Corrado la Martire

The Role of Comets between Historical Events and Natural Disasters

A Philosophical Perspective from Ibn Bāǧǧa's 'Commentary on Aristotle's Meteorology'

Abstract Comets were historically linked with significant events and celestial omens. However, they were not considered noteworthy in ancient times, as they were simply regarded as being irregular phenomena caused by exhalations near the Earth's surface. In his 'Commentary on Aristotle's Meteorology', Ibn Bāǧǧa mentions the destruction of Byzantine cities, likely Helike and Boura, along with a comet in 373 BC. Although ancient authors have reported this event with mystification, Olympiodorus, Avicenna, and Averroes mentioned it in their comments on Aristotle's 'Meteorology' without acknowledging the presence of a comet. This article explores why Ibn Bāǧǧa mentions the comet and how he organised meteorological events like this into a coherent system that presupposes regular movements, from which apparent irregularities follow.

Keywords Aristotle; Comets; Earthquakes; Ibn Bāǧǧa; Meteorology

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1 Introduction

In 373 BC, an earthquake occurred in the Gulf of Corinth, Greece.[1] Then, a flood swept through the area, causing further destruction. Finally, a comet appeared in the sky, which was interpreted as a sign of the gods' anger.[2]

Some 1,500 years later, Ibn Bāǧǧa (d. 533/1139), the Arabic philosopher and first commentator of Aristotle in al-Andalus, wrote the 'Commentary on Aristotle's Meteorology' ('Šarḥ al-Āṯār al-ʿulwiyya', lit. "Commentary on the Upper Signs").[3] In this commentary, Ibn Bāǧǧa provides a fascinating account of a natural disaster that struck ancient Byzantine cities.

This paper explores Ibn Bāǧǧa's reception of the story of the earthquake, the flood, and the comet of Helike and Boura from Aristotle's 'Meteorology'. This analysis will shed light on the reception of this story in the Arabic literature and provide insights into Ibn Bāǧǧa's perspective on the necessity, contingency, and predictive aspects of meteorological phenomena through observation and calculation.

2 The Seismic Event in Byzantine Lands and the Role of Comets in Ancient and Medieval Literature

The catastrophe in the Gulf of Corinth has been described by many authors, but most of these accounts were written centuries after the event.[4] According to their testimony, the cities of Helike and Boura angered the god Poseidon by committing a crime against one of his sanctuaries.[5] As punishment, Poseidon caused an earthquake and flood that submerged the cities and their inhabitants under the sea.

Although Xenophon was nearby at the time of the destruction, he did not report any destructive effects on the cities.[6] The sole direct source for the event is Aristotle, who mentioned in his 'Meteorology' a seismic event and a comet in

1 Cf. Morgan and Hall 2004.

2 On the vast literature about comets as tokens of doom, see Schechner-Genuth 1997.

3 Two critical editions of Ibn Bāǧǧa's 'Commentary on Aristotle's Meteorology' have been published, both in 1999: Ibn Bāǧǧa: Šarḥ al-Āṯār al-ʿulwiyya, and Lettinck 1999. Lettinck's monograph also includes a translation and an analysis of the contents compared to Aristotle's text. I am currently working on a new edition with English translation, commentary, and glossaries, which will be published soon.

4 For example, Diodorus Siculus: Library of History XV, 50, pp. 88–91.

5 The sources disagree on the kind of crime committed: impiety against gods; disobedience of Helike to a decision of a council of confederated town states; killing of suppliants. For a complete list of ancient sources, see Rizakis 1995, p. 11.

6 See ibid.

Achaea in 373 BC.[7] However, he did not describe the story of Helike and Boura as a spectacular destructive event. Authentic ancient Greek texts also do not refer to the cities' total loss. The story first appeared in such catastrophic terms only centuries later in local legends and forged texts.[8] It is believed that Ps.-Aristotle's 'De mundo' may have largely influenced later literature by mentioning Helike and Boura and providing additional details about the event's destructive nature.[9]

Aristotle is the only source to mention a comet alongside the earthquake and the flood. Seneca also mentions the comet, possibly due to his interest in the topic.[10] It appears that scholars in meteorology typically only commented on phenomena that interested them personally.[11] For example, the Hebrew redaction by Samuel ibn Tibbon (d. c. 1232) of Aristotle's 'Meteorology' reflected his own philosophical concerns, leading him to focus more on certain topics than others.[12] Al-Kindī (d. c. 256/870) wrote treatises on only a couple of selected subjects, namely, precipitation and wind.[13] Ibn Bāğğa also adopted a similar selective approach.

The story of Helike and Boura inspired medieval and ancient literature and underwent several revisions across different cultures and scientific disciplines.[14] It intrigued philosophers and intellectuals, who reflected on the theological or naturalistic interpretations of the event.[15] Proponents of the latter approach could

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7 He mentions this episode in his 'Meteorology': Meteorologica I, 6, 343a36–343b5, p. 44, which deals with comets and the Milky Way, and also later in his work in two other cases: II, 8, 366a24–366b1, pp. 206 f.; ibid., 368a34–368b13, p. 218. For a general introduction to Aristotelian meteorology, see Wilson 2013. Wilson provides a study of the first three books of the 'Meteorology'. The fourth book, which is concerned with homogeneous bodies and applies different explanatory principles, is outside the scope of his study.

8 For example, in the 'De mundo' or in Seneca, referring to Callisthenes; cf. Rizakis 1995, pp. 285–287.

9 Cosmic Order and Divine Power (De mundo 396a17), p. 37: "Analogous events also occur in the sea: there are chasms in the sea, and often withdrawals and incursions of waves, sometimes with a recoil, sometimes with only a forward motion, as is reported about Helice and Bura".

10 Seneca: Natural Questions VII, 5, p. 236.

11 As Rinotas' article in the present volume shows, Albert the Great, for example, appears to have placed significant emphasis on the concept of *symbola* in the elemental processes underlying the exhalations.

12 Otot ha-Shamayim, p. lxii.

13 For an analysis of al-Kindī's letters on precipitation and wind, see Lettinck 1999, pp. 107–111, 176.

14 On comets, see also Martinelli's contribution in the present volume.

15 Although comets are not mentioned in the Qurʾān, beliefs about their religious importance are quite diverse and can be found in various literary works. For a general overview of this aspect, as well as historical material in Arabic that describes comets and meteors, see Cook 2016, p. 1392.

draw from various philosophical sources besides Aristotle, such as Abū Maʿšar (d. 272/886), Avicenna (d. 428/1037), and Averroes (d. 595/1198),[16] to investigate the origins, mechanisms, and effects of natural disasters. However, the comet was probably viewed as an insignificant detail in the overall destructive event. According to Aristotle, comets are sublunary phenomena consisting of hot, dry, windy vapours; and since comets are not celestial phenomena but occur within the Earth's atmosphere, they were regarded as having played no role in the destruction of cities. Consequently, the physical explanation of comets and the fact that they did not conform to the Ptolemaic patterns of fixed and moving stars was the main cause for them receiving scant attention in Arabic astronomical books, as clearly stated in the works of the mathematicians and astronomers al-Ḫwārizmī (d. ca. 235/850) and Naṣīr al-Dīn al-Ṭūsī (d. 672/1274).[17]

At some point, the story of the comet alongside a natural disaster resurfaced in the account of the comet in Ibn Bāǧǧa's 'Commentary on Aristotle's Meteorology'. Ibn Bāǧǧa refers to it in a section of the commentary dedicated to comets, which was most likely taken from the chapter on comets in Aristotle's 'Meteorology'. He recognised the potential of this historical event to shed light on the relationship between natural philosophy, astronomy, and the prediction of meteorological phenomena. Therefore, he employed a peculiar scientific explanation for natural calamities.

16 Research on natural disasters in Arabic philosophical literature is still in its early stages, with Abū Maʿšar (d. 272/886), Avicenna (d. 428/1037), and Averroes (d. 595/1198) being the most prominent sources. Some references can be found in Chalyan-Daffner 2017. One example is the 'De diluviis' ('On Floods'), which contains a commentary on a passage from Plato (Timaios 22c–23b) by Avicenna. Then there is Abū Maʿšar's 'Book of the Thousands' ('Kitāb al-Ulūf'); cf. Burnett 1976. Additionally, Averroes' short and middle commentaries on the 'Meteorology' offer an account of the destruction of the Byzantine cities. The findings presented in this paper should be considered preliminary, as they are based primarily on Ibn Bāǧǧa and Aristotle, and further research into other Arabic philosophical literature is needed to verify and expand upon them.

17 al-Ḫwārizmī: Mafātīḥ al-ʿulūm, p. 195; al-Ṭūsī: Memoir on Astronomy, vol. 2, p. 384. It is worth noting that Ibn Bāǧǧa was interested in astronomy, as he reported having observed a conjunction of Mars and Jupiter around 500/1107 (Lettinck 1999, pp. 434 f.). In a letter to Ibn Ḥasdai, he also made some critical remarks on the astronomers Ibn al-Haytam and al-Zarqālī, particularly in relation to the determination of the orbits of the planets Mercury and Venus (Ibn Bāǧǧa: Rasāʾil falsafiyya, p. 78). According to Maimonides, he studied astronomy with a student of Ibn Bāǧǧa; cf. Wirmer 2014, p. 12, n. 44.

3 Sources Used by Ibn Bāǧǧa to Describe the Destruction of Byzantine Towns

In his 'Commentary on Aristotle's Meteorology', Ibn Bāǧǧa mentions the destruction of Byzantine towns three times while rejecting the idea that comets and the Milky Way are celestial phenomena. He writes:

> Many of them [the meteorological phenomena] are invisible (*amḥaqa*) without entering under the rays [of the sun], like the star that appeared in the Byzantine lands when the sea wiped out many cities. It appeared when the sun was in the region of the winter solstice, and [the star] remained for a few days. It moved away and dissolved in the constellation of the Twins without the sun reaching it and then disappeared.[18]

The information provided by Ibn Bāǧǧa about the flooding of the Byzantine cities is rather vague, which makes it difficult to determine his sources. It is clear that a comet was present during the devastating event. Ibn Bāǧǧa describes a star appearing and disappearing (a comet) and the sea wiping out the cities. In another part of his commentary, he only mentions the star appearing and disappearing above some Byzantine cities.[19] Later in the text, he provides information about the star appearing and disappearing, and he states that the towns were submerged.[20] Therefore, two meteorological phenomena are intertwined: a comet and a flood, as in Aristotle's account of Achaea in the chapter on comets.[21]

Ibn Bāǧǧa's account does not specify the names or numbers of the cities affected, using the generic terms *bilād* ("countries, cities"; sg. *balad*) and *mudun* ("cities"; sg. *madīna*). It is worth noting that he uses the plural form, indicating that his source does not match Aristotle's text. In Aristotle's 'Meteorology', only one city, Achaea, is mentioned, whereas in the 'De mundo', two cities are mentioned. Therefore, Ibn Bāǧǧa should have used either the singular or the dual form of *madīna* or *balad* instead of the plural. His account implies a large-scale destructive event involving multiple cities.

Furthermore, there are discrepancies between the Arabic translations of the 'Meteorology' and Ibn Bāǧǧa's version of the story. Yaḥyā ibn al-Biṭrīq's (d. c. 215/830) translation shows signs of contamination, and the section on comets

18 Lettinck 1999, p. 442, ll. 10–15, with corrections.

19 Ibid., p. 444, ll. 12–15.

20 Ibid., p. 446, ll. 16–23, with corrections.

21 Aristotle: Meteorologica I, 6, 343a36–343b5, p. 44.

in the Arabic translation seems one of the most heavily shortened.[22] Additionally, the story of Helike and Boura is absent from Ḥunayn ibn Isḥāq's (d. 260/873) "compendium" (*ǧawāmiʿ*) and Samuel ibn Tibbon's translation. However, it is worth noting that the section on comets, to which the story of Achaea belongs, is not entirely absent from the translations. Both Ibn al-Biṭrīq and Samuel ibn Tibbon comment on Aristotle's remark against Hippocrates that comets do not only occur in the northern part of the sky, which is also a critique found in Averroes's 'Middle Commentary on the Meteorology' ('Talḫīṣ al-Āṯār al-ʿulwiyya'):[23] they also occur in the southern zone, like the comet of Achaea, which the translations failed to mention but Ibn Bāǧǧa does mention when he talks about comets.[24] This suggests that Ibn Bāǧǧa used not only Ibn al-Biṭrīq's translation, as argued by Paul Lettinck in his edition,[25] but also other sources which included the account of the Byzantine cities in the section about comets.

According to Ibn Bāǧǧa, the destruction of the cities occurred during the winter solstice, which is an interesting addition. In Chapter 14 of Book I of the 'Meteorology', Aristotle describes a great winter that happens at long intervals and causes a devastating deluge.[26] Aristotle attributes these phenomena to a great winter, which periodically brings an overabundance of rain to certain regions of the Earth for an extended period. This great winter is characterised by climatic and geological phenomena that alter the boundaries between drylands and the sea, resulting in some regions becoming arid while others become wet. This leads to fluctuations in river and sea levels and floods. However, there is no record of

22 Ibn Bāǧǧa relied on Ibn al-Biṭrīq's translation of Aristotle's 'Meteorology', which differs significantly from Aristotle's text. According to Ibn al-Biṭrīq's version, a flood devastated only one region of Greece during the reign of King Dawkāliyānūs (Deucalion); cf. Aristotle's Meteorology in the Arabico-Latin Tradition, p. 57, l. 4. The only reference to comets in Ibn al-Biṭrīq's translation is to their appearance in both the north and south, with a particular emphasis on sightings in the south during the time of al-Arḫūn (ἄρχοντος; *al-Arḫūn*; Aristotle's Meteorology in the Arabico-Latin Tradition, p. 27, l. 201). Ibn al-Biṭrīq seems to have mistakenly used the term ἄρχοντος as a proper name (al-Arḫūn), like Gerhard of Cremona (*ariun*; Aristotle's Meteorology in the Arabico-Latin Tradition, p. 26, l. 202) and Samuel ibn Tibbon (*argon*; Otot ha-Shamayim, p. 39, l. 317). The chapter on comets in Averroes' 'Middle Commentary' refers to a certain king's time (*ʿahd fulān al-malik*) (Ibn Rušd: Talḫīṣ al-Āṯār al-ʿulwiyya, p. 47, l. 4), like Ibn Tibbon's text in the reading of Ms. N (*ha-meleḵ*) (Otot ha-Shamayim, p. 38, l. 316). A similar account of the flood can be found in Averroes' short and middle commentaries on the 'Meteorology', in which he provides two descriptions of disastrous events, the first of which is quite similar to Ibn Bāǧǧa's story, while the second is more distinct.

23 Ibn Rušd: Talḫīṣ al-Āṯār al-ʿulwiyya, pp. 47 f., comm. 43.

24 For Ibn al-Biṭrīq's translation, see Aristotle's Meteorology in the Arabico-Latin Tradition, p. 27, ll. 196–200. For Ibn Tibbon's translation, see Otot ha-Shamayim, p. 38, ll. 313–316.

25 Lettinck 1999, p. 430, ll. 14–20, n. 6 and n. 7.

26 Aristotle: Meteorologica I, 14, 352a29–33, p. 112 f.

the destruction of Helike and Boura occurring during the winter solstice. Therefore, it is possible that Ibn Bāǧǧa, or the tradition preceding him that he used as his sources, merged the historical account of Helike and Boura with information from 'Meteorology' I. 14 to explain the surge of the sea and the overabundance of rain that caused the flood.

As for other sources, it is difficult to say that Ibn Bāǧǧa had access to them, as there is insufficient evidence to support this claim. Lettinck has spotted some common features between a work translated by Ḥunayn ibn Isḥāq, which contains a paraphrase of the commentary of Olympiodorus (d. after 565), and Ibn Bāǧǧa's explanations of the thin and thick exhalations.[27] Ibn Bāǧǧa also mentions Alexander of Aphrodisias (fl. c. 200) in the section of his commentary on the Milky Way; however, regrettably, there is a lacuna in the text following this mention.[28] There are some similarities between Ibn Bāǧǧa's text and Olympiodorus' commentary on the 'Meteorology'. For example, both mention a thick and a thin version of the two exhalations, and both raise objections to Aristotle's view on the Milky Way. Lettinck has pointed out these similarities but fails to mention that Ibn Bāǧǧa provides a brief account of earthquakes. His explanation of how the exhalation behaves below the Earth's crust resembles Olympiodorus' account of the earthquakes.[29] Interestingly, Olympiodorus relates this process to "the great comet which appeared at the time of the earthquake in Achaea and the tidal wave":

> For [conditions were] suitable for the great comet to appear just before an earthquake and a flood occurred during the time of which there was an abundance of smoky exhalation. This was a time when winds became very intense [56.25] both above and below the Earth's surface. The subterranean [winds] caused earthquakes; due to the [winds] blowing in opposite directions above the Earth's surface, the sea was piled up and rose to a very high level. Then, after the other winds fell and eventually ceased to blow, the water was discharged in its direction, and a flood occurred. Floods do not [56.30] occur due to rain.[30]

Olympiodorus stands out as the sole figure who discusses an earthquake, a flood, and a comet in conjunction. Ibn Bāǧǧa's explanation of the earthquakes, which Lettinck does not acknowledge in his description of Ibn Bāǧǧa's commentary,

27 Lettinck 1999, p. 60.

28 Ibid., p. 434, l. 19.

29 Ibid., pp. 17, 19.

30 The First Book of Olympiodorus' Commentary on Aristotle's Meteorology, p. 161.

closely resembles that of Olympiodorus.[31] Furthermore, like Olympiodorus, there is a link between comets and floods. So why does Ibn Bāğğa provide a physical explanation for comets and earthquakes, similar to Olympiodorus, but not for floods? One possible explanation for this omission is that Ibn Bāğğa selectively chose which meteorological phenomena to discuss in his commentary. Ibn Bāğğa may have considered floods to be a by-product of changes like earthquakes, which he covers in more detail. He may have intentionally left out some aspects, such as floods, to focus on other topics that he deemed more critical to understanding the sublunar phenomena.[32]

4 Ibn Bāğğa's View on the Necessity and Predictability of the 'Meteora'

Before talking about the destruction of the Byzantine cities, Ibn Bāğğa makes some interesting remarks about his idea of meteorology. He writes:

> The things which are objects of investigation in this kind of natural science [i.e. meteorology] […] are in the same place, for their place is the moved air, and they are comets, suns, stars appearing with the sun, goats, rods, and torches. First, we say what is common to them. We say that these are (1) not necessary in any of the types of necessity (*laysat iḍṭirāriyya wa-lā bi-naḥw wāḥid min al-iḍṭirār*). That they (2) do not exist permanently (*ġayr dāʾima al-wuǧūd*) [because they are intermittent], we will show that; that they (3) appear permanently (*dāʾima al-ẓuhūrihā*) – that is self-evident. I also say that they (4) do not necessarily have regularity (*al-intiẓām*) because they have been sighted and the times of their appearance do not take place uniformly (*ġayr mutasāwī*), nor do the times of their disappearance.[33]

31 Lettinck 1999, pp. 17, 19.

32 It is important to note that there is a repeated phrase (dittography) found in both manuscripts of Ibn Bāğğa's commentary, precisely in the midst of the section on earthquakes, which previous editions failed to recognise. The reason for this repetition remains unclear and could be either a mistake made by the scribe or an indication of a missing portion of text. While it is tempting to speculate that the missing section might have pertained to floods, there is no way to conclusively prove this. We can only assert with confidence that the section on earthquakes is most likely incomplete.

33 Lettinck 1999, p. 442, ll. 2–10, with corrections.

In this text, Ibn Bāǧǧa makes some observations about some meteorological events: comets, suns, stars appearing with the sun, goats, rods, and torches.[34] These are phenomena that Aristotle emphasised as only apparently irregular, since, in the Aristotelian cosmos, nothing is irregular and everything has causes (which, in the case of meteorological phenomena, are very complex).[35] Firstly, Ibn Bāǧǧa notes that such events are (1) "not necessary in any of the types of necessity", since they come to be and pass away. Secondly, he states that these events (2) "exist permanently". Thirdly, he argues that they (3) "appear permanently". Finally, he points out that they (4) "do not necessarily have regularity", in the sense that these events are often invisible, like the comet that appeared at the destruction of the Byzantine towns.

Let us start from the "types of necessity" (1). The concept of "necessity" (*ḍarūra*) is frequently discussed in Ibn Bāǧǧa's commentaries, and a detailed analysis is beyond the possibilities and scopes of this paper.[36] In his 'Commentary on Aristotle's Physics' ('Šarḥ as-Samāʿ aṭ-ṭabīʿī'), in Book II, he discusses the different types of nomological "necessity".[37] Here, Ibn Bāǧǧa refrains from making a clear distinction between unconditional and hypothetical necessity, contrasting with Aristotle's perspective as presented in 'Physics' II. 9. He posits that the existence of entities inherent to nature is not a matter of necessity; rather, it is determined by their ultimate goal.[38] He describes in other terms what Aristotle called conditional necessity, which means that everything in nature is not necessary by itself but through a cause. In the context of the comets, they exist by virtue of their causes (the exhalations and the heavenly motion), and their purpose is to imitate the circular movements of the heavens with their slanting movement. However, the occurrence of a meteorological event is not always guaranteed, even if the conditions are met.

On the other hand, Ibn Bāǧǧa contributes the idea that necessity is characterised by its unchangeable nature and is intrinsic to natural entities due to their

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34 These are all phenomena arising when hot, dry, fiery exhalations are ignited. These terms are also used in Aristotle: Meteorologica I, 4, 341b1–5, p. 28, as well as in the later tradition as technical terms for specific phenomena. See Wilson 2013, pp. 117–120.

35 "Of all these phenomena, some we find inexplicable, others we can to some extent understand." Aristotle: Meteorologica I, 1, 339a2 f., p. 4; transl.: ibid., p. 5.

36 I partly explore the topic of nomological necessity in la Martire [forthcoming].

37 There are various editions and translations of this text. One is Ibn Bāǧǧa: Šurūḥāt al-Samāʿ al-ṭabīʿī. Lettinck 1994 contains a critical edition of unpublished parts of Ms. Wetzstein I 87 and an English paraphrasis. Then, there is an English translation of an excerpt from Book I in McGinnis and Reisman 2007, pp. 267–269. David Wirmer is currently preparing a new critical edition of the commentary.

38 Ibn Bāǧǧa: Šurūḥāt al-Samāʿ al-ṭabīʿī, p. 27, ll. 8 f.: *fa-kull lāḥiq li-ḥaqq al-ǧism al-ṭabīʿī min qibal ġāyatihi fa-laysa bi-l-ḍarūra.*

material composition, a concept that Aristotle refers to as absolute necessity.[39] Absolutely necessary substances are simple (not composed) and incorruptible, and necessary events have to happen always, like the motion of the celestial bodies. The celestial bodies exist permanently. In the sublunar world, nothing "exists permanently" (2), and therefore, nothing is absolutely necessary.

Ibn Bāğğa states that absolute necessity works against nature, which acts by virtue of its purpose.[40] He gives the example of a living being dying due to this type of inevitability. However, this inevitability can yield outcomes similar to those of randomness, implying consequences that nature did not intend. If we extend this reasoning to the 'Meteorology', the absolute necessity of the heavenly realm plays a role in the sublunar world, but there is always a possibility that a heavenly cause might fail to bring about its effect on a sublunar plane.

So, when Ibn Bāğğa says that meteorological events are "not necessary in any of the types of necessity", he rejects two kinds of necessity. He rejects the conditional necessity because it would imply that the meteorological events are associated with a temporally ordered final cause; he then rejects absolute or material necessity, which is the idea that matter is a sufficient cause and explanation for all natural phenomena. It would be like saying that rain is the effect of a prior condensation of vapour, while it is just the condensation of vapour. This is in contrast with the views of Avicenna and Aristotle, who maintain that the necessity of matter is responsible for the coming-to-be of things.[41]

Moving back to the quote provided at the beginning of this section, he states that these events do not (3) "appear permanently" and (4) "do not necessarily have regularity." By saying that the comet of the Byzantine towns "moved away and dissolved in the constellation of the Twins without the sun reaching it, and then disappeared", he implies that the comet appears beyond the zodiac and exhibits different behaviour from constellations and celestial bodies in general. In addition, some meteorological phenomena may occasionally be imperceptible due to their nature as earthy exhalations that change into a 'gas' and, subsequently, into fiery matter. This fire eventually vanishes not because of the arrival of cold and moistness but because the smoky substance is exhausted. Under certain circumstances, this process occurs so quickly that the event itself is invisible, which is the fourth point of his text: the events are often invisible. This contrasts with events that may take weeks or even months to occur, highlighting the varied unfolding of meteorological phenomena.

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39 Ibid., p. 27, ll. 9 f.: *fa-amma mā yuğadu min ṭarīq al-mādda fa-ʿalā innahu lā yumkinu siwāhu.*

40 Ibid., p. 27, ll. 10–14. The text is resumed in Lettinck 1994, p. 166.

41 Belo 2007, pp. 43 f.

With regards to the predictability of such events, in his super-commentary on Galen's 'Commentary on the Aphorisms [of Hippocrates]' ('Šarḥ fī l-Fuṣūl'),[42] Ibn Bāǧǧa acknowledges that environmental factors can affect human judgement and that the heavenly body determines the climate through which the physiological temperament of the individual is affected. He writes:

> Hippocrates said: life is short and art is long, the moment is fleeting, experience is a danger, and judgment is hard. And it is better for you not to limit yourself to doing what you should but to take into account the actions of the patient, those around him and his circumstances. […] This means that what you can be certain of is insufficient without the actions of the patient and those around him being aimed at bringing about the judgment – unless the preceding facts that can hinder the achievement of the experience and the environmental circumstances, such as the air and its conditions, are in a state in which they do not distract you. If they are otherwise, it will be most difficult to reach a judgment.[43]

It is a very subtle but significant parallel between medicine and meteorology, natural philosophy, and practical arts that hints to some interrelations that Ibn Bāǧǧa might have seen and that deserve more exploration than the present paper can achieve. In a similar vein, he writes in his 'Commentary on Aristotle's Meteorology':

> In mathematics it has been explained that all centres are near the centre of the world. Therefore, eccentricity hardly occurs outside the elements ***.[44] However, there is no system (*niẓam*) for what is known, and it has no [annual] cycle in most cases, except for what exists from the sun. It differs in its parts and in the conditions of its parts, so that not every type is similar in its definition to every single type. Let us suppose that the relation of this is among its causes, and by supposing it we do not take away the contingency (*imkān*) of the elements.[45]

Here, Ibn Bāǧǧa talks about the star system and says, in other words, that each star is unique. Then he adds that the relationship between stars produces a particular

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42 There are two critical editions of this work: Ibn Bāǧǧa: Šarḥ fī l-fuṣūl, pp. 176–214; Forcada 2011, pp. 373–393.

43 Forcada 2011, p. 369.

44 Lacuna here in both manuscripts.

45 Lettinck 1999, p. 402, ll. 17–23, with corrections.

effect. These statements may resemble astrological premises, leading some to believe that Ibn Bāǧǧa believed in the predictability of phenomena based on the observation of the stars. However, according to Ibn Bāǧǧa, the causes resulting from the relations among stars in the heavens do not "take away" or eliminate the contingent causes, and thus, they must compete with them. This allows for the autonomy of nature and the contingency of sublunary changes without sacrificing the idea of a unified cosmos. It also means that astrometeorological prediction is inherently uncertain and imprecise, leading to potential errors in predictions, like when it uses stars as indicators to predict the weather and track seasons.[46] Since sublunar phenomena are particularly complex, predicting their occurrence and chance of coincidence—such as that of a comet, earthquake, and flood—is much more challenging.

At the same time, this passage seems to suggest either that the elements are inherently contingent or that the meteorological events are contingent with respect to the elements. Unfortunately, there is nothing about the contingency of the elements in his work. He talks about contingency and necessity in his works on logic, like the possibility of a phenomenon similar to an eclipse. He says that there cannot be more than one eclipse (since only one is necessary) but there can be things that look similar to an eclipse, showing that, for him, the definition of universal terms is predicable of all their (multiple) instances.[47]

For the sake of the present paper, I believe that the concept of 'contingency of the elements' suggests that the elements themselves are not inherently contingent but, rather, that the meteorological events that depend on the elements are contingent with respect to them. In other words, the elements themselves are necessary and essential components of the natural world, just as water is a necessary component of the flood, but the meteorological events that arise from the interactions between the elements are contingent and variable, which is why not every drop of water belongs to the flood. This understanding of "contingency" (*imkān*) helps to explain why meteorological events can be unpredictable and why they vary over time and space, even though the underlying elements remain constant in their "system" (*niẓām*).

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46 A similar argument about meteorological prediction can be found in the section on Abū al-Rayḥān al-Bīrūnī in Borroni's article in the present volume. See also Schmidl's article about forecasting in the present volume.

47 Ibn Bāǧǧa: Taʿālīq Ibn Bāǧǧa ʿalā manṭiq al-Fārābī, p. 46, ll. 5–8. The topic inevitably deserves more investigation, which should start from his works on logic. Ibn Bāǧǧa's logical writings have been passed down to us in a relatively extensive form, but the only surviving manuscript is poorly organised. This confusing structure of the text is likely one of the reasons why this part of Ibn Bāǧǧa's work has received little attention so far.

5 Conclusion

Ibn Bāǧǧa's account of the comet and the flood in the Byzantine towns provides an insightful glimpse into the scientific mindset underlying the reception of Aristotle's 'Meteorology' I. 6. His use of observation and calculation to explain not only rare and catastrophic observable events but also invisible ones challenged the prevailing supernatural and mythical explanations of classical historiography. Although Ibn Bāǧǧa recognised the potential for error in the meteorological predictions, his work laid the foundation for the development of a modern observational approach to meteorology.

By examining Ibn Bāǧǧa's account, we also gain a deeper understanding of the scientific advancements achieved during his era and the enduring legacy in shaping the understanding of the 'Meteora'. The concept of necessity emerges as a pivotal element for understanding the dynamics of sublunar and heavenly motions, but this is only one possible epistemological perspective. Ibn Bāǧǧa explored the applications of necessity in other fields, and this is a fascinating avenue for future research.

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