A treatise on the plague by Giovanni Battista Baliani

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Abstract: Giovanni Battista Baliani in 1653 published a booklet of some success entitled *Trattato di Gio. Battista Baliano della pestilenza: ove si adducono pensieri nuovi in più materie.* This work, little-known today, is of interest not so much with regard to the history of medicine or epidemiology, as the title might suggest, but for what concerns the philosophy of nature of the 17th century. In this treatise Baliani brought his conceptions about the constitution of matter in an attempt to explain the nature and spread of the plague with the aid of two constituents of nature: light and matter. Light is conceived as inanimate and immaterial substance. Matter is in turn formed by various principles (not first principles however) including sulphur, oil saltpetre, mercury. These are then traced back to two first principles, following Aristotle: earth and wa ter. Baliani also exposed his empiric conceptions of science and strongly stated a rejection of authority which should be taken into serious consideration only if it fits the experience and is supported by it. True explanations must be based on reason which in turn is based on experience. And experience must be incontrovertible.

Keywords: Epistemology, philosophy of nature, history of science, experience and expeirments

1. Introduction

In 1638 Giovanni Battista Baliani (1582-1666) wrote *De motu naturali gravium solidorum* (Baliani 1638) in which the law of falling bodies was derived using as principles empirical laws considered for him indubitable. The epistemological approach of Baliani was opposed in some way to that of Galileo exposed in the *Discorsi e dimostrazioni matematiche sopra due nuove scienze*, also published in 1638 shortly after the *De motu naturali gravium solidorum*. In his work Galileo drew the law of motion by a simple and intuitive principle that however had no empirical character or at least did not have definite evidence of an experimental nature, according to which the speed of a heavy body uniformly grows with time during its fall.

In 1646 Baliani published a new enlarged edition of his book, entitled *De motu naturali gravium solidorum et liquidorum* (Baliani 1646), to which it had been added three sections on the motion of fluids. But mostly, all considered in a sneaky way, the epistemological approach was overturned. According to Baliani the science of motion could not be based on an empirical principle but required principles of natural philosophy. The principles on which Baliani intended to found the law of motion were the constancy of the effect of force of gravity and the preservation of the acquired

impetus. Based on these principles, he arrived to a law of motion that contrasted that found in 1638. There the falling bodies followed the law of the odd numbers, here that of the natural numbers. Baliani noted that these two laws differed little if well interpreted, but it was the first to be only approximate. Hence the conclusion that one cannot decide the correctness of a law only on the basis of experience, which can be deceiving. Thus a physical law must be deducible from general principles.

Of course one wonders what had produced this change and why Baliani who until then had behaved essentially as a mathematician moved his interest toward the philosophy of nature. The biographical information of Baliani and his correspondence are little known; so one can only guess. A first hypothesis traces the interest of Baliani for natural philosophy at the Jesuit philosopher Nicolò Cabeo (1586-1650). Baliani knew him in Genoa in 1632, and made with him a friendship. Cabeo had printed in 1646 his commentary on *Meteorologica* of Aristotle, the *In quatuor libros Meteorologicorum Aristotelis commentaria* (Cabeo 1646), that strongly revisited the Aristotelian philosophy, that became after the *Philosophia magnetica* (Cabeo 1629) of 1629. A second hypothesis concerns the contacts with the Jesuit Honoré Fabri that Baliani met in 1647.[1] In 1746 Fabri had published a text, *Tractatus physicus de motu locali* (Fabri 1746), in which there were reported considerations on falling bodies very similar to those of Baliani. A third hypothesis, which play the role of final cause, ventilated by Costantini (1969), sees socio-political reasons, always connected to the contact of Baliani with Jesuits scientists (besides Cabeo and Fabri at least also Orazio Grassi). He would have been convinced by the Jesuits to get in contrast with Galileo and the change of his epistemological position would have been simply a pretext. That view is shared in Galluzzi (2001). This external justification however seems to me a bit forced to explain the change of epistemological positions of Baliani and his involvement in natural philosophy. That the interest of Baliani was not instrumental I think is documented by his interest in natural philosophy reported in different contexts, and especially in his last printed work, the *Trattato di Gio. Battista Baliano della pestilenza: ove si adducono pensieri nuovi in più materie.* (Baliani 1653)[2] This treatise, which had some publishing success, probably because of the way it tackled the phenomenon of the plague, was actually a treatise of natural philosophy.

In this paper the focus is on Baliani's treatise of the plague, a work that has not been considered until now in the literature apart from a slight hint of an interesting but marginal aspect in Drake (1967). The treatise is interesting because it illustrates a case of evolution of natural philosophy within the Aristotelianism. (Dear 1995) Baliani as Nicolò Cabeo is linked to Aristotle's *Meteorologica*, but has changed many aspects by introducing an approach that can be defined mechanistic, at least broadly.

[1] Contacts of Baliani with Fabri are documented by the correspondence of Baliani with Grassi (Moscovici 1967, pp. 256-261), with Mersenne and of Mersenne with Pierre Mousnier, a Fabri's disciple. (Galluzzi 2001, p. 267)

[2] Baliani declared a previous edition of 1647.

2. 'Trattato di Gio. Battista Baliano della pestilenza'

Not many philosophical writings of Baliani remain. From his correspondence with the Jesuit mathematician Gio Luigi Confalonieri (c.1600-1653) we know, however, that Baliani expressed his interest in this area much earlier than the publication of the *De motu gravium solidorum* of 1638. In January 1639 he wrote a letter to Confalonieri stating that he prepared a note on the nature of light 'many years before'. (Costantini 1969) Still in September 1639, he wrote to Bonaventura Cavalieri (1598-1647):

> Though I made some study in mathematics, my interest is rather in finding effects and causes of natural things, of which I always thought that we know little if we do not have the support of mathematics, which guarantees the truth. Thus I tried to use it. Anyway I never estimated that philosophical matters do not depend on philosophical principles. (Moscovici 1967, p. 204)

Baliani did not find time to publish a full treatise of natural philosophy. He limited himself, in 1653, to write the less demanding *Trattato di Gio. Battista Baliano della pestilenza: ove si adducono pensieri nuovi in più materie* (herein after *Trattato della pestilenza*) (Baliani 1653), that officially devoted to the plague, dealt with arguments of natural philosophy and given its nature permitted a less rigorous treatment of philosophy.

The treatise was divided into two books; the first book is entitled: *Of the nature of the plague* (pp. 1-153), the second book is entitled: *It is likely that contagion only cannot cause the plague* (pp. 155-198). From the general title and those of the two books, it would appear to be dealing with a medical textbook. Actually it was not the case, and could not be so, because Baliani was not a physician. Certainly the topic of the plague was quite central and it was also the one which ensured the success of the book, because the subject of the plague was faced for the first time with scientific method and reference to modern conceptions of natural philosophy. However, most of the text, and almost all of the first book, covered topics of natural philosophy. In particular it dealt with topics which were then classified as meteorological, in line with the Aristotelian tradition of *Meteorologica,* along with elements of biology and botany.

The most salient aspects of Baliani's epistemology expressed in the *Trattato della pestilenza* are the superiority of the method *more geometrico* and the refusal of authority. The adoption of the method '*more geometrico*' for Baliani did not however implie applying mathematics to philosophy. Baliani here followed Aristotelian epistemology, by adapting it to his purpose, according to which any science has its own principles:

> Based on this truth I strived to distinguish, to the extent that I could, in any branch of learning, certain things from uncertain ones [...] By reducing the discourse to syllogisms, in any of every [discourse] the major premise will be one of such propositions that are naturally known by everybody, the medium premise depends

> on postulates in mathematics, revelation in theology and experience in philosophy. (Baliani 1653)[3]

where 'philosophy' should be intended as natural philosophy; in this field the philosopher should only base on experience and deduction.

At no time did he make reference to the approach of mixed sciences. This appears surprising considered that in his books on motion and in other writings he dealt with various matters such as those regarding atmospheric pressure, the mechanism of tides, the astronomical hypotheses, in mixed mathematics.

Even a superficial reading of the book suggests analogies with Baliani's treatise of the plague and Cabeo's commentary on *Metereologica*. The subject matter was similar, though the treatment of particular aspects was different. There is the same disdain toward authority, the corpuscular conception of matter, the search for efficient causes of all phenomena, the lack of any use of mathematics.

2.1 Elements of Natural Philosophy

2.1.1 Light

Baliani identified two opposing principles of nature, two substances, matter and light. The two substances repel each other; matter has a natural tendency to join, "that by his own name is called gravity"; to gravity opposes the force of light that tends to push back matter. Bodies derive from the interaction between these two opposing principles. (Baliani 1653, p. 71)

Baliani immediately declared that light is substance and not accident, but it is an immaterial substance. To justify this assertion Baliani refers to empirical experience. Light penetrates the porous bodies; therefore it is immaterial since matter cannot penetrate matter. Light passes through the vacuum, for example the one generated in the glass tube filled with mercury and inverted, and so it is substance. (Baliani 1653, p. 15) Colors are instead accidents and depend on the variations of light illuminating the parties of a body. To justify his claim at a metaphysical level Baliani referred to Platonic conceptions of light as those of Marsilio Ficino (1433-1499), that Baliani had to know. With the introduction of the immaterial substance he could thus formulate this interesting pattern constitutive of all creation:

Material substance not animated	Substance not material not animated
Material substance animated (animals)	Substance not material animated (soul)

Light for its immateriality has no inertia (modern term). The least force can put it into motion immediately as an opposing force can stop it immediately, unlike the material bodies that tend instead to continue their motion. Baliani's position is connected to that

[3] Preface (not numbered pages). My translation.

of Kepler, based on his passive concept of inertia, for which light was weightless and thus offered no resistance to the power of luminous body emitting it:

> The motion of light does not occur in time but in an instant. Because, as demonstrated in Aristotle's books on motion, there is a certain relationship between time and ratio of motive force, or weight, to medium. But here [the ratio] of power to moved light is infinite, since light has no matter and therefore no weight. But the medium does not resist light, since light lacks matter by which resistance could occur. Therefore the speed of light is infinite. (Kepler 1604)[4]

Baliani, however, considered the active role of inertia too and drew different conclusions. Since light has no inertia, it cannot move without a force that pushes it. As soon as the force ceases, the motion of light stops. The light, moreover, does not move with infinite speed but with a variable finite speed dependent on the 'force' which is exerted by luminous bodies. The sun is the primary luminous body. It is itself light and therefore immaterial substance. Light and fire are the same.

2.1.2 Matter

The discussion on the composition of matter is quite convoluted. Baliani said that we must rely on the experience, on the chemical analysis of the material substances. (Baliani 1653, p. 9)

Baliani started by presenting the two most reliable theories of the period, that of Aristotle of the four elements (earth, water, air and fire) and that of Paracelsus of the three elements (salt, sulphur and mercury). Meanwhile he discarded air and fire as the building blocks of matter. The fire because it is nothing but a manifestation of light and as such immaterial. The air, which is assumed as an elementary substance, because it only enters into the constitution of mixtures to fill pores left open by the hardest parts of matter. In the identification of the elements constituting the mixture Baliani individuated as principles salt, sulfur and mercury; but, he said, in fact they are not first principles, but that further analysis shows that they are derived through transformations (chemical?) from earth and water which are the real first principles. A similar idea is found in the meteorology of Cabeo (1646), which goes back to Aristotle, in this dual conception of the constitution of matter.

> Therefore, the homeomerous bodies both in plants and animals *consist of water and earth* [emphasis added]. And what are metals, such as gold, & silver, and whatever else of this sort, [consist] of these [water and earth] and an exhalation, either of which, is enclosed [within the earth] as is stated in other places. (Cabeo 1646, vol. 2, p. 342)

Baliani had a corpuscular conception of matter. Corpuscles of element form minima, without any deep interaction. So bodies are not homeomerous as Aristotelian

[4] My translation.

substances. The corpuscular conception of matter served to Baliani, also to explain the phenomena of expansion and compression of bodies. His reference was mainly to air which is a simple substance. The air consists of minima, separated by bubbles of vapor. Expansion and contraction of the vapor bubbles explains expansion and contraction of the air:

> The air because of all its detached minima, is very permeable so that bubbles of vapor can easily enter, and that with their expansion and reduction (for much, or little heat, or to be otherwise pressed) are the reason that the air is either expanded or shrunk, keeping (for what I know) the same form where such variation results from major or minor, heat; and changing it if it derives from being compressed; to be more flattened, as the compression is increased. (Baliani 1653, p. 87)[5]

For solid bodies the mechanism is the same, only that the bubbles are not only vapor but also of an oily substance.

3. Other philosophical works

Baliani specified better his ideas on natural philosophy in the *Dialogo secondo* of his *Opere diverse*. (Baliani 1666, pp. 39-57) Here he maintained that the approach of mathematics could be of some help to philosophy not only because of its deductive arguing, but also because it requires a rigorous analysis of principles. These should be absolutely sure and derived from empirical evidence. In this way any controversy among philosophers could be avoided and philosophy would cease to be conjecture and become exact as mathematics.

To this purpose Baliani criticized the Aristotelian theory of elements, because it was not directly derivable from the experience, and suggested the approach followed by chemists (*chimici*) that made the 'autopsy' to the matter. He also specified that the first principles of matter are water, earth and light and declared that he could base a philosophy on them which had the same certitude as mathematics, where consequences are deduced by means of syllogisms from certain principles.

> Various are the casts of mind, so that one considers as true for a reason, another [considers] as false for another [reason]. [...] if, instead, there were greater moderation and people accustomed to know with more moderation and to distinguish what is known from what is unknown, it is certain that wise men would be in agreement with things of which there would be exact knowledge. (Baliani 1666, pp. 43-44)[6]

It is thus clear that Baliani has maintained throughout his life the same basic epistemological assumption: the principles of philosophy should be based on experience and experiments, which are infallible in themselves.

[5] My translation.
[6] My translation.

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