, but that close to the poles, and the extreme polar zones, the same thing was true because of the cold. Experience [experientia] has now shown both these statements to be false. Construct another "science," then, for your first is now false. So how can you maintain that your propositions are eternally valid, incorruptible, infallible, and incapable of being otherwise - you miserable worm, who scarcely know, and are scarcely even capable of knowing, what you are and whence you come and whiter you are going?[10]

Even though Sanchez painted an entertaining picture of know-nothing scholars convinced of their infallibility and incapable of reacting to new observations, it must be asked whether this picture resembles the reality of sixteenth-century traditional natural philosophy. Was Sanchez parodying fictionalized pompous schoolteachers or the cutting edge of Aristotelian natural

philosophy? Moreover, before 1550, did Western thinkers really think that every important truth could be found in books, rather than in experience? And, was it really not until the second-half of the sixteenth century that Aristotelians began to notice the discovery of the New World?

The Torrid Zones: Doubt, Conjecture, and Revision

While the idea of the torrid zone was widespread from antiquity through the Renaissance, Aristotle's authority was hardly hegemonic. Other ancient authors elaborated and questioned Aristotle's division of the earth and his belief in two habitable zones. Belief in a torrid zone was rampant, even though some ancients such as Crates of Mallos (fl. 150 A.D.) and Macrobius (5th c. A.D.) envisioned four *oikoumenai*. Aristotle's view that humans live in the southern hemisphere, however, found an uneven reception. Some affirmed Aristotle's position, and others considered the possibility of human life in the southern hemisphere either dubious or unanswerable. For example, the geographer Strabo (ca. 63 B.C.- 23 A.D.), believing the Atlantic Ocean to be too large to sail across, refused to comment on the possibility of life on the antipodes. On the other hand, Cicero (106-43 B.C.), in *The Dream of Scipio*, wrote of a different race of antipodal men who had no contact with those of the northern *oikoumene*.[11]

Perhaps the most significant elaborations of Aristotle's geography in late antiquity came in the persons of Claudius Ptolemy (85-165 A.D.), an astronomer and geographer, and Augustine (354-430 A.D.), a Church Father. Using reports from travelers, Ptolemy expanded the range of the habitable zone and divided it into seven climates. The northern border of the torrid zone, however, was not the tropic as it was for Aristotle, but the parallel on which the city Meroe lies, which is approximately 16 5/8 degrees north. Ptolemy also contended that the polar regions are uninhabitable, and that the parallel which runs through Thule, an apparently mythical city, that was believed to be somewhere around 63 degrees north and perhaps on what are called today the Shetland Islands.[12] Ptolemy's arguments are not based on mathematics, despite his skill in that field, but rather are informed by histories and empirical evidence and Aristotle's general schema. Like Aristotle, Ptolemy conjectured symmetry and believed that the southern hemisphere was habitable could be divided into the same climates as those in the north.[13]

The division of the earth into specific zones had ramifications not just for geography and meteorology, but also for theology. Augustine dismissed the belief that there was an inhabited southern continent and that there could exist a race of men permanently separated from the north. A human population on distant continents, however, presents problems for the belief in the single creation and common descent of all humans. The implausibility of the navigation of oceans, suggests that God created counterparts to Adam and Eve in the southern hemisphere, if it is inhabited. Furthermore, a just God would not create people in an area inaccessible to Christ's apostles, because they would be damned as a result of unfair conditions.[14] Thus for Augustine, scripture was proof that the antipodes must be free of humans.

A melding of Augustine's and Aristotle's views resulted in the common medieval belief that there was only one inhabited zone, which corresponded to the northern orb where Europe is found; a torrid zone, too hot to support human life, borders the *oikoumene* to the south. In the late Middle Ages, the Augustinian/Aristotelian position dominated conceptions of the nature of the earth and its climates and is found in the, *Sphere of Sacrobosco*, the most common astronomical text book of the Middle Ages, and its commentaries. The author of this work, John Sacrobosco, a scholar from the late 12th or early 13th century, about whom little is known, slightly altered the placement of Ptolemy's seven climes, agreeing that the southern border was

at the latitude of Meroe, but maintaining that the northern-most clime was marked by the parallel at 50½ degrees north. Although the text is slightly unclear, he seems to have believed that the southern hemisphere mirrors the northern.[15] For Sacrobosco, these limits to the *oikoumenai* were not to be observed as strict rules. He admitted that in the polar regions there might be islands and human habitations, but that the living conditions must be so bad that the area does not deserved the category of a clime.[16] Michael Scot, a famed translator and scholar of the first decades of the thirteenth century, revised Sacrobosco's position by adding Augustine in his commentary on the *Sphere*. After outlining Augustine's argument, he concluded that the antipodes must not be habitable, because such a proposition contradicts religion (*contra fidem*).[17]

We must be careful not to ascribe too much homogeneity to either the ancient or medieval positions regarding the extent of the habitable earth. Columbus read about the Augustinian, Aristotelian, and Sacroboscian positions in his annotated copy of Pierre d'Ailly's *Imago mundi* and disbelieved the claim that the torrid zone was uninhabitable because of reports from Portuguese sailors who had crossed the equator while sailing down the western coast of Africa.[18] Columbus' disbelief, however, was probably not shocking to his contemporaries, but found company in highly authoritative texts. For example, Albertus Magnus (1206-1280) cited reports of cities in the distant south.[19] Pietro d'Abano's *Conciliator* (ca. 1310) contains a detailed *quaestio* over the question of the habitableness of the torrid zones and areas below the equator, in which he discussed a plurality of views, which included accounts of very southern cities in India. Pietro concluded that indeed some places in the equatorial region are uninhabitable and that it was not determined whether anyone lives below the equator, thus leaving the question open to new evidence.[20]

While ancient and medieval scholars questioned that the existence of an uninhabitable torrid zones was proven, during the Renaissance doubts grew among Aristotelian commentators, in part, because of the epistemological status of the field of meteorology. Some of the leading Aristotelian scholars interpreted Aristotle's *Meteorology* as advocating the conjectural nature of scientific knowledge, thereby recognizing limits to natural philosophy. Well before de Acosta's travels, leading Aristotelian commentators, such as Pietro Pomponazzi in the 1520s, noted that the voyages of discovery brought further doubt on the existence of torrid zones and argued that experience trumps the theories found in ancient texts. For most Renaissance scholars, authoritative writings were sources of evidence, which at times contradicted each other as well as experience. Authority in and of itself did not deliver unadulterated truth, but was an aid to discovering it. A number of medieval and Renaissance Aristotelians neither feared contradicting Aristotle, nor thought their science was infallible. For these scholars, the reports of sailors threw the existence of uninhabitable zones into doubt. The rejection of this tenet, however, was not seen as fatal to natural philosophy in general and did not create a crisis that demanded a paradigm shift.

Aristotle's philosophy provided a framework for natural philosophy in the Middle Ages and Renaissance. This framework was flexible, oftentimes providing methods for inquiry rather than dogma. The prohibition of *metabasis* is one of these guiding principles. Based on the *Posterior Analytics*, the principle of the prohibition of *metabasis* contends that explanations should be appropriate to the phenomena that they explain, and that methods from one subject cannot be applied to other subjects.[21] Thus different fields of inquiry require different methods and confer corresponding degrees of certainty. For example, deductive arguments elucidate the nature of mathematical entities, such as lines and shapes, but cannot be applied to politics, which although ordered, to a degree, cannot be known with the same certainty as mathematics. Natural

objects, therefore, can be known with relative degrees of certainty. Geometry can describe accurately the stars and planets that have eternal regular motion. The sublunary world, however, is characterized by chaotic and episodic change. As a result, according to Aristotle, meteorological knowledge is hypothetical and approximate.

Meteorology stood out among subjects in Aristotelian natural philosophy because of its intractability. For Aristotle, meteorology was not predictive but examined change in inanimate substances in the sublunary region. Topics that were included in this field were: precipitation, rainbows, comets (which were thought to be sublunary), meteors, earthquakes, the motions of seas and rivers, and underground springs. Like all of his natural philosophy, the goal of meteorology was to give the causes of phenomena. Unlike for much of the natural world, however, the explanations for meteorology were almost entirely based on material and efficient cause, not the formal and final causes that were preeminent in most of his works.[22] According to Aristotle, the four elements (earth, water, air, fire) compose two exhalations, one wet and vaporous, the other, hot and smoky, that circulate between the surface of the earth and the moon, which is the liminal point between terrestrial and celestial realms. The elements and the exhalations are the material causes of meteorological phenomena. The efficient cause comes from the motions of the celestial bodies, in particular the sun, which drives the exhalations and causes their transformations. These transformed bodies remained imperfect, never truly gaining a new substantial form.

Aristotle's meteorology stressed irregular and rare phenomena, such as meteors, comets, floods, volcanic eruptions, and typhoons, which, because of their episodic nature, defy certain explanation. He wrote: "Of these things some puzzle us, while others admit of explanation in some degree."[23] [check quotation] The theory of the dual exhalations does not derive from syllogistic reasoning, but from abduction, i.e., inference to the best explanation, as Cynthia Freeland has argued.[24] The exhalations provide conceptual unity to a wide range of phenomena, that otherwise might be considered disparate. Other ancient thinkers also noted the difficulty of accurately explaining meteorological phenomena; for this field both Theophrastus (d. 287 B.C.) and Lucretius (99-55 B.C.) gave a number of possible explanations in their meteorological discussions rather than a definitive account.[25] Thus in antiquity, meteorological queries were frequently resolved only in a provisional manner.

Medieval and Renaissance meteorology took Aristotle's *Meteorology* as its guide and starting point. The subject of meteorology was central to Aristotelian thought. Medieval and Renaissance scholars typically believed that the *Meteorology* was the fourth part of natural philosophy; it follow the *Physics, De caelo,* and *De generatione et corruptione* and preceded the biological and psychological works. Scholars developed and expounded upon the subject in lecture courses at universities, the content of which can be known from their written commentaries and *quaestiones* derived from William of Moerbeke's thirteenth-century Latin translation of the text. Teaching of the *Meteorologica* was a standard part of Italian university curriculum at least as far back as the initial years of the fifteenth century if not earlier. According to the 1405 university statutes at Bologna, the *Meteorology* was to be taught in the second year as part of the classes in ordinary philosophy.[26] Although the commentaries that emerged from these courses follow the text of Aristotle, they were by no means uncritical or unoriginal; nor were the theories developed from them so univocal to suggest that the field of meteorology was considered to be complete and certain, as Sanchez described it for Aristotelians.

By the first decades of the sixteenth century, Aristotle's own claim of puzzlement with regard to meteorological phenomena inspired scholars in Italy, who used the *Meteorology* to support the claim that natural philosophy was a conjectural science. This view clearly emerged in the works of Agostino Nifo (1473-1538), a writer who is most noted for his participation in debates over the immortality of the soul and his role in advancing the so-called *regressus* method in natural philosophy, a method that combined induction and deduction, and which some scholars have seen to be the historical root of the "scientific method."[27] It is unnecessary to anachronistically identify the *regressus* theory with the modern notion of "scientific method," to appreciate its sophistication, and its importance in epistemology from Galen to Galileo. The theory argued that through sense perception, it was possible to establish was called *quia*, "the what there is," or natural effects, and thus establish basic empirical truths about nature. Using this knowledge as a foundation, induction led to an explanation, called the *propter quid*, that is, the "why" that gave an account for the *quia*. An understanding of the *propter quid*, could then serve as a foundation for deduction of further effects, which would in term lead to the formulation of a more comprehensive explanation. It was in this way that natural science was thought to be able to progress over time, and that natural philosophy was, to a certain degree conjectural. Nifo relied on the wavering nature of the field of meteorology as evidence of the uncertainty of the natural sciences.

Nifo's *Commentaria in libris Aristotelis Meteorologicis* (first published in 1531, it was written in 1523) was the first sixteenth-century exposition on *Meteorology* to be published in Italy. It enjoyed wide readership and went through more editions than any other commentary on this book in the sixteenth century.[28] He used meteorology, and Aristotle's confession of the inability to understand all causes to distinguish the natural sciences from the mathematical. He writes: "It must be said that natural science is not a science *simpliciter*, such as the mathematical sciences are, but is a science that explains the why (*propter quid*). [check quotation] It is the science of finding the causes which can be held through a conjectural syllogism, that gives the *propter quid* of the effect." This account of the effect however is not definitive. He supported this claim by his use of Aristotle's meteorology and argued that, "Aristotle in the book of the *Meteorology* concedes that he does not provide the true causes of natural effects, but that which is possible through conjecture."[29] Thus conclusions about the causes of meteorology, unlike mathematics, are at best tentative, and subject to revision if there are changes in the understanding of the nature of meteorological effects. For Nifo, contrary to Sanchez, meteorology is hardly infallible but rather open to new experiential findings.

Experience, during the Middle Ages and Renaissance, was far broader for natural philosophers than the narrow definitions of experiment that scientists have since adopted. What fell under this rubric and was appropriate as evidence included not just personal observations or contrived tests, but also truths about the natural world that were thought to be universally agreed upon and experiences of others either contained in books or transmitted by word of mouth. Reports made by navigators and their crew, having been deemed reliable, were sufficient evidence for questioning and revising Aristotle.

Nifo's rejection of the Aristotle's division of the world into habitable and uninhabitable zones is a good example of one stage of the application of the method of *regressus*. According to Nifo, when Aristotle claimed that the pole regions and the tropics were uninhabited he did so without consulting history books (*historia*). Following Alexander of Aphrodisias, the Aristotelian commentator from the second-century A.D., Nifo claimed that perhaps in Aristotle's time there were no reports that contradicted his schema. By Nifo's time, however, there were

such accounts; sailors had reported that people do live close to the North Pole, above sixty degrees, "thus what Aristotle attempted to establish by conjecture, is not verified by history."[30] Nevertheless, Nifo maintained the rectitude of the barrenness of the torrid zone. Even though, even during Alexander's time, it was known that Ethiopians lived in this zone, the zone itself could not be declared habitable in a strict sense because they live, "almost beyond the norms of nature."[31] Thus Nifo rejected some of Aristotle's conjectures because of experience, while the general framework persisted and the meaning of habitable zone could be interpreted so that it included only the regions where people could live well and not the areas where Ethiopians allegedly lived poorly.

The insistence on the conjectural nature of knowledge about the physical world, that Nifo held, was even stronger in the thought of his rival and contemporary Pietro Pomponazzi (1462-1524). Pomponazzi spent most of his professional life as first a professor at Padua and then Bologna. Famed for his brushes with ecclesiastical authority, for his denial that the immortality of the soul could be proven philosophically, rather it was an article of faith not reason, he moved from a position of fideism to that of near skepticism, which runs through the lectures on Aristotelian text that his gave in the last years of his life at Bologna.[32] These courses treated Aristotle's biological works and the *Meteorology*.[33]

Despite his more than occasional pride in uncovering what he considered to be the true opinion of Aristotle, Pomponazzi actively encouraged his students to doubt accepted knowledge. Such doubting was directed toward Aristotle and his interpreters. His doubts primarily arose from contradictions among texts, interpretations, logic, and experience. And unlike earlier masters of textual conciliation, Pomponazzi admitted that he could not solve all of the contradictions. Furthermore, he argued that the best way to solve a number of these contradictions is to claim that Aristotle is wrong. In his view, the job of the philosopher is to discover the truth for himself, independent from past authorities.[34] The concept of certainty played scarcely any role in his meteorological commentaries, and the chosen solutions are often described not as true but as better, more tolerable, or more pleasing.[35]

Pomponazzi found significant authority in Aristotle. Authority, however, was conditional, and the role of the philosopher is to judge authorities, "because in philosophy," Pomponazzi writes, "one should not believe an authority without reason."[36] The authority derives from Aristotle's words themselves and the commentators should only be used with care, especially the works of certain unnamed commentators, who Pomponazzi believed to have put forth interpretations that are based on caprice and unsound readings of the text. In his view, the good philosopher is aware of Aristotle's authority, in fact, "the good philosopher should pore himself over Aristotle's text,"[37] yet uses reason to solve interpretative problems as well as to judge the validity of Aristotle's arguments. For example, after being unable to explicate Aristotle successfully, he urged his readers to find a solution for themselves. He told his students: "Aristotle's authority is great. And it does not seem easy to find a solution to this question. You consider it."[38]

Unquestioning acquiescence to Aristotle is not a philosophical method, according to Pomponazzi. He repeatedly argued that Aristotle was human, and thus erred, like the rest of us. He bluntly wrote: "many want Aristotle to have spoken well with respect to everything, and they are stupid."[39] The formulae and theories that structure natural philosophy are provisional and should be overturned whenever experience demonstrates their failings. He wrote: "If he [Aristotle] was wrong, let there be a condemnation of him."[40] When he finds that Aristotle has contradicted himself he confesses his inability to save his arguments, claiming that, "I do not

know how to answer except that Aristotle was a man and was capable of making mistakes."[41] Rejecting all earthly authority when he found two opinions of equal value, he stated: "I believe neither Aristotle nor Galen knew which opinion is more true, but only God does."[42]

Pomponazzi's corrections to Aristotle, and to his interpreters, most often come from experience, because Aristotle at times induced larger rules from an insufficient amount of experience.[43] Experience for Pomponazzi was broad and not equivalent to Baconian empiricism. He included as experience in his meteorological work, observations taken from Plutarch's histories on the existence of a man whose toe would not burn, Avicenna's observations on the actions of poisonous snakes, as well his own memories of a spectacle that took place in Mantua when he was a child.[44] His appeals to experience are often vague and rely on commonplaces; in multiple discussions he adds phrases such as "as is clear from experience" to justify or reject a claim.[45]

While Pomponazzi advocated the use of reason to form philosophical positions, experience holds a higher position. Citing Avicenna's *Canon* and Aristotle's *Physics*, he writes that: "When reason is contrary to experience, then reason must be thrown out and put to experience."[46] Thus, while Aristotle, at times, used an insufficient amount of evidence in induction, Pomponazzi, nevertheless, saw Aristotle as privileging experience over reason in explaining natural phenomenon. After asking why Aristotle only puts forth only the phenomena without giving an explanation when he describes how honey is affected by the moist and the cold, Pomponazzi answers with the dictum that "it is possible to be known better through experience than theory."[47] The promotion of experiential approaches to natural philosophy is not foreign to Aristotle's natural philosophy. His use of observation, experiments, and experience is well documented.[48] Pomponazzi's emphasis on experience, however, contrasted with the analytic methods of many late-medieval practitioners of natural philosophy that was more often dependent on logic and mathematics than observation.[49]

Given Pomponazzi's position with respect to the epistemological roles of experience, authority, and theory, his take on the existence of the habitableness of the antipodes and the torrid zones is somewhat curious. He prefaced his discussion by examining the Peripatetic view, which he claimed clearly holds that the zones between the tropics are uninhabitable. After going through the arguments for this position, and pointing out their weakness, he cited a letter from the Venetian ambassador to Spain.[50] According to this letter, the ambassador crossed the torrid zone and traveled toward the south pole, where he saw over 300 islands, discontinuous with continental land masses, and an "infinity of inhabited locales." In Pomponazzi's opinion, the contents of this letter show that Aristotle's theory is fatuous. Moreover, this experiential evidence suggests that other parts of natural philosophy, such as astronomy, are monuments to human vanity rather than certainty, "the desire of glory and attention leads us to say things about the heavens, when we are ignorant of even the terrestrial regions."[51] If natural philosophy errs with respect to subjects in our proximity, such as meteorological phenomena, it is even less likely that we can know with certainty about the composition of the distant celestial realm.

Given this assessment, it would seem that whether the torrid zones and antipodes are inhabited would be an open-and-shut case. For Pomponazzi, however, there was one strong argument that humans did not live in these regions, namely the authority of Augustine.[52] Even though, philosophers' sense experience contradicts Augustine's position, Pomponazzi could not bring himself to directly reject the Church Father. After rejecting the potential solution that because these inhabitants are wild and without discipline, they should be damned as lacking in sense, he confessed that he could not solve the dilemma and refused to reject Augustine. His

reasons have his personal history behind him. In 1518, his teachings on the immortality of the soul were condemned by the Church, which, at the time, was heavily influenced by Augustinians.[53] Pomponazzi recanted and agreed not to teach arguments that might be construed to deny the personal immortality of the soul. In explaining his refusal to disagree with Augustine, he mentioned his skirmish with the Church, writing that the position for which he was declared in error was "fatuous" and claimed that when it "comes to issues of faith, I always subject myself to Priests and whatever they tell me." As a result, he offers no definitive solution since he "does not know how the Priests solve this argument."[54]

Scholars have more than once charged Pomponazzi with deception in his deference to the Church, because of his presentation of coherent arguments for a position antithetical to Church doctrine, which is followed in a later chapter by a denial of the ability of philosophy to answer the same question, because it was a matter of faith.[55] These charges are problematic because of their assumption of Pomponazzi's heterodoxy and their transference of modern anti-clerical attitudes to the Renaissance.[56] It is more than reasonable (and common among medieval Christian theologians) to believe that the personal immortality of the soul or the creation of the universe can be known only through faith.[57] One wonders, however, to what extent this fideism is possible with the issue of the habitability of the antipodes and torrid zones. Even though once experience shows that these zones are inhabited, there seems little else to do but not interpret Augustine as being literally true, but it is not necessary to accuse Pomponazzi of disingenuousness. Given that he was a layman, Pomponazzi was most likely correct in claiming making such interpretation was not his business, but that of priests. Pomponazzi, a philosopher untrained in theology, ignorant of their solution, thus refused to make more pronouncements on how to solve a theological question. Nonetheless, it is easy to suspect that Pomponazzi was a bit gleeful that the Augustinians, who by the 1520s had fallen out of favor in Rome because of Martin Luther, a former Augustinian monk, would be forced to perform some exegetical acrobatics in order to save the coherency of Augustine's pronouncements. Even Augustinians, however, did not seem to be overly concerned with maintaining a literal interpretation of Augustine. During the sixteenth century numerous Augustinian monks traveled to the New World and Asia as missionaries.

Conclusion

Later Aristotelians followed Nifo's and Pomponazzi's rejection of Aristotle's conjecture of uninhabitable regions. Francesco Vimercati, originally from Milan but later a professor of Greek and the College Royale, in Paris, noted, in his 1556 commentary on the *Meteorology*, that the torrid regions, the southern hemisphere, and the northern polar regions were inhabited. He wrote that these locals were discovered after the time of Ptolemy and Aristotle, but are readily recognized by more recent geographers.[58] The most common Jesuit textbooks on natural philosophy, those by the Coimbrans, which were commentaries on Aristotle as well, citing Christopher Columbus by name, gave a six-prong explanation of why the torrid zones were indeed habitable: the equal nights and days prevented excessive warming, the areas were full of vapors and therefore cooling rains, God endowed the primeval earth in such a way as to make them cool enough to support human life, they were full of mountains and valley, the oceans cool them, and winds, which have their ultimate source in God's providence, disperse the heat of the sun.[59] The Jesuit order, at this time, was both a starch defender of Aristotle and a promoter of

worldwide voyages and missions. The experiences derived from the discovery of the New World, however, were stronger than maintaining a strict adherence to Aristotle's authority.

When compared to later debates over the mutability of the heavens and the location of comets, it does not appear that writers of Aristotelian commentaries had much trouble relinquishing Aristotle's position at all.[60] This willingness to go against Aristotle is due to the lack of ambiguity of the evidence that these zones were inhabited. While the telescope could be doubted as an inaccurate instrument, providing distortions of experience rather than enhancement,[61] and disputes over the application of mathematics to the physical world provoked questions about the conclusions made by Tycho Brahe and Galileo,[62] by the middle of the sixteenth century it would have been impossible to deny the numerous claims made by sailors who had seen the New World. Moreover, Aristotle's position had been a matter of debate within the Aristotelian tradition since antiquity; it was not a central tenet and thus was subject to revision.

Jacopo Zabarella, a leading professor at Padua, believed that Aristotelian natural philosophy, despite Aristotle's being fallible, attained perfection with regard to its structure and form, that is, its general principles and methods, but not with regard to its characterization of all natural things.[63] Geocentricism, supralunary comets, mutations in the heavens each, to a great extent, threatened the form and structure of the Aristotelian cosmos, by rendering key doctrines, such as the distinction between the supralunary and sublunary, the relativity of direction, the relation between celestial powers and earth, as meaningless. To the contrary, Aristotle's conjectures about geographic regions, about which he knew nothing firsthand, provoked laughter in de Acosta and scorn in Sanchez, were not part of the structure and form of his account of the natural world but rather a description of some of its contents, which could be revised without throwing general principles in doubt. Although the inhabitability of the torrid zones was rejected, the belief in the existence of climates that affected persons, peoples, and animal species persisted. As late as the 18th century, Montesquieu endorsed the theory that climate affects government and mores in his *Spirit of the Laws*, and Thomas Jefferson felt obliged to use the phrase "torrid zone" to describe the natural habitat of wooly mammoths and elephants.[64] Renaissance Aristotelians, such as Pomponazzi and Nifo, were more than willing to revise Aristotle. His authority was not absolute, but merely the best guide available; and well before 1550, scholars thought that not all important truths, such as the earth's climate, were to be found only by reading texts.

Endnotes

[1] Nicolò Vito di Gozze, *Discorsi sopra le Metheore d'Aristotele, Ridotti in dialogo & divisi in quattro Giornate*. (Venezia, 1584), 77r.

[2] Lorraine Daston & Katharine Park, *Wonders and the Order of Nature, 1150-1750* (New York: Zone Books, 1998), 146-159.

[3] Reijer Hooykaas, "Humanism and the Voyages of Discovery in 16th-century Portuguese Science and Letters," *Mededelingen der Koninklijke Nederlandse Akademie van wetenschapen*, AFD. Letterkunde Nieuwe Reeks Deel 42, no. 4 (1979); Reijer Hooykaas, "The Rise of Modern Science: When and Why?" *British Journal for the History of Science* 20 (1987), 453-473.

[4] For the historiography of the scientific revolution see: H. Floris Cohen, *The Scientific Revolution: A Historiographical Inquiry* (Chicago: University of Chicago Press, 1994).

[5] Christoph Lüthy, "What to Do with Seventeenth-Century Natural Philosophy? A Taxonomic Problem," *Perspectives on Science* 8 (2000), 164-195, esp. 166-170.

[6] For example, see: Margarita Bowen, *Empiricism and Geographical Thought: From Francis Bacon to Alexander von Humboldt* (Cambridge: Cambridge University Press, 1981), 36.

[7] Aristotle, *Meteorology*, 363a15.

[8] Antony Grafton, *New Worlds, Ancient Texts: The Power of Tradition and the Shock of Discovery* (Cambridge, Mass.: Harvard University Press, 1992), 1.

[9] José de Acosta, *De natura novi orbis libri duo* (Cologne, 1592), 22

[10] Francisco Sanchez, *That Nothing is Known*, (tr.) Douglas F. S. Thomson (Cambridge, Cambridge University Press, 1988), 221-222.

[11] James S. Romm, *The Edges of the Earth in Ancient Thought: Geography, Exploration, and Fiction* (Princeton: Princeton University Press, 1992), 121-140.

[12] Ptolemy, *Geography*, 7.5. For the identification of Thule see: J. Lennart Berggren and Alexander Jones, *Ptolemy's Geography* (Princeton: Princeton University Press, 2000), 180. Ptolemy's *Geography* was not available in Western Europe until the fifteenth century, although his positions regarding this issue were passed on indirectly.

[13] Ptolemy, *Geography*, 7.5.

[14] Augustine,*City of God*, Bk. XVI, Chap. 9.

[15] Lynn Thorndike, *The Sphere of Sacrobosco and its Commentators* (Chicago: University of Chicago Press, 1949), 129.

[16] Thorndike, *The Sphere*, 139-140.

[17] Thorndike, *The Sphere*, 321.

[18] Edmond, Buron, *Ymago Mundi e Pierre d'Ailly. Teste latin et français des quatre traités cosmographicques de d'Ailly et des notes marginales de Christophe Colomb. Etudes sur les sources de l'Auteur*, 3 vols. (Paris: Maisonneuve frères, 1930); W. G. L. Randles, "Classical Models of World Geography and Their Transformation Following the Discovery of America," in *Geography, Cartography and Nautical Science in the Renaissance* (Burlington , Vt: Variorum , 2000), I: 38-39.

[19] Albertus Magnus, *Opera Omnia*, (ed.) August Borgnet (Paris: L. Vivès, 1890) 4:604.

[20] Pietro d'Abano, *Conciliator differentiarum philosophorum et praecipue medicorum* (Venice, 1565 [reprint Padova: Antenore, 1985]), Differentia LXVII, fol. 100v-102v.

[21] Aristotle, *Posterior Analytics* 75a38-75b6. For the history of this prohibition see: Amos Funkenstein, *Theology and the Scientific Imagination* (Princeton: Princeton University Press, 1986), 299-327.

[22] For a discussion of the relative absence of teleology in the *Meteorology* see: Liba Taub, *Ancient Meteorology* (London: Routledge, 2003), 80-84.

[23] Aristotle, *Meteorology*, 339a2-3.

[24] Cynthia A. Freeland, "Scientific Explanation and Empirical Data in Aristotle's *Meteorology*," *Oxford Studies in Ancient Philosophy* 8 (1990), 67-102.

[25] Hans Daiber, "The *Meteorology* of Theophrastus in Syriac and Arabic Translation," in *Theophrastus: His Psychological, Doxagraphical, and Scientific Writings*, William W. Fortenbaugh and Dimitri Gutas, eds., (New Brunswick: Transaction Books, 1992), 166-293, English trans. of treatise, 261-271.

[26] See rubrica lxxviii: "De lectura et ordine librorum legendorum." in Carlo Malagola (ed.), *Statuti delle università e dei collegi dello studio bolognese* (Bologna: N. Zanichelli, 1888), 274.

[27] For the *regressus* see: John Herman Randall, Jr., *The School of Padua and the Emergence of Modern Science* (Padua: Antenore, 1961); Nicolas Jardine, "Epistemology of the Sciences," in Charles B. Schmitt *et al.* (eds.), *The Cambridge History of Renaissance Philosophy* (Cambridge: Cambridge University Press, 1988) 708-711; Charles B. Schmitt, "L'aristotelismo nel veneto e le origini della scienza moderna," in Luigi Olivieri (ed.), *Aristotelismo veneto e scienza moderna* (Padua: Antenore, 1983) 79-103, (English version) 104-123; W. L. Wisan, "Galileo's Scientific Method: a Re-examination," in R. E. Butts and J. C. Pitt (eds.), *New Perspectives on Galileo* (Dordrecht: D. Reidel, 1978), 1-57. For a

biography and the chronology of Nifo's teaching see: Edward P. Mahoney, "Agostino Nifo," *DSB* X (1974), 122-124.

[28] For the editions of this work see: Charles H. Lohr, *Latin Aristotle Commentaries II: Renaissance Authors* (Florence: Olschki, 1988), 282-287.

[29] Agostino Nifo, *Expositio super octo Aristotelis Stagiritae libros de Physico Auditu* (Venice, 1552), 6v: "Dicendum, scientiam de natura non esse scientiam simpliciter, qualis est scientia mathematica, est tamen scientia propter quid: quia inventio causae, quae habetur per syllogismum coniecturalem, est propter quid effectus. per haec delentur obiectiones, quae contra haec fieri solent: Prima quidem delentur ex eo, quia non est circulus in demonstratione, cum primus processus sit tantum syllogismus, secundus vero demonstratio propter quid. deletur etiam Secunda obiectio, quia effectus semper est notior ipsa causa in genere notitiae quia est. nunquam enim causa potest esse ita certa quia est, sicut effectus, cuius esse est ad sensum notum. Ipsum vero quia est causae, est coniecturale, utrum tale esse coniecturale est notius ipso effectu, in genere notitiae propter quid. nam posita inventione causae semper scitur propter quid effectus. unde & Aristo., in libro Meteororum concedit se non tradidisse veras causas effectuum naturalium, sed quo erat sibi possibile coniecturabiliter. sed de his hactenus."

[30] Agostino Nifo, *In libros Meteorologicorum, in librum de Mistis, sive Quartum Meteororum, ab antiquis nuncupatum & ordinatum* (Venice, 1560), 329: "Est ergo opinio Aristotelis terrae habitabilis partes, quae bene, & ordinatae habitantur, esse duas: nostram, quae est in cona cancri, & illam, quam antipodes habitant, quae est sub cona capricorni, hanc nostram habitabilem esse videmus. Sed illam Aristoteles habitatam esse, ut Alexan. inquit, Non per historias tradit, sed per coniecturas, eo quia Sol eodem modo se habet ad illam, sicut ad nostram. Et licet temporibus Aristotelis fortasse habitatio in illa per historias non erat cognita, ut Alexan. inquit. Tamen temporibus nostris per navigationes habitata reperitur. Asserunt enim invenisse gentes adeo versus illum polum habitantes, ut polus elevetur ad gra. 60. & sic quod Aristoteles coniecturis probavit, historia [non?] comprobatur."

[31] Ibid.: "Respondet Alexan. Aristotelem esse locutum de bene habitantibus, modo isti aethiopes non bene habitant, sed propre aquas, quasi praeter naturaliter viventes."

[32] On his promotion of doubting see: Stefano Perfetti, "Docebo vos dubitare. Il commento inedito di Pietro Pomponazzi al *De partibus animalium*," *Documenti e Studi sulla Tradizione Filosofica Medievale* 10 (1999), 439-466.

[33] Lohr, *Latin Aristotle Commentaries* 347-362.

[34] For Pomponazzi's spirit of independence see the introduction to: Antonino Poppi, *Corsi inediti dell'insegnamento padovano* vol. 1 (Padua: Antenore, 1966), xv. For his method of commentary on *De partibus animalium* see: Stefano Perfetti, *Aristotle's Zoology and its Renaissance Commentators (1521-1601)* (Leuven: Leuven University Press, 2000), 33-63.

[35] E.g., Pietro Pomponazzi, *Dubitationes in quartum Meteorologicorum* (Venice, 1563), Dubitatio XIII, 8r: "Quare Alexandri expositio mihi videtur melior,"; Dubitatio, XXVI, 17r: "& haec responsio magis tolerabilis est."; Dubitatio XXVIII, 20v: "Mihi, ut verum fatear, magis place sententia Thomae de Garbo."; Dubitatio XLVII, 28r: "multo magis mihi placet haec responsio."; Dubitatio XLIX, 31v: "& mihi verior opinio,"; Dubitatio LXXIII, 41r: "Valeat haec responsio quantum potest." On the limits of certainty in this philosophical setting see: Luigi Olivieri, *Certezza e gerarchia del sapere: crisi dell'idea di scientificità nell'aristotelismo del secolo XVI* (Padua: Antenore, 1983), 117-133.

[36] Dubitatio XLIX, 30v: "(in philosophia enim non credendum authoritati sine ratione)"

[37] Dubitatio XLIX, 33v.

[38] Dubitatio XL, 37v: "Magna est authoritas Aristotelis. & solvere quaestionem hanc mihi non videtur facile. Vos considerate." See also: Dubitatio LXXXI, 40v: "Certe ego non video modum salvandi Aristotelem in hoc loco, … Meliorem solutionem ego non habeo. Si vultis meliorem, quaerite."

[39] 40v: "Multi volunt Aristotelem in omnibus bene dixisse, & stulti sunt."

[40] Dubitatio LXXXIII, 42v: "Domini ego nescio dici oporteat, neque possum Aristotelem defendere. Si erravit, eius fit damnum."

[41] Dubitatio CXXVI, 49r: "Aliud dubium, videtur Aristoteles sibi contradicere...nescio respondere, nisi, quod Aristoteles fuit homo, & potiut errare." On the history of this phrase see: Luca Bianchi, "'Aristotele fu un uomo e poté errare': sulle origini medievali della critica al 'principio di autorità,'" in Luca Bianchi (ed.), *Filosofia e teologia nel Trecento. Studi in ricordo di Eugenio Randi*, (Louvain-la-Neuve: Fédération internationale des instituts d'études médiévales, 1994), 509-533 [reprinted in updated version in Luca Bianchi, *Studi sull'aristotelismo del Rinascimento* (Padua: Il poligrafo, 2003), 101-132].

[42] Dubitatio XLII, 22v: "quae tamen opinio sit verior, credo ego nec Aristotelem, nec Galenum, hoc scivisse: sed solum Deum."

[43] Dubitatio XIIII, 17v: "Adde quod videtur philosophus facere insufficiente inductionem..." See Antonino Poppi, *Introduzione all'aristotelismo padovano* 2nd edition (Padova: Antenore, 1991), 13-44, for a characterization of Paduan Aristotelianism as privileging experience at the expense of metaphysics.

[44] Dubitatio LXIIII, 38v. Plutarch's story of the man with the incombustible foot as well as similar observations on the venom of snakes is also found in: Pietro Pomponazzi, *De naturalium effectuum causis sive De incantationibus* (Basel, 1567) 46-47.

[45] See Dubitatio LXXI, 40v: Certe ego non video modum salvandi Aristotelem in hoc loco, propterea quod si ex spiritu fit aqua, haec est humectatio, ut patet ad sensum"; Dubitatio CVIII, 47r: "Sed haec solution non placet, quoniam eadem pars terrae potest madefieri & etiam liquefieri, ut patet experientia."; Dubitatio IX, 4r: "& huius opinionis author fuit Calculator. quae tamen salvo meliori iudicio mihi videtur falsa est: est enim contra experientiam."; Ibid: "Verum meo iudicio melior est opinio communis, quam opinio Gaiet. ideo probo ego hoc esse contra sensum & experientiam, quod Gaietanus dicit."

[46] Dubitatio XII, 6v: "Avic. autem quarta primi, & Arist. 8 physicae ausc. Dicit, quod quando ratio adversatur experientiae, tunc omittenda ratio, & standum experientiae." Cf. Aristotle, *Physics* 8.1, 262a18ff.

[47] Dubitatio LXXVI, 41v: "Ego dicerem quod hoc potest sciri magis per experientiam quam per rationem."

[48] E.g., Louis Bourgey, *Observation et experience chez Aristote* (Paris: J. Vrin, 1955); G. E. R. Lloyd. "Experiment in Early Greek Philosophy and Medicine," *Proceedings of the Cambridge Philological Society* N.S. 10 (1964), 50-72, reprinted with introduction in *Method and Problems in Greek Science: Selected Papers* (Cambridge: Cambridge University Press, 1991) 70-99.

[49] John E. Murdoch, "The Analytic Character of Late Medieval Learning: Natural Philosophy without Nature," In L. D. Roberts (ed.) *Approaches to Nature in the Middle Ages* (Binghamton, NY: Center for Medieval & Early Renaissance Studies, 1982), 171-213.

[50] Pietro Pomponazzi, *In secundum librum Meteororum*, Ms. *Ambrosiana* 96 R sup., fol. 69v: "Notetis quod ego habeo epistolam missam a quodam Veneto. qui iverat in Legationem ad Regem Hispaniae, et venit versus polum Australem, opportuit ergo ut transiret torridam zonam, dixitque ibi esse plusquam trecentum insulas, tamen scribit illas esse discontinuas et quod ibi sunt infinita loca habitata. Ideo en quae hic dicitur ab Aristotele sunt fatuitates, ut videtis." A portion of this quotation and a similar *reportatio* are transcribed in: Bruno Nardi, *Saggi sulla cultura veneta del Quattro e Cinquecento* (Padua: Antenore, 1971), 52. On the widespread availability of printed reports of the discovery of the New World in Northern Italy, see: Liz Horodowich, "Armchair Travelers and the Venetian Discovery of the New World," *The Sixteenth Century Journal* 36 (2005), 1039-1062; Rudolf Hirsch, "Printed Reports on the Early Discoveries and their Reception," in Fredi Chiappelli (ed.), *First Images of America: The Impact of the New World on the Old* (Berkeley/Los Angeles/London: University of California Press, 1976) 2:537-538.

[51] Pomponazzi, *In secundum librum*, fol. 69v: "Cupiditas tamen gloriae et affectionis ducit nos ad dicendum saepe de superis, cum inferiora ignoremus."

[52] Pomponazzi, *In secundum librum*, fol. 71v: "Tamen argumentum adduco, quod omnium est fortissimum, quoniam Divus Augustinus ibi de Civitate dei cap. ultimo ubi disputat utrum sint antipodes vel non dicit ipse quod non sunt, imo ponere ipsos antipodes nihil aliud sit nisi fictio, et fatuitas Astrologorum, et Philosophorum."

[53] For the influence of Augustinians on the Papacy during this time see: John W. O'Malley, *Giles of Viterbo on Church and Reform* (Leiden: Brill, 1968), 41-49.

[54] *In secundum librum*., fol. 71v-72r: "Unum est quod Augustinus negat illa loca, et tamen philosophi tenent et experientia et sensus unius haec docere. Quid conclusio dicendum est. etiam ibi sunt homines bestiales, et non disciplinabiles, quo ergo docebimus eos quod credant, ea quae sensum fugiuntur profecto res est magna difficultatis, quo modo ergo deberent ipsi damnari, cum ipsi sint quasi bestiae, et feri sic, et forsan, quod nihilo sciunt de fide, imo sine forsan nihil credunt de his, quae non credimus, Cum ergo non sint in causa, quare debent damnari? Domini mei quoniam ego pervenio ad aliquem passsum ubi agitur de fide tunc ego me subijcio Fratribus, et quicquid ipsi mihi dicunt, ego credo: subijcio me semper correctioni ecclesiae: Profecto ego miror de multis qui se multa scire profitentur et minima videtis nos ignorare: maxime tamen miror de Averroe qui iurat animam suam has esse demones quas onit, et sunt mera sophismata. ego dimitto hoc, et cogitetis, et volo quod dicatis vestram sententiam, quantum credatis ipsum scivisse de copulatione intellegentis possibilis cum intellectu agente, quae mihi videtur maxima fatuitas. videtur autem homini ambitionbem, qui pollicetur demonstrationem causae et esse, quae profecto non valet unum quadrantem. Taceo de illa copulatione intellegentis. Unum est quod Aristotelis via est animam fuisse mortalem, manendo in via sua, et puris naturalibus. Infide ego nescio quid sit respondendum: Nescio enim quomodo illi Frates solunt argumentum, ego enim nescio solvere, tam Augustinus expresse negat illas habitationes quas diximus, et dicit esse phantasias Philosophorum, et Astrologorum."

[55] On Pomponazzi's condemnation and his recantation, see: Martin L. Pine, *Pietro Pomponazzi, Radical Philosopher of the Renaissance* (Padua: Antenore, 1986), 126-131. For accusations of his undercover attacks on established religions see: Martin L. Pine, "Pietro Pomponazzi's Attack on Religion and the Problem of the *De fato*," in *Atheismus im Mittelalter und in der Renaissance*, Friedrich Niewöhner and Olaf Pluta (eds.), (Wiesbaden: Harrassowitz Verlag, 1999), 145-172.

[56] Paul O. Kristeller, "The Myth of Renaissance Atheism and the French Tradition of Free Thought," *Journal of the History of Philosophy* 6 (1968), 233-243.

[57] For fideism and its opponents in the Middle Ages see: Etienne Gilson, *Reason and Revelation in the Middle Ages* (New York: Scribner, 1950).

[58] Francesco Vimercati, *In quatuor libros Aristotelis Meteorologicorum commentarii* (Paris, 1556), 229.

[59] Collegium Conimbricense, *In quatuor libros de Caelo* (Lyon, 1608), col. 402-406.

[60] Stillman Drake & C. D. O'Malley, *Controversy on the Comets of 1618* (Philadelphia: University of Pennsylvania Press, 1960).

[61] William R. Shea, *Galileo's Intellectual Revolution*, 2nd ed. (New York: Science History Publications, 1977), 79-81.

[62] Anna De Pace, *Le matematiche e il mondo: richerche su un dibattito in Italia nella seconda metà del Cinquecento* (Milano: FrancAngeli, 1993); Rivka Feldhay, "The Use and Abuse of Mathematical Entities," in *Cambridge Companion to Galileo*, (ed..) Peter Machamer (Cambridge: Cambridge University Press, 1998), 92-93.

[63] Heikki Mikkeli, *An Aristotelian Response to Renaissance Humanism* (Helsinki: SHS, 1992), 43.

[64] Baron de Montesquieu, *The Spirit of the Laws*, (tr.) Anne M. Cohler, Basia Carolyn Miller, & Harold Samuel Stone (Cambridge: Cambridge University Press, 1989), Bks. 14-17, pp. 231-284; Thomas Jefferson, *Notes on the State of Virginia* (New York: Library of America), 168.