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Theories of Animals as Weather Signs in Renaissance Italy

Introduction

In classical antiquity, many accepted the idea that animals' behaviors were signs of future changes in the weather. The rules for making such forecasts proliferated in collections that form a coherent tradition of weather signs.¹ The earliest extant collection dedicated to weather signs, now attributed to Theophrastus but considered to be by Aristotle for centuries, provided an extensive list of signs and eliminated «any philosophical underpinning or scientific framework» that might link the appearances of the sun, moon, and animal behaviors to weather.² This tradition of weather signs runs from Theophrastus through Aratus of Soli's *Phaenomena* to Roman works, including three extant Latin translations of Aratus, Pliny's *Natural History*, and Virgil's *Georgics*. These works show little interest in causal explanation and were instead devoted to poetic virtuosity or transmitting traditional knowledge that could be applied to agricultural and other manual endeavors.³

Subsequently, animal signs for weather prediction were marginalized in the ancient and medieval astrological traditions. Ptolemy's *Tetrabiblos* (2.13), a foundational astrological text, while containing a number of meteorological weather signs, puts forward no animal signs; and al-Kindi's *De mutatione temporum* concentrated on astrology for its rules for weather forecasting.⁴ Weather prediction found in medieval written sources is, for the most part, astrometeorological.⁵ Nevertheless, the ancient tradition of weather signs persisted and was revived in the early modern period, bolstered by more expansive readings of ancient sources. In the sixteenth century, a number of thinkers, including Pietro Pomponazzi, Agostino Nifo, and Ulisse Aldrovandi, sought to uncover the hidden causes

1. Liba Taub, *Ancient Meteorology*, London, Routledge, 2003, pp. 37-69.

2. Theophrastus, *On Weather Signs*, ed. by C. W. Brunschön, David Sider, Leiden, Brill, 2007, p. 4.

3. Taub, *Ancient Meteorology*, pp. 43-58.

4. Al-Kindi, *Scientific Weather Forecasting in the Middle Ages*, ed. by Gerrit Bos, Charles Burnett, London, Kegan Paul International, 2000.

5. Stuart Jenks, *Astrometeorology in the Middle Ages*, in «Isis», 74 (1983), pp. 185-210.

behind the connections between animals and weather. Their theories, in turn, reveal diverse attitudes toward divination and augury, astrological influences, and the relation between signs and efficient causation. In sum, Renaissance understandings of the purported links between animal behavior and weather reveal cosmological, epistemological, and theological commitments; views on the differences between humans and animals; and the willingness to transform ancient literary traditions uncovered by humanist investigations into material for natural philosophy and natural history.

Animals as Weather Signs in the Ancient and Medieval Tradition

Theophrastus's *On Weather Signs* lists phenomena used to forecast changes in weather. The work is organized according to the category of weather. Separate sections treat signs of rain, winds, storms, fair weather, and then finally miscellaneous signs. A typical sign is sparse in its formulation, indicating the sign and then the effect. For example, one reads: «A raven in winter producing many sounds is a sign of storm».⁶ Theophrastus considered animal signs to be less reliable than those based on the appearances of the sun and the moon and on the rising and settings of constellations that correspond to the changing of the seasons.⁷

Despite the absence of elaborate causes in this treatise, Peripatetics sought out such explanations elsewhere. It is possible that this work was meant to be a collection of observations that could be used to formulate general rules or to investigate the links between sign and effect. A few of the examples in Theophrastus's collection correspond to passages in Aristotle's works where he formulated potential causal explanations for animals' forecasting of the weather. For example, in *On Weather Signs*, the time when flocks of cranes fly is described as indicating when storms will arise.⁸ In the *History of Animals*, Aristotle seems to have justified the use of the behavior of cranes as an indicator of storms on the grounds that they are highly intelligent and capable of flying to great heights where they can see clouds and other meteorological indications of bad weather. The causes are thus linked to the birds' sagacity and their access to information that is not available to humans positioned at lower elevations.⁹

While Theophrastus maintained that his weather signs were based on observations either made by him and his associates or by others of «no small repute», the use of animals, in particular birds, as a means of predicting the future corresponds to traditions of augury practiced in the ancient world. Many of these prac-

6. Theophrastus, *On Weather Signs*, p. 85.

7. *Ibid.*, pp. 61-63.

8. *Ibid.*, p. 83.

9. Arist., *HA*, 9.10.614b18-21.

tices were based on interpreting the flight of birds.¹⁰ Although ancient philosophers presented diverse accounts of divination, there was widespread belief that it was difficult to understand why animals might help predict the weather and the outcomes of human affairs. Indeed, Epicurus suggested that the correspondence between weather and signs from animals resulted from mere coincidence.¹¹ To the contrary, some Stoic philosophers gave justifications for divination based on the idea that all events form part of a causal chain that ultimately depends on God's providence. For Stoics, augury and induction based on animal signs are valid because they derive from the same divine mind that orders the universe.¹² Similarly, Cicero in *De divinatione* recounted the idea, without endorsing it, that a «divine mind» (*divina mens*) causes the flight of birds that function as omens.¹³ Cicero, however, seemingly remained skeptical of the possibility of explaining animal signs. This dialogue refers to an attempt made by the Stoic philosopher Boethus of Sidon, the author of a non-extant commentary on Aratus's *Phaenomena*. Boethus gave a plausible account of why the heavens and the sky can help prognosticate the future but failed to explain why animal behaviors do. «Who is there who could suspect that frogs foresee this?» Boethus asked. He answered only that they have a power of foresight beyond human understanding.¹⁴ The character of the dialogue named Marcus Cicero expressed skepticism about the use of birds' flights in augury more generally, that is, in predicting not the weather but the outcomes of human endeavors. He described it as an erroneous practice of the ancients that survives only as part of traditional religion, contending that Roman society retained this practice, like many rites, to bolster the authority of the republic.¹⁵ In contrast to Cicero's character in the *De divinatione*, some late-antique Platonists endorsed both the efficacy of augury and of divination using animals. Notably, Plotinus, in the *Enneads*, theorizing that the world is a single unity, used the concepts of sympathy and coordination to argue that all parts of the world form a chain. The existence of this chain suggests that divination through both stars and birds can announce the future.¹⁶ It appears, however, that in this passage Plotinus was considering birds in the augural practices that predict outcomes for human actions rather than as signs for the weather.

In the Latin Middle Ages, the distinction between weather signs and augury remained, reinforced not just by skepticism toward the effectiveness of augury but also by doubts about its religious legality for Christians.¹⁷ Despite persistent con-

10. Theophrastus, *On Weather Sign*, p. 61.

11. Taub, *Ancient Meteorology*, pp. 37-38; Epicur., *Letter to Pythocles*, in D.L., 10.98-9.

12. Francis Henry Sandbach, *The Stoics*, London, Duckworth, 1989, pp. 79-82; Samuel Sambursky, *Physics of the Stoics*, Princeton, Princeton University Press, 1959, pp. 65-71.

13. Cic., *Div.*, 1.53.

14. *Ibid.*, 1.9.

15. *Ibid.*, 2.33.

16. Plot., *Enn.*, 2.3.7.

17. Alexander Fidora, *Divination and Scientific Prediction: The Epistemology of Prognostic Sciences in Medieval Europe*, in «Early Science and Medicine», 18 (2013), pp. 517-535.

cerns about augury, a few medieval zoological writings discussed animal signs. Albertus Magnus wrote the most extensive and influential Aristotelian consideration of zoology in medieval Latin Christendom. His *De animalibus* consists of twenty-six books and contains a mixture of his own observations, reports from antiquity, philosophical discussions, and zoological anatomy. The distinction between observing animals as augury or as weather signs determines Albertus's willingness to investigate causation. Albertus reported beliefs about the ominous or propitious properties of animals but refused to conjecture about their causes. For example, after citing the appearance of crows and vultures, known for their sagacity, which presages dangers and the destruction of civilization, he narrated a recent occurrence in Sweden in which the presence of a flock of crows preceded the death of the local count. In this case, Albertus did not deign to attribute a cause. He maintained that «to dispute on the wisdom and the conjectures of augurs belongs to another science», presumably theology.¹⁸ Elsewhere, he cut short his discussion of the *caladrius*, a bird that according to legend is capable of diagnosing disease, since the topic was closer to a case of augury than to a subject of natural philosophy.¹⁹

As for weather signs, Albertus put forth several explanations that refer to the intelligence, sagacity, and sensations of animals. He held that animals differ in sagacity or prudence relative to the degree that they imitate man's perfection and rationality.²⁰ Some weather signs result from the animals' prudent desire for self-preservation or ease of life. Dolphins signal maritime storms because they seek safety near the shore.²¹ Ducks seek to fly with winds that aid their flight, thus it is possible to predict winds, cold, and rain from their paths.²² The sandfish (*scincus scincus*), a lizard native to northern Africa, announces the direction of imminent storms when it protects itself from oncoming winds.²³ Albertus was open to the idea that the especially sensitive senses of birds and other animals were superior to those of humans. Roosters, because they «easily sense the changes in the air that result from the motions of the sun», are capable of marking time with their crowing.²⁴ The *echeneis naucrates*, or remora, a fish that according to legend was capable of stopping ships, presages storms as it feels the underlying matter of winds rise up from the depth of the sea and then stabilizes itself by attaching itself to rock «just like an anchor».²⁵

18. Albertus Magnus, *De animalibus libri XXVI*, 2 voll., ed. by Clemens Bacumker, Münster, Aschendorff, 1916, I, pp. 618-619.

19. *Ibid.*, II, p. 1446.

20. Guy Guldentops, *The Sagacity of Bees: An Aristotelian Topos in Thirteenth-century Philosophy*, in *Aristotle's Animals in the Middle Ages and Renaissance*, ed. by Carlos Steel, Guy Guldentops, Pieter Buellens, Leuven, Leuven University Press, 1999, p. 285.

21. Albertus Magnus, *De animalibus*, II, p. 1530.

22. *Ibid.*, II, p. 1441.

23. *Ibid.*, II, p. 1546.

24. *Ibid.*, II, p. 1496.

25. *Ibid.*, II, p. 1532.

Albertus put forth a nearly identical description of the cuttlefish's supposed capacity for predicting storms; when they sense vapors, they bind themselves to rocks before the storm thereby protecting themselves from the sea's violence. Albertus linked this ability to prognosticate to his understanding of psychology. He theorized that cuttlefish were among the «dull and imprudent animals» that are more capable of predicting such dangers better than wiser and more prudent animals. He proposed that these duller animals being less concerned with themselves are more capable of receiving external impressions.²⁶

This explanation parallels the Aristotelian account of the alleged phenomenon that only stupid people receive divinations in their dreams, an account that Albertus endorsed. Aristotle maintained that some sense stimuli are too faint to be noticed while awake because conscious humans are overwhelmed by a flood of sensations. While asleep, however, some people can perceive these slight sensations. The sleeper's faculties of perception exaggerate the input, so a small noise becomes loud thunder in a dream. Similarly, the first stages of diseases, caused by humoral imbalance, might be noticed during sleep despite being imperceptible while conscious. In this manner, a dream can be a sign of future disease. Beyond these harbingers of physical distress, Aristotle thought it could be possible that other kinds of movements and perceptions might enter dormant souls prompting the receiver to use these vivid reveries for divination. Some people are more susceptible than others to these telling dreams, according to Aristotle. Categorizing humans by their temperaments and by their mental capacities, he thought that the melancholic, those with unstable minds, the garrulous, and the simple are prone to possessing this extraordinary divinatory ability because their own thoughts are not strong enough to obscure these faint stimuli.²⁷ Accordingly, Albertus applied an analogous explanation for the supposed phenomena that some less intelligent animals, like the cuttlefish, sense dangers more quickly and consequently their behaviors are more apt to be harbingers of storms.

Pomponazzi and Nifo

Because Albertus's *De animalibus* was the most extensive philosophical treatment of animals written during the later Middle Ages, it had a considerable impact on Renaissance understandings of zoology.²⁸ During the Renaissance, prominent Italian philosophers, such as Pietro Pomponazzi and Agostino Nifo, were well aware of his views and at times cited them.

Divination came under renewed scrutiny in the years around 1500. Giovanni Pico della Mirandola tried to discredit astrology and his nephew Gianfrancesco

26. *Ibid.*, II, p. 1340.

27. Arist., *Div. Somn.*, 2.463b12-22.

28. Stefano Perfetti, *Aristotle's Zoology and its Renaissance Commentators, 1521-1601*, Leuven, Leuven University Press, 2000, pp. 1-3.

Pico warned of the theological dangers of prognostication and divination.²⁹ Despite rejecting many forms of divination as irreligious and superstitious, Gianfrancesco Pico allowed prediction that could be justified causally or experientially. For example, predicting that wood will burn when exposed to fire is neither foolhardy nor impious, he contended.³⁰ Animal signs are also potentially legitimate. In his view, animals can presage the future because they act according to their natural instinct that impels them toward safety and comfort. For example, swallows' acute senses and small bodies allow them to flee Zephyr, a westerly wind, before humans are able to sense it.³¹ Thus, for Gianfrancesco Pico, knowledge of the causes behind animals' behavior can help predict future weather and legitimize it as a permissible form of prognostication.

Pomponazzi dismissed the wholesale rejection of divination found in Gianfrancesco Pico's works and retained causal structures similar to those of Stoics to explain why animals are signs of the future. While professor of philosophy at Bologna, he wrote two of the most controversial philosophical works of the first decades of the sixteenth century: *De immortalitate animae* and *De incantationibus*. Both are notable for their naturalism. *De immortalitate animae*, printed in 1516, argued that according to Aristotle and the dictates of Peripatetic philosophy it is probable that the human intellect does not survive the death of the body. The treatise set in motion waves of incriminations, defenses, and apologies.³² *De incantationibus*, written in 1520, was not printed until decades after Pomponazzi's death in 1525, although it circulated widely in manuscript in the years immediately after its composition.³³ In that work, Pomponazzi contended that the use of demons as a philosophical explanation did not conform to reason or experience and that explanations based only on natural causes could better account for a wide range of seemingly miraculous or preternatural phenomena, including human powers of divination. In his discussion of divination, he found parallels between animal and human capacities to understand the future. Like Albertus, he wished to understand why animal behavior predicts weather. Unlike Albertus, he believed their use as a forecasting tool is related to the foundations of the ancient art of augury, which he maintained was an effective divinatory practice.

In the tenth chapter of *De incantationibus*, Pomponazzi proposed that apparitions, visions, and dreams that signify the future are not supernatural but the result of natural causes that ultimately stem from God's care for the universe and

29. Giovanni Pico della Mirandola, *Disputationes adversus astrologiam divinatricem*, ed. by Eugenio Garin, 2 voll., Torino, Nino Aragno, 2004.

30. Gianfrancesco Pico della Mirandola, *De rerum praenotione libri novem*, Strasbourg, Knobloch, 1507, sigg. Eiv-Eiir.

31. *Ibid.*, sig. Eiir.

32. Paul Richard Blum, *The Immortality of the Soul*, in *The Cambridge Companion to Renaissance Philosophy*, ed. by James Hankins, Cambridge, Cambridge University Press, 2007, pp. 211-233.

33. Laura Regnicoli, *Produzione e circolazione dei testimoni manoscritti del De incantationibus*, in *Pietro Pomponazzi: Tradizione e dissenso*, ed. by Marco Sgarbi, Firenze, Olschki, 2010, pp. 131-180.

from the celestial intelligences' providential ordering of the universe.³⁴ He asked rhetorically whether, just as astrologers can make predictions from the stars, «is it not possible that these [signs] can be recognized even in beasts?»³⁵ For example, expert sailors can predict storms using various signs.³⁶ But ancient historians recounted that animals predicted more than the weather, accounts which Pomponazzi accepted because of the authority of ancient sources. Relying on histories, he contended that the significant turning points of the lives of famous men are preannounced by seers who interpret signs that are visible in «beasts, plants, the elements».³⁷

Pomponazzi explained that these indications of the future might be the result of celestial bodies that affect and alter the air, creating the appearance of soldiers or saints in the sky. Alternatively, they might make similar impressions directly on the soul, either during sleep or even on those who are awake, if they are free from worries and have a clear mind. People who directly receive these impressions – Pomponazzi wrote – are like «animals that have foreknowledge of future events».³⁸ Many of the examples of animals that he gave – the rooster who senses the new day and changes in weather, the crow that is a sign of a massacre, and dolphins that indicate storms – are found in Albertus's *De animalibus*. He wrote that these animals are *stellae secundae* (second stars) and, contrary to Theophrastus, are more reliable indicators of the weather than celestial bodies because they «are closer to the effects that will be produced». As a result, sailors and farmers make «more certain predictions» than astrologers.³⁹

Pomponazzi extended the ability of animals to predict the future to human events in addition to the weather. This ability derives from links between animals' natures and the ordering power of the heavens. The crow that signifies future evils is fleeing his normal habitat because of the «impression of celestial bodies» that are responsible for the cataclysms. In an argument that has a clear parallel in Cicero's *De divinatione*, Pomponazzi contended that some birds have internal properties – analogous to the hidden powers of *materia medica*, like scammony – that are the reason that their movements to the left or right or their songs signify favorable or unfavorable outcomes for humans. This knowledge depends not on philosophical reasoning. Rather, «we know this through much experience», that is, that crows and other birds have internal properties and natures that react to celestial causes.⁴⁰ In his eyes, animals are part of a chain of causation that begins

34. Guido Giglioni, *Il cielo sopra l'Aquila. Pietro Pomponazzi su immaginazione e devozione popolare*, in *Pietro Pomponazzi: Tradizione e dissenso*, ed. by Marco Sgarbi, Firenze, Olschki, 2010, pp. 271-283.

35. Pietro Pomponazzi, *De incantationibus*, ed. by Vittoria Perrone Compagni, Firenze, Olschki, 2011, p. 86.

36. *Ibid.*, p. 86.

37. *Ibid.*, pp. 87-88.

38. *Ibid.*, p. 92.

39. *Ibid.*, p. 92.

40. *Ibid.*, p. 95; Cic., *Div.*, 1.10.

with God, moves through the intelligences and their celestial spheres, and alters the animals below in a determined and providential manner that allows humans, at least some of them, to know the future.

In the *De immortalitate animae*, Pomponazzi argued that the fact that animals presage not just the weather but human events suggests that they are part of a cosmic chain of causation and that the heavens can directly form impressions on the human soul about the future. Thus, animal signs confirm the possibility of natural divination in humans. He believed that there was continuity between animals and the bulk of humanity; most humans, and especially those who live in extreme climates, do not use their intellect and thus live like beasts.⁴¹ This continuity is reflected in the shared ability to prognosticate. According to Pomponazzi, celestial bodies produce portentous wonders and prodigies for the goodness of humankind, and their making of portents «in sheep» suggests that they should also be able to do the same in people who possess powers of divination.⁴² Citing a passage from Aristotle's *History of Animals*, which recounted that crows left Athens and the Peloponnese at the time when mercenaries under Medius were killed at Pharsalus as evidence that the birds have a sense of the unfolding of the future, Pomponazzi concluded that some humans must also have this capacity to predict the future.⁴³ Thus, he asked: «If birds and many other beings that lack reason can indicate through the impression of the heavens, why not also humans similar to them?»⁴⁴ Animals' ability to foretell the future, whether as weather signs or as auguries of human events, reveals their place in the cosmic order as well as the capacities of the human soul to receive knowledge directly from the celestial intelligences.

For decades Agostino Nifo was Pomponazzi's rival. They engaged in heated disputes while teaching at Padua in the first years of the sixteenth century. Later, they were immersed in bitter polemics about the question of the mortality of the human intellect in the years just before 1520. Both lectured on Aristotle's *Meteorology* and Nifo's commentary on it, first printed in 1523, was among the most frequently printed and read during the sixteenth century. Aristotle, with few exceptions, eschewed consideration of weather signs or forecasting in his *Meteorology*. In the passages where he considered signs, such as in his treatment of earthquakes, a phenomenon he believed to be caused by subterranean winds and thus meteorological, the signs of future tremors were employed as evidence for the underlying causes.⁴⁵ For example, the absence of wind that precedes and predicts

41. Roberto Lo Presti, *(Dis)embodied Thinking & the Scale of Beings: Pietro Pomponazzi & Agostino Nifo on the "Psychic" Processes in Men & Animals*, ed. by Stefanie Buchenau, Roberto Lo Presti, Pittsburgh, University of Pittsburgh Press, 2017, p. 47.

42. Pietro Pomponazzi, *Tractatus de immortalitate animae*, ed. by Gianfranco Mora, Bologna, Nanni & Fiammenghi, 1954, p. 216.

43. *Ibid.*, p. 222; Arist., *HA* 9.31.618b12-17.

44. Pomponazzi, *De immortalitate*, p. 222.

45. Jean-Marc Mondasio, *Meteorology and Weather Forecasting in the Middle Ages*, ed. by Alexander Fidora, *Die mantischen Künste und die Epistemologie prognostischer Wissenschaften in*

earthquakes is evidence that vapors beneath the earth's surface are the efficient cause, because the stillness in the air suggests that many destructive vapors are below, not above, the earth. Similarly, Nifo held that the field of meteorology used signs to conjecture on the causes of the weather phenomena, believing that because of the difficulty of the topic, many of its theories were not certain.⁴⁶

Unlike Aristotle and many of his medieval and Renaissance commentators, Nifo tried to integrate his understanding of weather signs with his interpretation of Aristotle's *Meteorology*. Nifo thought that *On Weather Signs* was written by Aristotle not Theophrastus, yet it was not the only source for his investigation.⁴⁷ Nifo wrote that he had «collected [signs] from good authorities», which included Pliny and Hippocrates.⁴⁸ His understanding of weather phenomena generally, but especially marvelous or extreme examples, was colored by his familiarity with both ancient texts and more recent experiences. He cited Pliny's enumeration of the specific years in which it rained wool, sponges, worms, frogs, fish, milk, and blood, in addition to the time it rained blood in his home town Sessa, not far from Naples.⁴⁹ These «monstrous rains» were signs of future cataclysms, in Nifo's view. These signs seemingly are causally connected to the stars, as they portend the same outcome that Mars and Mercury do, namely violence. Other signs while not monstrous are still harbingers of future evils, namely plagues and other epidemics. They coincide because of concomitant sublunary causes: rainy years are less healthy, presumably as the result of an excess of humidity.⁵⁰ While Nifo in general was a firm proponent of astrology, many of the prognostications discussed in his commentary on Aristotle's *Meteorology* are tied to these sublunary factors. Hail, for example, portends a year of famine since it destroys vegetation. After hail melts, Nifo theorized, its liquid enters into pores in the ground where it destroys plants' powers of growth.⁵¹

In Nifo's commentary on the *Meteorology*, he discussed these signs of calamities, cataclysms, and disasters together with weather signs, including those derived from animals. He pondered causation, although he admitted that the proposed explanations were neither definitive nor complete. He wrote: «For some, a reason can be given, for others it cannot, but they are confirmed by observation».⁵² He expressed greater confidence in establishing causes of future rain and fair weather that derived from the appearance of the sun and the moon than from animals. The halos, parahelia, and colors of the moon reflect the thickness of the air,

Mittelalter, Köln, Böhlau, 2013, pp. 167-181.

46. Craig Martin, *Renaissance Meteorology*, Baltimore, Johns Hopkins University Press, 2011, pp. 33-34.

47. Agostino Nifo, *In libris Aristotelis Meteorologicis commentaria*, Venezia, Scoto, 1547, fol. 45r.

48. *Ibid.*, fol. 44r.

49. *Ibid.*, fol. 43v.

50. *Ibid.*, fol. 44r.

51. *Ibid.*, fol. 45v.

52. *Ibid.*, fol. 45v.

the presence of pluvial matter, or earthy exhalations in the sky, which in turn are the material causes of imminent weather phenomena. Inanimate bodies' role in the chain of causation is more apparent than that of living beings. He was less certain, therefore, of the reason why animals are signs of future rain, although he did not doubt that they are. The commentary lists the behaviors of roosters, cranes, ants, frogs, cows, swallows, asses, and crows that presage rain. Despite his lack of certainty, Nifo provided a preliminary explanation. He wrote: «Signs from animals as well were collected, for which we cannot assign a cause, except from their sensations; for animals being less engaged and having weaker bodies perceived the changes of weather».⁵³ Animals simply feel oncoming weather better than humans do. Animals' delicateness, lack of engaged intellect, and the sensitivity of their powers of sensation account for why they predict the weather, according to Nifo.

Nifo's interest in weather signs extended beyond his commentary on Aristotle's *Meteorology*. He wrote what is perhaps the only Renaissance commentary on Theophrastus's *On Weather Signs*, which was printed in 1540. While in name the commentary is an interpretation on the work now credited to Theophrastus, in essence it is Nifo's attempt to integrate the work into natural philosophy by adding causes. In order to achieve this goal, Nifo demonstrated the coherency of the ancient tradition of weather forecasting, integrating citations of Ptolemy, Aratus, Theon of Alexandria, and Pliny. Once again, the reasons for why animals are predictive are less developed than those for the two luminaries and aerial phenomena. And once again, the causes are linked to animal sensation, as well as to instinct. In the section about the signs of fair weather, Nifo wrote that «many signs are accustomed to be taken from birds and from animals, for animals are moved by some kind of inborn instinct from the impression of the celestial bodies through the disposition of the air that leads to an understanding (*cognitio*) of the weather».⁵⁴ Thus, Nifo clarified the relation between celestial powers and animal cognition, whereby the heavens affect the air, which in turn affects the animals. Animals' actions are signs because they reflect the conditions and qualities of the air that are the proximate causes of changes in weather. For example, he asserted that mating among animals later in the year than usual is a sign of mildness because it is connected to the greater presence of humidity and coldness in the air during August.⁵⁵

Nifo's interests were wide-ranging. In 1531 he published *De auguriis*, a work that treats ancient customs and beliefs regarding augury. The first book describes ancient practices. The second book discusses objections to the plausibility and legitimacy of the art. He concluded that the cause of the belief in auguries was

53. *Ibid.*, fol. 50.

54. Agostino Nifo, *De verissimis temporum signis commentariolus*, Venezia, Scoto, 1540, p.

43.

55. *Ibid.*, p. 47.

demonic.⁵⁶ Yet, in the introduction he lent credence and gravitas to the subject by mentioning that Aristotle collected examples of augury in his *History of Animals* – Nifo cited the example of crows mentioned above – and believed that sneezing could be propitious. In his commentary on the *History of Animals*, Nifo was non-committal about Aristotle's possible endorsement of augury and limited himself to historical exposition. He interpreted the passage as merely showing that «the absence of crows signified a destruction of this sort according to the augurs of that region» and not necessarily according to Aristotle.⁵⁷ In *De auguriis*, however, he differentiated «presages» from other kinds of omens and indications used in augural practice. He wrote: «A presage is more common, for each animal to presage is presaging what is caused, that is, to sense the future beforehand».⁵⁸ Nifo contended that auguries cannot work, and therefore are superstitious, because according to Peripatetic philosophy accurate predictions can be made only when there is a correspondence between cause and effect. While in medicine and astrology such connections exist – stars are causes of the arrangement of the lower world, and symptoms are effects of disease – in other cases, including divination through dreams and augury, the link is merely accidental.⁵⁹ Animals as presages of weather fall into this acceptable category. Here, Nifo lifted material from his *Meteorology* commentary: little crows cawing frequently announces rain because they understand from heavenly impressions made on the air that the weather is changing.⁶⁰

This distinction between acceptable presage and dangerous and erroneous augury recurs in Ulisse Aldrovandi's *Ornithologiae*, a monumental volume first printed in 1599, which presents a natural history of birds that combines personal observation, humanist erudition, and a commitment to Aristotelian natural philosophy. Unlike Nifo and Pomponazzi, Aldrovandi spent a large portion of his scholarly career observing and collecting specimens of animals.⁶¹ In the introduction to the work, he distinguished auguries from presages. He contended that because augury conjectures about events that depend on the human will it is independent from natural causes. Since only God has foreknowledge of these events, the practice is «erroneous, superstitious, and clearly contrary to holy Scripture».⁶² Aldrovandi cited *Jeremiah 27* and *Deuteronomy 18* in support of its prohibition. Other conjectural arts, such as medicine, and agriculture, that rely on natural causes, however, are acceptable. Accordingly, Aldrovandi not only de-

56. Agostino Nifo, *De auguriis*, Basel, Hervagius, 1534, p. 117.

57. Agostino Nifo, *In omnes Aristotelis libros. De Historia animalium, De partibus animalium, & earum causis ac de Generatione animalium*, Venezia, Scoto, 1546, p. 280.

58. Nifo, *De auguriis*, p. 10.

59. *Ibid.*, pp. 104-105.

60. *Ibid.*, p. 112.

61. Paula Findlen, *Possessing Nature: Museums, Collecting, and Scientific Culture in Early Modern Italy*, Berkeley-Los Angeles, University of California Press, 1994, pp. 304-316.

62. Ulisse Aldrovandi, *Ornithologiae, hoc est de avibus historiae libri XII*, Bologna, Manolesiana, 1681, p. 12.

fended observing birds for forecasting but offered elaborate explanations of the natural causes that link birds' behaviors with changes in the weather. These explanations built on those found in Nifo's work.

In contrast to the error of augury, it is possible to know why birds are presages with «great certainty». While birds do not use reason to understand changes in weather, they possess a «keenest natural instinct», which allows them to «perceive most often changes in the weather that excite and threaten them».⁶³ In many cases, avian reactions to impending weather depend on physiology and the four prime qualities. Aquatic birds exult at the arrival of cooling rain that will relieve them from hot vapors. Other birds prefer dry conditions and flee incoming wet weather. It is possible to predict weather from changes in birds' song because intemperate wet air can affect their voice as it enters into the birds' lungs and arteries. Following the idea that changes in the air affect internal changes within birds, Aldrovandi put forward the natural causes behind the signs of numerous species of birds, combining his own personal observations with maxims taken from Pliny and the *Georgics*.⁶⁴ Aldrovandi followed Nifo in distinguishing natural signs from augury and sought to define the physiological chain of causation that renders animals' behaviors signs of future weather.

Conclusion

The revival of the ancient tradition of weather signs remained remarkably persistent. Attempts to render it relevant to meteorology and natural history recur in the seventeenth and eighteenth centuries. Francis Bacon, in his *History of Winds*, wrote that he sought to collect the various rules for the prognostication of winds, paying little attention to astrology but more to the nature of meteorological and aqueous phenomena and to the «instincts of animals».⁶⁵ Indeed, toward the end of the history he listed 78 maxims for prognostication that include ten that address animal behaviors as indicators of future winds, rains, fair weather, and storms. The signs listed by Bacon, relating to aquatic birds, dolphins, pigs, and spiders all correspond to passages in Pliny's *Natural History*.⁶⁶ Despite there being a strongly traditional element to Bacon's list, it perhaps represented a challenge to the astrological techniques typically employed in the annual predictions of weather throughout the Renaissance, as he asserted that he would ignore the more elaborate techniques astrologers employed.⁶⁷ Using animals to foretell future weather, however, was acceptable and even formed part of his vision for the

63. *Ibid.*, p. 9.

64. *Ibid.*, pp. 10-11.

65. Francis Bacon, *Historia ventorum*, in *The Oxford Francis Bacon*, ed. by Graham Rees, Oxford, Oxford University Press, 2007, vol. 12, p. 28.

66. *Ibid.*, pp. 118-119.

67. *Ibid.*, p. 22.

new sciences. Yet, Bacon did not consider the reason why animals might be presages of the weather, beyond his mention of instinct. At the end of the work, Bacon hypothesized about the matter and the causes of the winds, but he did not seek out an explanation or speculate why these animals' behaviors might forecast the weather.⁶⁸

Later naturalists, however, sought to reintroduce causation for the phenomena. Even in the aftermath of the scientific revolution, authors of scientific works on meteorology still pondered animal signs. Giuseppe Toaldo, a professor of astronomy at Padua who systematically recorded the weather in an effort to develop an observationally based meteorology, treated a number of signs taken from Aratus in his 1770 *Saggio meteorologico*. An Italian translation of the Aratus's *Prognostics*, the second part of his didactic poem, forms an appendix to the volume. Toaldo reported that Nifo's *Commentariolus* was one of his sources, even if this book, in his view, was «full of useless repetitions».⁶⁹ Toaldo, like his Renaissance predecessors, sought not just to transmit the ancient tradition but to render it coherent by providing physiological explanations. But instead of the cosmological, astrological, and humoral explanations of Pomponazzi, Nifo, and Aldrovandi, he applied more recently developed theories of the workings of nature. «Organic beings and animal machines», he wrote, «feel the changes of the surrounding air» because they have the «most mobile fluids and most irritable fibers», irritability being a central idea of Albrecht von Haller's understanding of the contraction of muscles. Animals with «their natural instincts, their more acute organs [...] feel these impressions before we do».⁷⁰

While scholars have emphasized Toaldo's conviction that lunar effects can predict the weather, he chose a different explanation for animal signs.⁷¹ In the decades before the publication of his *Saggio*, Benjamin Franklin argued that lightning and electrically-charged sparks artificially generated and stored in Leyden jars were identical, and Jean-Antoine Nollet and Joseph Priestly developed theories of electricity as a subtle fluid.⁷² In Italy, Giambattista Beccaria had endorsed Franklin's experimental approach and maintained that electric fluid was responsible for a large number of atmospheric and meteorological phenomena. Following upon Franklin and Beccaria, Toaldo was among the first investigators into atmospheric electricity – he designed early lightning rods – and speculated on the existence of electricity within living bodies, applying this theory to explain

68. *Ibid.*, pp. 124-128.

69. Giuseppe Toaldo, *Della vera influenza degli astri, delle stagioni, e mutazioni di tempo, saggio meteorologico*, Padova, Stamperia del Seminario, 1770, p. 201.

70. *Ibid.*, p. 196.

71. Stefano Casati, *La meteorologia lunare di Toaldo*, in *Giuseppe Toaldo e il suo tempo: Scienze e lumi tra Veneto e Europa*, ed. by Luisa Pigatto, Paolo Casini, Cittadella, Bertonecello, 2000, pp. 697-719.

72. John L. Heilbron, *Electricity in the 17th and 18th Centuries: A Study of Early Modern Physics*, Berkeley-Los Angeles, University of California Press, 1979, pp. 307-402.

why animal behavior predicts future weather.⁷³ Criticizing the approaches of Renaissance explanations, he wrote: «Little was understood of these signs, attributed therefore to natural divination, until the new discovery of electric-animal fire».⁷⁴ In his view, the «delicate machines» of animals «probably» have a vital power of electricity, which is the «great instrument of organic movement». The electricity in the atmosphere that gains force from vapors and humidity affects the electric fire within animals. Toaldo conceded that the precise mechanism of how this happens was unknown but insisted that electricity offered a justification for traditional beliefs in animal signs.⁷⁵

Even though Toaldo's explanation differed from Nifo's and Aldrovandi's, in some sense his project was the same. Accepting the validity of the ancient tradition of weather signs, they used current understandings of physiology and physics to provide a causal account of both popular conceptions and the rules regarding animals found in the writings of antiquity's philosophers and poets.

73. Paola Bertucci, *Enlightening Towers: Public Opinion, Local Authorities, and the Reformation of Meteorology in Eighteenth Century Italy*, in «Transactions of the American Philosophical Society», 99 (2009), pp. 35-39; Antonio Lepschy, *Giuseppe Toaldo e il conduttore elettrico*, in *Giuseppe Toaldo e il suo tempo: Scienze e lumi tra Veneto e Europa*, ed. by Luisa Pigatto, Paolo Casinsi, Cittadella, Bertonecello, 2000, pp. 483-501.

74. Toaldo, *Saggio*, p. 196.

75. *Ibid.*, p. 197.