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ARTICLE

Telesio on Natural Paradoxes: A Metaphysics from Marginal Cases

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Abstract

The foundation of Telesio's physics is remarkably straightforward: he assumes that every phenomenon is explained by referring to the agency of two main principles, heat and cold. Yet, Telesio's apparently simple physics leads to paradoxes when dealing with two specific problems which Aristotle had already discussed: the explanation of how rivers form and of how insects might be generated in a furnace. If water is simply earth made fluid by the action of the heat, why do rivers maintain a regular course, and how can the flow of water remain constant? And if generation can occur whenever spirit is enclosed to form a living being, thanks solely to the action of the heat, would it not be possible for animals to be generated by controlling any source of heat? This essay shows that Telesio's answers to these questions reveal his approach to metaphysics, and that this in turn must trigger a historiographical reassessment of the portrait of Telesio at the threshold of modernity.

Introduction

The first edition of Telesio's *De natura iuxta propria principia* (1565) begins with a straightforward description of how the heat of the sun interacts with the cold of the earth to give rise to the world as we know it: everything originates from the interplay of these two principles with matter (which in this edition is itself defined as a third principle)[1]. The famously direct opening of the first chapter of Book 1 – '*Bernardinus*

[1]Telesio (2006 [1565]: 12): '*Tria igitur apparent rerum principia*' (translations are my own if not stated otherwise). This formulation, which originally opened the second chapter of the first book, had already changed in the new version of the chapter inserted at the beginning of an important copy of *De natura* republished by Roberto Bondì (Telesio (2011 [1565])). This new version of Chapter 4 is substantially longer and more detailed. On matter as a principle, acted on by the two opposite principles of heat and cold, see Telesio's interpretation of the '*constitutio primorum corporum*' according to Aristotle, in Telesio (1965-1976

Cosentinus haec cogitabat' – sets the tone for the explanation which follows, developing around equally direct formulations such as the one at the beginning of Chapter 4:

> Cold and heat therefore appear as the first active principles of things. The bodies placed at the extreme limits of the universe can be conceived of as occupied and constituted by these principles in their full power, while all the bodies situated in the middle are occupied and constituted by the same principles in their diminished and weakened power[2]. (Telesio 2006 [1565]: 14)

The reduction of the principles to two active ones is presented as the key to understanding all processes of generation and of constant mutation in the world, leaving behind even the physics of the four elements, since air and water derive ultimately from the interaction of the sun and the earth[3]. A key result of this approach is underlined by Telesio himself: it is unnecessary and indeed contrary to experience to assume a substantial difference between the celestial and the terrestrial world, as Aristotle had done[4]. Instead, *terra* and *caelum* are firmly linked to each other: they are not composites – since they are, in their essence, cold and heat respectively – and are regarded as the origin of everything else, which is generated by their action on each other (Telesio 2006 [1565]: 15).

There is a long-standing tradition of reading Telesio's approach as 'resolutely empiricist' (Garber 2016: 120)[5]. It goes back to Francis Bacon's own reading of Telesio as someone 'who philosophizes according to sense alone', and thus 'talks not badly about the system of the world, but very ignorantly about principles', even if he is occasionally guilty of twisting facts (Bacon 1996: 250–251 and 46–47; see also Garber 2016: 125). If the Renaissance approaches to Aristotle were to be divided between metaphysical and naturalistic, then Telesio's philosophy would be considered as 'the most radical realisation' of the latter approach, allegedly displaying a total 'break with the "metaphysical"'one (Keßler 2000: 99).

The aim of this article is to suggest that this view of Telesio as an empiricist is at odds with his approach to the explanation of two natural scenarios, which can be viewed as paradoxes within Telesio's naturalistic view. These are Telesio's reflections on the

[1586]: I, 342–351). This chapter constitutes a good example of Telesio's 'ability to overturn the Peripatetic system from within', as argued by Giglioni (2010: 70). Having previously put forward his own understanding of the role of heat and cold against Aristotle, Telesio then points to a fundamental agreement between his system and the Peripatetic one. On the relationship between matter, heat and cold, see Schuhmann (1990).

[2]See Telesio (2009 [1570]: 36) and Telesio (1965-1976 [1586], II: 104–106).

[3]On the interplay of cold and heat in the context of the reception of Aristotle's *antiperistasis*, see Mulsow (1998: 47–51); Giglioni (2010: 71).

[4]For a discussion of the key passages where Telesio formulates his disagreement with Aristotle on this point, see Bondì (1997: 32–33). On the relationship between the sublunary elements: Aristotle (1978 [1952]: 7 (339a15-20)). On the natural motion of the elements, with special reference to *De caelo*, see Lang (1998: 97–208, esp. 208): 'because every body must be heavy or light, i.e., possess inclination, we can understand nature and natural motion as this intrinsic principle at once constituting a thing's nature and dynamically orientating it towards its natural place, down for earth, up for fire, and toward their respective places in the middle for air and water'. On ether as the fifth element, see Lang (1998: 173–180).

[5]For a clear and detailed overview of historiographical engagement with Telesio, see Bondì (2019); Bondì (1997: 139–160).

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possibility that rivers might change their course and why that would happen; and his discussion of the possibility that animals might be generated in furnaces, due to the heat of the fire. These two different cases are, in fact, deeply connected, and the link is to be found in Telesio's reduction of physical principles to only two, cold and heat, and in his explanation of how they interact in order to give shape to the world. In other words, both phenomena – rivers changing course and animals born on account of the heat of the fire – are explained by referring to the broad framework sketched above, that is, to the way in which water is produced by the interaction of sun and earth, on the one hand, and to the general law governing the reproduction of animals, on the other.

These two specific and, in some respects, marginal cases bring to light incongruences, or indeed paradoxes, in Telesio's philosophy. They also demonstrate that, if empiricists claim that 'scientific theories should be accepted or rejected on the basis of how well they save the phenomena', then Telesio is not an empiricist (Bogen 2011: 7). He does not appear to be interested in saving phenomena that he did not view directly, or that he might have viewed only partially. Instead, he opts for a complicated explanation of natural phenomena, in order to save a streamlined metaphysics at the core of his philosophy.

Telesio's interpretation stimulated critical reactions. In his series of queries in response to the 1570 edition of *De natura*, Francesco Patrizi had already pointed out that the foundations of Telesio's philosophy appeared to be metaphysical rather than physical (Patrizi 1981: 470)[6]. This essay suggests that the two marginal cases selected reveal unexpected argumentative turns in the framework of thought sketched in the first pages of *De natura* – a framework which was very daring in its apparent simplicity, and whose metaphysical afflatus has been often mistaken for an empiricist manifesto[7].

Changeable Rivers

In *De natura*, Telesio refers to a passage in which Aristotle addresses the problem of why and how the quantity of water in the sea can remain constant, while we also know of places on earth which seem once to have been covered by water yet are now dry:

> It follows that the sea will never dry up: for before it can do so the water that has left it will fall again into it, and to admit that this happens once is to admit it continues to happen. If, then, you arrest the sun's course, what is there to dry the water up? But if you let it continue in its course it will, as we have explained, always draw up the fresh water when it approaches and let it fall again when it retires. This idea about the sea drying up arose because many places were observed to be drier than they were formerly; and we have already explained that the cause of this phenomenon is an excess of rain at certain periods, and

[6]Patrizi (1981: 470): '*Contemplatio omnium pulcherrima, quaeque universam tuam philosophiam comprehendit; sed magis metaphysica videatur quam physica*'.

[7]I am aware that the relationship between empiricism and metaphysics is more complex than a simple opposition. In what follows I am merely concerned with problematizing a certain historiographical portrait of Telesio which is largely based on the contrast between these two approaches.

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> that it is not due to the growth of the universe as a whole and its parts. Some day the opposite will happen, and after that the earth will again dry up. And so the process must go on in a cycle. For this is a more reasonable way of accounting for the facts than to suppose that the whole universe is in process of change. (Aristotle 1978: 145–147 [356b25-357a3])

Telesio frames Aristotle's argument within his own theory about the action of heat and cold: he states that even for Aristotle the seas contain heat, which is extinguished only by the action of the cold that turns the water into a frozen and compact state. This is especially important for Telesio because water originates from the heating of the earth by the sun, and this is why the seas must contain heat: they are basically earth become fluid[8].

Telesio nevertheless goes on to state that ultimately the action of the two main principles leads to constant, mutual transformation: even those things which are most different from the nature of the earth at first become thicker and start to resemble the earth, and finally are transformed into earth itself if exposed to (a certain intensity of) cold. What is most different from the earth is primarily fire: its flames are light, extremely mobile and impalpable, as opposed to the darkness, immobility and solidity of the earth (Telesio 2006 [1565]: 14)[9]. To describe the transformation from the qualities of fire to those of the earth, Telesio writes that the fiery sun sends out (*emittere*) the heat, while the earth counteracts by exhaling (*effundere*) cold. Both agents aim at turning each other into their own nature, depriving the other of its distinctive qualities while infusing its own and ultimately transforming the other into itself. The whole spectrum of existent things derives from this constant attempt of the earth to mutate fire into dark, immobile, and cold matter, and of the sun to extinguish these very characteristics (more precisely defined as *facultates* and *condiciones*) from the earth (Telesio 1965-1976 [1586]: I, 36)[10]. It is important to underline at this point that for Telesio, celestial heat and the heat of fire are essentially the same, so that he ultimately identifies the sun, heat and fire as the opposite of the earth's coldness. I shall come back to this point when discussing the generation of animals.

In light of the explanation above, water cannot be considered one of the principal agents, differentiated by essence from earth and fire; instead, it is understood as a specific product of the interaction of the two main agents[11]. Since these agents appear to exercise their influence on each other ceaselessly, it can be assumed that the production of water, as with any other formation resulting from the interplay of heat and

[8]On dryness and wetness in relation to cold and heat, and especially on wetness as a result of matter's expansion, see Schuhmann (1990: 126).

[9]On Telesio's description of the phenomenon of the flame, leading to the identification of the fire with the sun's heat, see Mulsow (1998: 238).

[10]It should be noted that in this edition, Telesio specifies that the *tenuitas* of the sun derives from its creation directly by God. See Telesio (1965-1976 [1586]: I, 36): '*Non alio sic a sole, sed ipso a Deo factus sol, purissimaque tenuitate constitui et copiosssimus indi ei potuit calor*'. On the terminology used by Telesio to explain how the heat acts on matter, see Mulsow (1998: 241).

[11]On this key point, see also the treatise *De mari*, in Telesio (1981 [1590]: 120–161, esp. 129). In the 1586 version of *De rerum natura*, Telesio interestingly tries to explain how his theory that water is not an original element conforms to the narration of the creation of waters in the Bible. See Telesio (1965-1976 [1586]: I, 106).

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cold, will be regulated by a constant balancing mechanism: if cold prevails, then the water will become earth; but if the sun is sufficiently intense, it will make the earth fluid again. This poses a potential and quite radical problem: if all things, apart from the two original bodies, exist because of a very delicate balance of the main agents, how then is their self-preservation guaranteed? How can they persist at all in their forms, if they are exposed to the constant action of the cold transforming them to earth, and of the heat loosening the grip and tightness of the earth? In other words, an inherent instability would seem to be the natural character of everything which is formed in between the earth and the sun.

Martin Mulsow's detailed study of the idea of self-preservation in the Renaissance showed how the conception of *conservatio sui,* while not initially a matter of controversy, slowly became a more prominent issue during the 16th century (Mulsow 1998: 18). Telesio is Mulsow's main case-study: he traces how Telesio reinterpreted the interplay of the two opposing agents in the context of the reception of Aristotle's concept of *antiperistasis*, highlighting the connection between their action and the general aim of self-preservation[12]. But while various sources can be identified behind Telesio's conception of the functioning of nature, Mulsow suggests that his theory ends in a radicalization of the model of contrasting principles. As I underlined at the beginning, Telesian physics appears to be extremely simplified in its basic structure: the radicalization to which Mulsow refers ultimately consists in an attempt at simplification[13].

The topic of the formation of water shows, however, that this radicalization endangers the crucial aspect of self-preservation examined by Mulsow: subject to the constant forces of the sun and of the earth, everything formed from their interaction seems to be doomed to extreme instability. In itself, this thought is certainly nothing new: Aristotle in the *Physics* had clearly stated that all natural things move in a cycle, from their beginning to their end, during which they are constantly exposed to the work of the contraries in nature (Aristotle, *Physics* I, 6, 189a1–189b16 and IV, 14, 223b24-224a2). It is therefore not the thought of the constant formation and dissolution of forms that is new in Telesio, but the radical interpretation of it, which results from the emphasis on the only two principles and the way in which they are supposed to interact. Telesio's nature is in danger of becoming a territory without any stability, in which the only law and criterion is the transitory primacy of one agent over the other[14]. In other words: the self-preservation of any formation becomes very difficult to explain. Should nature be condemned to constant, radical and fast change, making any persistence of formations extremely rare?

[12]See Mulsow (1998: 49), with a reference to *Meteorologica*, I, 12 (348b3-5). See Aristotle (1978 [1952]: 83): 'Now we know that hot and cold have a mutual reaction on one another (ἀντιπερίστασις) (which is the reason why subterranean places are cold in hot weather and warm in frosty weather)'.

[13]See Mulsow (1998: 98), where he explains that Telesio's conception of *naturae agentes* derives from at least four different distinctions drawn together.

[14]See also the interpretation in Schuhmann (1990: 127): 'A thing of whatever kind can, accordingly, if the necessary intermediate steps are gone through, in principle be turned into a thing of any other kind. There are no forms that would impose unbreakable limits on the development of nature. The amount of matter available is all that determines the range of what can or cannot be brought about in the realm of nature'.

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This is precisely the question which lies behind a handwritten comment in the margin of the famous copy of *De natura* in the Biblioteca Nazionale Centrale in Rome (sign. 71.3.D.29), and inserted at the point where Telesio (Book 1, ch. 18) explains the origin of rivers:

> This generation of rivers seems to be very sterile: it is indeed astonishing how the action of the sun could be such that it transforms as much earth as required by the flow of waters, and how the earth from which the Nile flows has not been completely dry for a long time? And if this happens by mutating the adjacent portions of earth, how is it that the Nile's springs does not change place? (Telesio 2011 [1565]: 95 [I, 18])[15]

The comment refers to Telesio's discussion of Aristotle's theory about the generation of rivers, with particular reference to *Meteorology*, II, 4, where Aristotle explains the connection between the two types of exhalations (the moist and the dry) and the origin of winds and rivers. The heat of the sun 'draws up the moist exhalation', since, when the sun then recedes, 'the vapour thus drawn up is condensed again by the resulting cold into water', and 'the water thus formed falls and is all distributed over the earth' (Aristotle 1978 [1952]: 165 [359b35-360a7])[16]. An important phenomenon at the basis of the formation of and changes in the river's quantity of water is therefore the condensation of vapors. In the case of rivers, the condensation seems to take place in the mountains which 'act like a thick sponge overhanging the earth and make the water drip through and run together in small quantities in many places' (Aristotle 1978 [1952]: 95 [350a4-7])[17]. Previously in the same text Aristotle had explicitly stated that rivers can dry up and new rivers, with their new springs, appear (Aristotle 1978 [1952]: 107 [351a14-351b3])[18], and that this cyclical mutation will take place in the future as well. These are, nevertheless, very slow changes which a human might not be able to observe in the course of a lifetime (Aristotle 1978 [1952]: 109 [351b8-14])[19].

On the other hand, the comment seems to suggest that we should be able to observe certain changes if the origin and variation of rivers were to take place as Telesio

[15]Telesio (2011 [1565]: 95 (I, 18)): '*Haec fluviorum generatio videtur nimis sterilis, mirum enim quomodo possit esse tanta solis actio ut tantam invertat terram quantam requirit aquarum effluxio, et quomodo iamdudum exiccata admodum non est illa terra de qua Nilus effluit? Et si inalterando proximas partes terrae id fit, quomodo fons Nili locum non mutat?*".

[16]On the conception of 'exhalation' in Aristotle, see Martin (2011: 6–7). See Aristotle (1978 [1952]: 91–93 (349b2-350a14)) about Aristotle's arguments against the so-called reservoir theory.

[17]This process is discussed in a vernacular dialogue devoted specifically to Aristotle's *Meteorology* in Zuccolo (1590: 100–101); on this work, see Cotugno & Lines (2016: 70–71).

[18]Aristotle (1978 [1952]: 107 (351a14-351b3): 'The same parts of the earth are not always moist or dry, but change their character according to the appearance or failure of rivers. So also mainland and sea change places and one area does not remain earth, another sea, for all time, but sea replaces what was once dry land, and where there is now sea there is at another time land. This process must, however, be supposed to take place in an orderly cycle'. Also, Aristotle underlines that it is not any condensation of water that gives origin to a river: a river is defined by the presence of a spring. See Aristotle (1978 [1952]: 167 (360a29-31)): '[w]e do not call a volume of water, however large, a river whatever its flow but only if it flows from a source'.

[19]On the topic of rivers changing course, with particular reference to the critique of Aristotle by the Italian Jesuit Niccolò Cabeo (1586–1650), see Martin (2011: 122).

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describes. For instance, every time the Nile overflows, the earth around it should dry up in a remarkable and observable way, since the sun would actively convert the earth into water. Following Telesio's theory, we need to assume that the sun's action would convert in water as much earth as is needed to produce that flow of water. But in place of this balance between the generation of water and the dissolution of earth, it is possible to envisage other scenarios: for instance, why does the place of the Nile not change according to which portion of the earth is turned into water? Indeed, if the sun can turn any portion of earth into water, how can Telesio explain the regularity with which the Nile overflows and then diminishes its flow, while still maintaining its course? To put it more generally, Telesio's explanation of the interplay between cold and heat seems to be unable to explain regularities in nature, precisely because it is based on the very basic principle of the contraries acting on each other, which is the pattern governing the production of water.

The tone of this comment on Telesio's theory has prompted Roberto Bondì to argue that – in contrast to what Luigi De Franco and Alessandro Ottaviani had assumed – the annotations in this copy of *De natura* are by an anonymous reader, and not by Telesio himself[20]. The reason is that the points raised question the very core of Telesio's physics. The example of the generation of rivers shows that there might be a clash between Telesio's physics and the observation of certain natural phenomena, and that he cannot explain why specific scenarios *do not* take place, and why nature is not subject to constant chaotic change.

In his series of *Obiectiones*, Patrizi argues that Telesio's theory about water formation is incompatible with natural observation, that it does not save the phenomena. In the second version of *De rerum natura* (1570) used by Patrizi, Telesio had directly addressed the question as to why rivers do not usually cease to flow, even if the production of water depends on the sun constantly turning enough earth into fluid form:

> The Peripatetics should not worry that the earth would continuously be turned in water, so that the flow of waters would not stop. Indeed, while the warmth introduced into the earth, out of which the waters seem primarily to be made, does turn into water those parts of it which are softened and loosened and made similar to water, it at the same time softens other parts and moves them towards the nature of water, so that once they have started to flow, they always do so and never stop, neither because of the action of the agent nor because adjacent matter is lacking[21]. (Telesio 2009 [1570]: 44)

[20] See Telesio (2011 [1565]: xx–xi). This copy contains annotations by at least two hands: a few comments are signed Paulus Monacus, while the author of the other comments has not been identified. A comparison between Telesio's handwriting (known from the 1570 copy: Telesio (1989 [1570])) and this hand in the recently reprinted 1565 copy shows that they are sufficiently different to require a detailed study to prove that they are one and the same. For a detailed description of the copy see Ottaviani's introduction to Telesio (2006: xv-xxxi).

[21] Telesio (2009 [1570]: 44): '*Nec si ut Terra in aquam diuturna opus est actione, propterea ne aquarum effluxus cessent verendum est Peripateticis quicquam; dum enim Terra inditus calor, a quo praecipue aquae fieri videntur, emollitas iam attenuatasque et aquae proximas factas eius partes in aquam invertit, emollit interea alias et ad aquae agit naturam; ut igitur semel fluere caepere fluunt semper, et nunquam fluere cessant nunquam vel agentis actione vel proxima deficiente materia*'.

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Compared to the first version, Telesio now directly engages with a critique, which Aristotelians might formulate: he explains that the sun never stops acting on the earth, so that once the water begins to flow, it will always continue to do so. Since the action of the sun is continuous, and there is always matter to be acted on, then the Aristotelians should not fear that Telesio's explanation will be unable to account for the regular flow (and regular change) of rivers[22]. Again, it is worth noting that Telesio is aware of potential criticism directed at the ability of his theory to describe and explicate the phenomena observed in nature, and their regular patterns.

Patrizi's starting point in his objection is precisely that Telesio distances himself from the Aristotelian view, without offering a plausible alternative:

> You object to the Peripatetics that the flows of waters are not generated by the condensation of subterranean vapours, since once the vapours have been consumed, the waters would disappear in many rivers. According to you, they are truly generated from the earth turned into water. But why does the earth not diminish when it is turned into water? If you concede that this happens, when large parts of earth disappear as they are turned into water, caves at any rate would open up and waters would decrease, unless you demonstrate that the earth regenerates and that [it does so] from that same place[23]. (Patrizi 1981: 470)

Patrizi is concerned with the practical consequences of Telesio's general explanation. If water is nothing other than earth made fluid, there should follow an observable diminution of the amount of earth when it is transformed into water. The fact that the earth does not constantly decrease in quantity can only be due to constant regeneration; but then why would the regeneration take place exactly where the transformation from earth into water had taken place? Moreover, should we not observe a massive transformation specifically of the *surface* of the earth, which is the part exposed to the sun (Patrizi 1981: 471)[24]? Yet, this is not what we observe. If Telesio's theory were true, the world should be far more chaotic, involving constant changes in the balance between the amounts of fluid and of solid matter, and their positions on the surface of the earth would also permanently vary. But nature appears to be less paradoxical than Telesio's physics allows us to imagine.

Not surprisingly, Antonio Persio's defence of Telesio includes a reply to this doubt expressed by Patrizi. Persio tries to explain why we do not observe drastic changes

[22]The same point was expressed as follows in Telesio (2006 [1565]: 35): '*Dum siquidem terrae partem in aquam invertit sol, in proximas etiam agit et inalterat proximas et in res immutat, quae parum ab aquae absunt natura, ut igitur semel fluere coepere, fluunt semper et nunquam cessant, nunquam vel materia deficiente vel agenti actione*'.

[23]Patrizi (1981: 470): '*Obiicis Peripateticis fluxus aquarum non a vaporibus subterraneis concretis generari, quia consumptis iamdiu vaporibus in tot flumina hae defecissent. Tibi vero ex terra in aquas acta generantur. Terra haec dum in aquas agitur, nonne imminuitur? Id si concedis, cum olim multae terrae in aquas actae defecissent, vel specus saltem aperti et aquae minores factae, nisi tu terram regenerari ostendas et unde eodem in loco*'. See Telesio (2009 [1570]: 12): '*et nisi assidue e Terra generentur aquae et ipsum etiam mare deficiat tandem universum, non in vapores modo solutum, sed in longe plurima entia immutatum inversumque*'.

[24]Patrizi (1981: 471): '*Non videtur terra immutari a sole in tenuitatem; si enim immutaretur superficies eius, quae maxime soli exposita est, maxime ea immutaretur. Id nequaquam fieri videtur*'. For Telesio's reply to this point, see Patrizi (1981: 462).

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such as those sketched above, and especially the disappearance of earth when it is transformed into water. All in all, he wants to prove that Telesio's physics can account for the regularities in nature and that it does not lead to paradoxes. His main argument is that the earth without doubt regenerates itself, because it is an active principle, just like the sun, and is therefore able to turn fluid back into solid matter (Persio 1981: 488)[25]. That this is indeed what happens is confirmed by experience, according to Persio: he repeatedly uses the verb *experire* to mark this[26]. Nevertheless, Persio does not address the crucial point in Telesio's theory: it is still necessary to explain why the action of the sun and of the earth are adjusted in such a way as to maintain overall a certain proportion and balance, so that the water is never exhausted, and the earth does not disappear substantially.

Whether or not such a metaphysical principle of intrinsic harmony is assumed determines the overall conception of nature. The exchange between Girolamo Cardano and Julius Caesar Scaliger provides further context to assess the far-reaching consequences of the debate on the generation of waters. In Book 2 of *De subtilitate*, referring both to the *Meteorology* and to *Ecclesiastes*, Cardano presents the starting point for the investigation: what is the origin of rivers, and why are they not exhausted by simply running constantly into the sea? He states that the theory about the origin of water from air or from the mountains (with reference to the *Meteorology*) cannot always be true: there are examples of water springing out of fields; moreover, it is improbable that rivers should come from the sea – as *Ecclesiastes* (1.7) seems to imply – since their water is not salty[27]. On the other hand, the melting of the snow cannot alone be responsible for maintaining a constant level of water, because there is not snow on every mountain, which could flow directly into a river (Cardano 2004: 275–276). Cardano's solution to the puzzle is as follows: 'This happens from all these causes; in truth, the main origin is that air is transformed into water, and then snow and continuous rain also contribute in no small measure to it. And Herodotus considers this to be the cause of the inundation of the Nile in Egypt' (Cardano 2004: 276–277)[28].

Scaliger devotes a lengthy section of his *Exotericae exercitationes* to the discussion of this solution proposed by Cardano. He begins by stating that Cardano's criticism of the theory according to which water is generated by air is correct, but that the rest is wrong. Scaliger's response employs a *reductio ad absurdum*: if it were the case that a large quantity of water was constantly extinguished by the action of the sun, then the sea would already have disappeared. But this is not the case, and indeed, Scaliger concludes, the basic quantity of water in rivers never diminishes thanks to

[25]Persio (1981: 488): '*Unde terra generat se ipsam, cum hoc proprium sit naturae agentis utriusque sese multiplicare et alteram in propriam substantiam invertendi vi praeditam esse*'. See also Telesio (2009 [1570]: 12): '*nisi enim assidue in aquas grandinesque et nives crassescat aer, in immensum excrescat, a novo quem assidue educit Sol assidue adauctus*'.

[26]The quoted passage continues as follows: '*quod etiam alii confirmant philosophi et nos experimur*' (Persio 1981: 488). See also Persio (1981: 480): '*Aerem vero aquasque omnes immutari quotidie videmus: nonne aquas modo a sole in tenuitates, modo a terra et frigore in glaciem verti experimur*?'

[27]On the sea's saltiness see also *De mari*, in Telesio (1981), especially chapters 1 and 4.

[28]Cardano (2004: 276–277): '*Ex omnibus his causis fieri; verum origo maxima est, quia aer in aquam transit, post etiam nix et imbres assidui ad hoc non parum conducunt. Quam etiam causam putat Herodotus inundationis quam Nilus facit in Aegypto*'. See Herodotus, *Histories*, II.19–25.

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a constant exchange with the sea: the sea's water is called 'primary quantity' (*quantitas primaria*) and cannot be extinguished. What varies is only the amount of water deriving from the melting of the snow or from the rain (Scaliger 1557 [*Exercitatio* 46, *De fluviorum generatione*]: fol. 72v)[29]. Ultimately, however, Scaliger refers to the role of the 'good architect' who created the universe in such a way that it functions harmoniously (Scaliger 1557: fol. 72v)[30]. This is the same idea in the background of the confrontation between Patrizi and Persio: the only way to explain the regularity in the balancing of heat and cold (and, as a consequence, the constant generation of water) is to assume a principle of harmony acting in nature. Yet this involves leaving the territory of physics and entering that of metaphysics.

Turning now to the second example – the generation of animals due to fire – Telesio's physics again shows paradoxical elements which remain opaque to the explanatory devices derived from the basic principles of his physics.

Fiery Animals

When explaining how animals are generated, Telesio insists that there are two requisites: first, spirit (*spiritus*), a material substance which is essentially heat and gives the animal life, must be produced; and second, this spirit must be contained and enclosed in an 'integument', which is the body of the animal (Telesio 1965-1976 [1586], I: 188). In other words, if the spirit produced can be kept in the body which is forming, then an animal is generated. This is why animals (but also plants) are 'spirit enclosed in its integument', and death is due to the fact that the heat of the spirit will sooner or later slip away from its own place of enclosure (Telesio 1965-1976 [1586], I: 180).

As was the case with the formation of rivers, so too with regard to the generation of animals, Telesio holds to a few apparently straightforward principles related to the general notion of the interplay between cold and heat set out above. He writes that the spirit is of the same nature as the heat of the sun and underlines that this is necessary because it is ultimately produced by the sun, and there must be a relation of similarity between the product and the agent producing it. Like the heat of the sun, the spirit is characterized by mobility, as opposed to the immobility of matter: as a material principle of life, spirit enlivens the body and endows it with perception (Telesio 2006 [1565]: 29)[31] But this general explanation of the nature of spirit and its life-giving

[29]Scaliger (1557: fol. 72v): '*Alia obiectio, Mare fluminibus non sufficeret. Maxima enim aquae pars calore Solis absumitur. Posterior huius orationis pars infelix est. Si enim quotidianis consuptionibus maxima pars aboleretur, absumptum iam esset mare: mare, inquam, etiam cum suis fluminibus […]. Mirum tibi, Cardane, dicam, atque adeo incredibile. Non minuuntur flumina. Non enim ea quantitas, quae e mari suppeditatur, quae primaria est: sed ea, quae solutarum nivium, aut ingruentium sit imbrium accessione*'. Scaliger explains the fact that the water of the rivers is not salty by implying a system of filtration. See Scaliger (1557: fol. 72r).

[30]Scaliger (1557: fol. 72v): '*At o Cardane, ille ille, quem in secundo De generatione divinus vir ait, omnia complevisse, tam bonus fuit architectus, tam prudens castellarius, ut Iulius Frontinus nihil ad eum*'. See Aristotle, *De generatione et corruptione* (336b32-337a1). Sextus Julius Frontinus is the author of *De aquaeductu* (completed c. 98 AD), in which he gives a full account of the history and management of the aqueducts of Rome.

[31]See also Telesio (2006 [1565]: p. 29): '*calor, dum integer invictusque manet, causa animalibus esse videtur, ut commovere se possint*'. This passage is a in fact a quotation from Theodor of Gaza's translation of Aristotle's *Problemata*, from a section in Book 3 discussing why drunkards tremble: '*ergo tremor, cum calor exstinguitur, accidit. Hic enim dum integer invictusque manet, causa animantibus esse videtur, cur movere se valeant*' (Aristotle 1560: 354 [875a24-26]). Note that the meaning is reversed in the cited Greek and Latin versions: the former

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role leaves open more than one possibility as to how the spirit can be produced and be enclosed in its integument. Indeed, on the basis of Telesio's account, animals can be generated not only from the seed of their parents, which carries the spirit within itself, but also directly by the sun, which, as it is similar to spirit, has the power to make (small) animals emerge out of putrid matter by acting on it in such a way as to produce spirit and a body capable of containing it (Telesio 1965-1976 [1586], II: 566)[32]. But there is also a third possibility, involving a rare but not impossible phenomenon: animals could be generated directly in fire, since the heat of the sun and of fire are of the same nature, and spirit is also heat. The generation of animals in a furnace appears therefore to be possible because it is based on exactly the same basic principles underlying sexual reproduction, as well as the so-called spontaneous generation which can occur under certain climatic circumstances[33].

Already in *De natura* Telesio mentions one example of generation by means of and in fire: the *pyrausta*. He writes that this insect is generated thanks to a very intense and continuous heat, which is capable of producing spirit inside the thick bronze of the furnaces of Cyprus (Telesio 2006 [1565]: 33)[34]. In the background of Telesio's example, there is a long tradition. He seems to refer directly to Book 9 of Pliny the Elder's *Naturalis historia*, where it is reported: 'in the copper foundries of Cyprus even in the middle of the fire there flies a creature with wings and four legs, of the size of a rather large fly; it is called the *pyrallis*, or by some the *pyrotocon*. As long as it is in the fire it lives, but when it leaves it on a rather long flight it dies off' (Pliny the Elder 1938-1963, III: 505–507 [11.42])[35]. What is new in Telesio's reference to this fiery creature is that he explains its generation by referring chiefly to his general framework of interpretation about the reproduction of animals.

In his account, the generation of the *pyrausta* in fire might well be a rare event, but not at all a mysterious one, since the explanation about the nature of the heat of the sun, of fire, and of spirit also makes the formation of animals in fire, at least in principle, a perfectly understandable phenomenon. What interests Telesio is giving an account of this type of generation, and of how it conforms to his own theory about the reproduction of animals. Yet the insertion of the example of the *pyrausta* in this context opens a new perspective on the generation of animals, on how it would occur,

states that 'when heat is extinguished (for heat appears to be the cause of motion in animals), the natural control of the body is lost': English translation in Aristotle (1995 [1984]: 1348). Gaza's Latin translation explains instead that when heat is preserved, rather than lost, it is the cause of movement in animals, which are able to move thanks to heat. See some useful notes on this in Aristotle (1991: 452).

[32]For Telesio's view on spontaneous generation, see Muratori (2013). On the conception of cosmic heat, see Hirai (2019).

[33]When reporting the sceptical *tropoi*, Diogenes Laertius (*Lives and Opinions of Eminent Philosophers*, Book 9, Ch. 11, § 79) mentions in the same breath spontaneous generation and the animals that live in the fire. Campanella (2007: 41) mentions Pliny's *pyrausta* in a chapter of *Del senso delle cose* dedicated to spontaneous generation.

[34]Telesio (2006 [1565]: 33): '*Et in Cipriis fornacibus pyraustas longe etiam valentissimus, quod nimirum summus tantum diuturnsque calor in densissimo aere spiritum ingeneret, at neque is e crassissima viscosaque re educat illum*'.

[35]This same passage is reported by Erasmus, who nevertheless reframes it entirely to fit with the proverb about the moth that flies into the lamp and is burnt. See Erasmus (1978: 262), Mann Phillips (1964: 19). There seems to be a certain confusion regarding the kind of animals which the terms *pyrallis, pyrausta*, and *pyrotocon* refer to: on the *pyrallis* (a bird), see Aristotle, *Historia animalium* 609^{a}18-19; on the *pyrausta* (an insect), 605b11-12; on the *pyrotocon*, see Janssens (1950).

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and in what ways it could be influenced. If fire can act in exactly the same way as the sun and can give rise to the same effect (the generation of an animal), then the decisive criterion is simply the intensity of the heat applied to matter. Indeed, Telesio explains that the heat of fire is usually too intense for the two requisites for generation – the production of spirit and its enclosure in the integument – to occur. But if the fire's heat is constant and powerful, as in the furnaces of Cyprus,[36] then there is no reason why it should not lead to generation, outside the pattern of sexual reproduction. This is set out in detail in the 1586 version of Telesio's main work:

> Therefore, fire is unsuitable for the generation of animals and plants not because its warmth is different from that of animals and from celestial warmth, but rather because it is too violent, and such that it draws out of everything all the spirit which it produces, by making it less subtle and by preparing and opening up a wide escape for it. Even animals do not generate anything when their wombs, or the sun itself, act like this. But fire, on the contrary, when it acts with moderate forces, that is, with forces which do not draw out the spirit, which it [i.e. the sun] produces, generates animals just like the sun[37]. (Telesio 1965-1976 [1586], II: 570)

First of all, Telesio again underlines that the heat of fire is not essentially different from that of the sun or from the warmth which is active inside the wombs of animals: the reason why fire does not usually allow generation is to be found in its greater intensity, as opposed to the constant and more moderate strength of the other two types of heat. Fire can produce spirit (the first requisite for generation), but because of its violent power is not able to retain it (the second requisite), so that the spirit flows out and does not lead to the generation of a living creature. This danger is also present when the warmth of animals or the sun's heat are involved in the process: it is simply less likely that generation will fail in these cases. It is therefore merely a scale of probabilities. The warmth of the womb is very suitable for enabling generation, because it retains the spirit transmitted along with the seed. The sun can also generate spirit from the earth and equally retain it to give shape to an animal (or a plant), but only when certain climatic conditions are guaranteed: this second way of generating seems to be more suitable for the generation of small animals rather than of large ones. Finally, fire can lead to generation just like the sun, and Telesio mentions here the example of the formation of small flying creatures in Cypriot furnaces.

At this point, Telesio repeats with minor changes the passage from the 1565 version of *De natura*: 'And in the furnaces of Cyprus the *pyraustae* appear to be formed by very intense fire: the exceedingly strong and continuous heat generates the spirit in the

[36]The intensity of the heat in these furnaces is underlined also by Campanella (2007: 41).

[37]Telesio (1965-1976 [1586], II: 570): '*Non igitur ad animalium plantarumque generationem ineptus est ignis, quod ejus calor ab animalium et a caelesti calore diversus sit; sed quod nimis est vehemens, et qui e quacumque re spiritum, quem ingenerat, educit omnem, et minus tenuem eum faciens et latum ei egressum aperiens patefaciensque: quae ubi vel animalium uteri vel ipse facit sol, et ipsi animalia generant nulla. At ignis contra, moderatis ubi agit viribus quibus videlicet spiritum, quem ingenerat, non educit, et ipse animalia generat veluti et sol*'.

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very dense bronze, but without drawing it out of the extremely thick and dense material' (Telesio (1965-1976 [1586], II: 570))[38]. Following Pliny's report, Telesio now adds that these insects die when they are moved away from the furnaces, but he gives his own explanation for this: 'They die, however, when they are moved away from the fire, since when the bronze is no longer heated, it becomes hard and is made thick and compresses the spirit within'(Telesio (1965-1976 [1586], II: 570))[39]. Again, this phenomenon is clarified through Telesio's understanding of the life-giving role of heat: the death of the *pyrausta* can then be interpreted as a particular (and extreme) case of this general rule.

Telesio's interpretation of the birth of the *pyrausta* within this framework is all the more striking if one considers that Pliny's report represented a puzzle for other 16th century authors[40]. For instance, Cardano in *De subtilitate* calls the generation of this insect *mirabilis* and ultimately relates it to the phenomenon of putrefaction which is responsible for the spontaneous generation of small animals. This follows from his observation that fire, just like extreme cold, is never able to give rise to the generation of an animal: it is therefore more probable that the animal would be generated somewhere else – in the case of the *pyrausta*, this would be directly from the *putredo* in the metal, not far from the fire – and then move away from the place where it originated (Cardano 1550: fol. 189v)[41]. In this way, Cardano frames this strange case of generation within his explanation of the origin of animals from putrid matter, which is the topic of Book 9 of *De subtilitate* (*De animalibus quae ex putredine generantur*). That this interpretation left a major point unexplained is highlighted by Scaliger, who states that he does not understand how putrid matter can be present at all in furnaces. Moreover, Cardano displaces the position where generation occurs – not directly in the fire, but immediately outside it – without explaining how the insect is able to sustain the extreme heat of the furnace (Scaliger 1557: fol. 262r-v)[42]. Telesio did not need to resort to such complicated details about the place where the animal is born and how it then moves into the fire, because he simply made the intensity of the fire responsible for giving life to the *pyrausta*: the starting point for his apparently less convoluted explanation is the absolute similarity of the heat of fire and that of the sun.

The substantial identification of all types of heat shows once again Telesio's attempt to simplify the explanation of natural processes. If, in the case of the rivers, this had led Patrizi and the anonymous commentator to imagine absurd scenarios which are not observed in reality, the reduction of all types of heat to one main function seems,

[38]Telesio (1965-1976 [1586], II: 570): '*Et cypriis in fornacibus, a longe scilicet ardentissimo igne pyraustae constitui videntur: summus videlicet modo diuturnusque calor in densissimo aere spiritum ingeneret, at neque is e crassissima maximeque viscosa re educat illum*'.

[39]Telesio (1965-1976 [1586], II: 570): '*Intereunt autem illae ab igne amotae, quod non amplius calefactum aes durescit densaturque et inexistentem spiritum comprimit*'.

[40]In *De occulta philosophia*, Agrippa divides the animals according to the element they inhabit: the *pyrausta* is an example of an animal living in the element of fire: Agrippa (1992: 100 [1.7]). In *De his, qui diu vivunt sine alimento*, Fortunio Liceti discusses the problem of the nutrition of an animal which lives in fire, like the *pyrausta*: Liceti (1612: 48 [2.45]).

[41]Cardano (1550: fol. 189v): '*E putredine igitur humidi solidissimi metallorum generatur Pyrausta, in ignis vicina parte, ut non corrumpatur humidum ab igne*'. On Cardano's conception of cold and heat, see Cardano (2004: 164–165).

[42]Daniel Sennert repeatedly refers to Scaliger's (and also to Liceti's) interpretation of the generation of the *pyrausta* in Sennert (1650: 117, 234).

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on the other hand, inadequate to account for the variety of nature. In Patrizi's view, for instance, such a theory leaves unexplained how the sun and the earth alone can give rise to an entire diversified spectrum of beings: how is the heat able to generate so many forms of life (Patrizi 1981: 472)? If this is due to the different ways in which the intensity of the heat acts on the earth, as Telesio suggests, then it should be possible to establish precisely what degree of heat is responsible for the generation of every single type of living being. From a simplified theory of generation, one easily slides again into complicated objections, which leave observation behind. Patrizi addresses his comments primarily to Telesio's identification of the warmth of the womb with the action of the sun which produces spontaneous generation; but the same critique could also be applied to generation in fire. One could ask, for instance, why the particular intensity of heat in the bronze furnaces of Cyprus should always form that (and only that) particular type of flying insect. If the two main factors in the process are only the intensity of the fire and the matter on which it acts, then one could go a step further and envisage that, in modifying these variables, the generation of the animals would be affected, too. Certainly, if the fire is too strong, it will not generate anything, but Telesio's theory might also pave the way for unexpected experiments: could one not intervene by adjusting the intensity of the fire in order to make it just right for generating other species of animals?

Conclusion: Metaphysics and Historiography

The discussion of animal generation supports a historiographical reassessment of Telesio's portrayal as an empiricist, reinforcing the metaphysical interpretation of nature that emerged from his explanation of the flow of water. Giovanni Gentile agreed with Bacon regarding the fact that Telesio's philosophy allegedly provided a view of nature that betrayed a lack of interest in human action (Gentile 1911: 56)[43]. Yet, the emphasis on the substantial similarity of all kinds of warmth suggests that Telesio could be included in an alternative lineage to the traditional genealogy of modern science. A text of doubtful attribution to Paracelsus, *De natura rerum*, develops alchemical practices on the basis of a similar conception of heat to that found in Telesio, sliding from a description of nature to a kind of artificial intervention which is not usually associated with Telesio's philosophy. The metaphysical foundations of Telesio's understanding of heat show a clear conceptual resemblance to an alchemical approach that emphasizes the potential for human exploitation, as the human being can intervene in the process of generation by controlling the intensity of the warmth required. Such alchemical elaborations, though not discussed in detail in Telesio's work, are not explicitly excluded either.

The pseudo-Paracelsian *De natura rerum* primarily discusses the generation of living beings. The work begins by introducing a notable distinction between generation 'which happens by nature' and that 'which happens artificially' (that is, alchemically). Nevertheless, according to the author of this text, life itself began by spontaneous generation[44]. Life is generated when the interplay of warmth and humidity leads to

[43]The reference is to Bacon (1996: 250–251). See also Bondì (1997: 142–143), Rossi (1957: 91).

[44]Pseudo-Paracelsus (1928: 307-403, esp. 312): '*von natur alle ding würden aus der erden geboren mit hilf der putrefaction*'. On this work, see Pagel (1982: 115–117), Gantenbein (2020).

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putrefaction, which is able to make matter 'vital' (*lebendig*): this applies not only to spontaneous generation but also to other cases such as the birth of a living chick from an egg, since the exposure to constant warmth makes the mucilaginous matter inside it putrid and, ultimately, alive. At this juncture, the text states explicitly that any source of warmth would serve the purpose of hatching the egg to produce this result: 'not just from the warmth of hens, but from any such kind of warmth'. This is the point at which the connection with the case of the *pyrausta* becomes clear, revealing at the same time the potential for human intervention which was not mentioned by Telesio. What follows in the text are practical instructions about how to produce the same 'degree of fire' needed to turn eggs into living chickens: this can be achieved, for instance, by putting the eggs in a glass with ashes; but even keeping the eggs under the armpit could prove a successful strategy (Pseudo-Paracelsus 1928: 312).

It is relevant to underline that the example of egg hatching is discussed by Telesio in the same chapter of the 1586 edition in which he clarifies how insects can be born in furnaces. After stating that the sun and fire are equally capable of generating – to the extent that generation can occur even when the sun is not intense, if exposure to fire can be provided instead[45] – Telesio clarifies this point by referring to the heat needed to allow the birth of living chickens from eggs. Both Telesio's *De rerum natura* and the pseudo-Paracelsian *De natura rerum* follow parallel paths, despite their great dissimilarities, not least in the style of the writing: they both base their inquiry on the identification of different forms of heat and proceed to disclose the role of fire as a substitute for the warmth of animals or the heat of the sun. Remarkably, both texts insist that these types of generation – even the type which occurs due to fire – are not at all mysterious and inexplicable, but simply follow from the laws of nature (Pseudo-Paracelsus 1928: 320–321).

Moreover, they both point out that fire can also be used to revive living beings who appear to be dead (or, in Telesio's words, in which the spirit seemed to be extinguished). Telesio affirms that insects which are immersed in water and beyond doubt dead can be brought back to life by placing them near to fire, and by covering them in warm ashes (Telesio 1965-1974 [1586], II: 570–572). Pseudo-Paracelsus describes this phenomenon in a similar tone: referring to flying creatures, he states that when 'they are drowned in water and no trace of life can be observed or found in them, and therefore they remain dead and could never become alive again by themselves, they regain their previous life as soon as one sprinkles them with salt and puts them in the heat of the sun and behind a hot oven. This is their resuscitation; then, if this does not happen, they stay dead' (Pseudo-Paracelsus 1928: 346)[46].

It is important to stress that the heat of the sun and that of an oven are considered equivalent from the point of view of this experiment; and despite some striking

[45]Telesio (1965-1976) [1586], II: 570): '*Itaque, quantumvis saevientibus frigoribus et sole amoto quamtumvis, in locis blande ab igne calefactis nihilo fere minus animalia sponte enascuntur, quam ubi ipse agit sol: et ex ovis etiam pulli oriuntur, si leviter blandeque calefiant, tantummodo videlicet, ut spiritus ingeneretur, at nullus elabenti egressus fiat se retineatur ibi et coërceatur. Et cypriis in fornacibus, a longe scilicet ardentissimo igne pyraustae constitui videntur*'.

[46]Pseudo-Paracelsus (1928: 346): '*so dieselbigen [Tiere] im wasser ertrenkt werden und gar kein leben mer an inen gesehen oder gefunden mag werden, und also tot bleiben und von inen selbst nimermer lebendig möchten werden, sobald man aber die mit salz besprenget und an heissen sonenschein und hinder ein heissen ofen sezet, uberkomen sie widerumb ir vorig leben. das ist nun ir resuscitation; dan wo das nit geschehe, bliben sie tot*'.

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details in the Pseudo-Paracelsian text, like the sprinkling with salt, both Telesio and Pseudo-Paracelsus draw analogous conclusions from the interpretation of the role of heat. Certainly, the Pseudo-Paracelsian *De natura rerum* goes much further in recommending how to employ the warmth of fire to produce living beings. Famously, this text also suggests that human beings can be created artificially, and the techniques suggested both for producing life and for reviving dead creatures include alchemical procedures (Pseudo-Paracelsus 1928: 313)[47]. Yet the contact points between such different writings are striking precisely because they are unexpected – at least from the point of view of the traditional historiographical portrait of Telesio as a key figure in the empirically inclined development of modern science.

Though the connection between Telesio and Pseudo-Paracelsus is purely at the level of a shared theoretical substratum, rather than of direct reception links, it bears consequences with regard to the construction of an alternative network of historiographical resemblances. Such a network does not project Telesio towards an observation-driven study of nature. At the same time, it also refrains from interpreting him as a metaphysician due to alleged Renaissance remnants in his philosophy, as if to say that the Renaissance world was metaphysical, and the modern world empirical, and that Telesio's philosophy remains suspended between the two[48]. Instead, reading Telesio next to Paracelsus enables an appreciation of the potential practical consequences of his surprising view of nature, in which metaphysical ideas emerge as the backdrop to the explanation of physical problems. Thus from Telesio's interpretation of the generation of insects in fire, one arrives directly at Pseudo-Paracelsus's view of the oven as a sort of incubator, which can be employed as such precisely because of the laws of generation, substituting natural forces (the sun or the warmth of animals) with more or less sophisticated artificial techniques.

Telesio's natural philosophy is at core not simply a metaphysics: it also assumes other unexpected roles such as that of a substitute for nature's creative power – a spagyric art, as the Pseudo-Paracelsus would put it. If in the case of rivers, Telesio had to justify the regularity of certain natural phenomena, given his theory about the formation of water; the instance of animals born in furnaces or in ovens introduces the possibility of human intervention in the (self-)preservation of living creatures. If this is a metaphysical turn, as Patrizi had already suggested, then at its core is a leap of faith regarding nature's capacity to regulate itself and the human being's own capacity to understand, and make use, of nature's laws. It is a metaphysics that is revealed from the study of marginal cases: its blueprint is the unsettling presence of paradoxes within a deceptively clear physics.

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[47]On the generation of human beings, see Pseudo-Paracelsus (1928: 313).

[48]This is essentially what Soleri (1942) suggests.

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