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AUTOMATON AND SPONTANEOUS GENERATION: A PROBLEMATIC ASPECT IN THE ARISTOTELIAN THEORY OF REPRODUCTION

MARZIA SOARDI
Dipartimento di Filosofia, Filologia, Arti
Storia, Critica dei Saperi, Università degli Studi, Palermo, I

SUMMARY

AUTOMATON AND SPONTANEOUS GENERATION IN ARISTOTLE

In Book III of the De generatione animalium*, Aristotle discusses about the problem of spontaneous generation, which will be object of interest for centuries, up to modern science.*
The aim of the paper is to examinate this topic trying to highlight what is the most remarkable problem in the Aristotelian theory: the ability of the matter of self-moving and self-reproducing and, connected to this, the relationship that exists in nature, in the Aristotelian biology, between a teleological based function and the presence of a necessary counterbalance in material form.
In the last part of the paper the attention will also be focused on the connection between spontaneous generation and sexual reproduction, underlining, once again, the importance of the material aspects, alongside the teleological ones.

In Book III of *De gener. anim*. Aristotle devotes a long discussion to the problem of spontaneous generation. In this discussion he refers to extremely simple beings such as insects, amoeboid creatures and gastropods that, due to certain climatic and environmental conditions, are capable of self-reproduction.

Key words: Aristotle - Spontaneous generation – Reproduction - Material necessity - Natural teleology

The interest in and the appeal of this idea of life as arising spontaneously and continuously from matter would last for centuries, through the Roman scientific literature of the imperial period, the Middle Ages and the Renaissance right up to modern science, where the focus of the whole debate would be on microbes as outcomes of spontaneous generation[1].

In the 19th century, in fact, this was the subject of the lifelong debate between Pasteur and Pouchet[2]. If spontaneous generation exists, Pasteur writes, "As the creator of life, God becomes unnecessary"[3]. On the other hand, from his anti-materialist point of view but sharing the same concern about the power of God in creating life, Pouchet defended the existence of spontaneous generation to demonstrate the principle of continuous creation by God.

The most remarkable thing in the whole history of the theory is that the main interest and problem consists in the ability of matter to move itself and reproduce asexually, which is also the core of the entire discussion on spontaneous generation in Aristotle. This discussion is the subject of a wide debate among scholars. The most emphasized question that arises from this topic and this problem in particular is the relation between material necessity and teleology in the Aristotelian thought.

In this article I will analyse the theory of spontaneous generation in Aristotle, taking into account this problematic connection and underlining once again the importance of the material aspects, in addition to the teleological ones, in Aristotle's theory of generation and, on a larger scale, of nature.

Methodological Introduction

As is well known, studies on Aristotelian biology, in general on Aristotle's concept of nature, have been dominated for a long time by the perspective of teleological function. This certainly does concern a core issue in Aristotelian thought. One could also

say that attention has certainly been sustained by the fact that Aristotle himself frequently and insistently highlights the importance of the final cause in explaining natural processes and the very existence of beings. Final causes coincide with complete substances as the realization of a potential for form. They also coincide with the functions performed by natural beings as actualizations of the pre-existing capacities for these activities.[4]

One important point to note, primarily for the knowledge and study of natural processes, is that the overall structure, and therefore the end of every natural being, allows us to understand the parts. In addition to a comprehensible and explicable function from the perspective of entelechy, there is yet another principle that appeals to matter for the so-called material necessity[5].

Therefore, necessity and purpose always appear to offset each other. Where one prevails, the other loses power without disappearing[6]. As far as living beings are concerned, the famous saying "we say that nature acts for an end and this end is a good" suggests that each species has been systematized in the best way possible[7]. But there is no inevitability to this good, this purpose, being realized. A material necessity exists that sometimes, contributes to the fulfilment of an end (functional matter) and at other times does not, and this is visible in the imperfections[8].

As has been widely recognized in recent years, teleological explanations cannot be completely comprehensive, as far as natural function is concerned. There is something that cannot be reduced to any type of finalism, a material necessity, as a matter of fact[9]. Generally speaking, it is Aristotle himself who argues that nature's processes and products exist for both a purpose and a material type of necessity[10].

Nonetheless, reproduction has been perceived as the teleological process par excellence. There is certainly no shortage of contributors, even in this field, who are concerned with tracing the importance of material factors. But I believe that it would be interesting to

try and bring about new elements in research aimed at enriching the overall picture, starting with the analysis of spontaneous generation and its relationship with sexual reproduction.

Automatos

Aristotle employs a term for spontaneous generation that has a long tradition: *automatos*[11]. Before Aristotle, this word applied to devices able to reproduce the movement of humans or animals as well as small mechanical theatres depicting mythological scenes. The same term was also used for puppets controlled by an intricate system of ropes and sticks.

Our primary source on these devices and how they work is Hero of Alexandria, who wrote his treatise *Peri automatopoietikes* in the first century AD.

According to Hero, the most remarkable aspect of *automata* is their ability to surprise and astonish the audience, hence, he says, he can understand perfectly well why those who constructed the *automata* were called "*thaumaturgoi*"[12]. The wonder arises from the *ekplecton,* the unexpected element caused by the fact that the source of the movement remains hidden and unrevealed.

A connection between *automata* and wonder is traceable in Aristotle as well. According to him, the need to inquire and the desire to understand derive from an initial state of astonishment and surprise when facing some problematic questions for the first time. In order to clarify this process he uses the incommensurability between the diagonal and the side of the square, the solstices and the *automata* as an example[13]. As Walter Spoerri demonstrated, in this case he refers to the kinds of devices described in Hero's work and not to simple puppets[14].

He explains not only the movement of animals through how these *automata* function but also the initial development of the embryo in the uterus.

Aristotle uses the same word in two other two cases: the first and more frequent is that of spontaneous (*automatos*) generation, the second is the one of accident and chance (*automaton*), as described in *Physics*, Book II.

Spontaneous generation and the concept of automatos

Aristotle dedicates a long section in *De gen. anim.* (III, 11) to *genesis automatos*, and there are various references within *Hist. anim.* to organisms that spontaneously generate. He refers to very simple creatures, insects, amoeboid creatures, and gastropods.

According to the explanation found in *De gen. anim,* the process occurs because of the animating heat contained by the *pneuma* in certain conditions present in the earth and especially in water, which is considered to be more capable than earth of shaping living beings.

> *Animals and plants are formed in the earth and in the water because in earth water is present, and in water pneuma is present, and in all pneuma soul-heat is present, so that in a way all things are full of soul; and that is why they quickly take shape once it has been enclosed*[15].

The first observation is that we are dealing with phenomena that occur with certain regularity. This, along with the fact that it may concern entire genera of species, poses a problem that has been discussed many times and is useful to recall and keep in mind here. The problem concerns the relationship between this account of spontaneous generation and the discussion in *Phys.* II, 4-6, on chance (*to automaton*), fortune, and the impossibility of labelling them causes in any causal relationship. What appears to be evident from the entire discussion on products of chance (*automaton*) is that it concerns accidental products caused by actions or natural processes directed at another end than that which was reached[16].

On the other hand, a rather recurring and regular series of spontaneous productions are present in biology that are not classified as acci-

dents over against other products that do not appear[17]. Entire groups of living beings are involved in this type of mechanism, and they behave with a certain regularity.

Some natural processes geared towards an end, just like some "artistic" ones such as medicine, may accidentally achieve ends other than those planned. The opposite may occur as well. That is, these processes were not the cause of these ends. Accidents may yield the same results as the teleological processes. In spontaneous generation the products are not by any means the same as sexual reproduction, and no group that normally reproduces sexually can accidentally generate spontaneously. As I said, this is a phenomenon that certainly deals with specific types of very simple animals. There is a beginning, given the action of the heat together with the conditions of the space. But both this beginning and that which follows are understandable mainly in light of a mechanical function that is inexplicable in light of a finalistic process. By finalistic process I mean one in which it is possible to establish an identity of form between, in the case of generation, the generator and the generated, through a causal relation. What Gotthelf calls "potential for form," which is the distinctive mark of processes directed towards the attainment of entelechy, is entirely lacking here[18]. The heat contained within the *pneuma* contributes to spontaneous generation, yet without any ties to cause and effect. Second, the final products do not formally replicate anything. The model still refers to the heat contained within the *pneuma,* which allows for the development of a generative process but the result changes according to geographical variables. No kind of process belongs to any *species* in particular produced spontaneously, just as the heat that allows this production does not belong to any other organism of the same kind.

If we look at the process of sexual generation, we could observe that the only common factor is the role of the heat. As has been well noted, sexual reproduction (which concerns species divided

into masculine and feminine opposites)[19] occurs through the action undertaken by the male agent through the sperm that penetrates the female matter (menstruation) to initiate the generative process and formation of a new being. The heat contained in the male semen allows reproduction to begin and the movement to start. It is also the fundamental element for successful embryonic development.
Reproduction is therefore explained in hylomorphic terms and as a passage from a potential state to an active one with an identity in form between the generator and the generated, which guarantees its causality and *entelecheia*.
In summary, the following points characterize reproduction by sexual beings:
- the presence of two sexual opposites
- the action of the male form impressed on the female matter, which is passive and receptive
- heat as a form of impulse transmission
- formal identity between the generator and the generated

Spontaneous generation is characterized by the opposite of the above:
- lack of two sexual polarities
- the presence of material elements that seem to be able to generate themselves without the presence of a formal push, only because of certain favourable climatic conditions (the presence of the *pneuma*'s heat)
- the absence of any ties to causality traceable in formal identity between the generator and the generated.

Therefore, according to Aristotle, it seems that very simple organisms exist in nature that are able to reproduce without the action of form. This is one of the more problematic points, that is, the ability of matter to move itself and to have the ability of *kinesis* within itself, admittedly due to heat, but, as we have just seen, without the action of any formal impulse. In the long section 9 of Book Z of *Met*., Aristotle distinguishes between what can be generated only through

art, such as a house, and what can be generated through either art or spontaneously. As far as *technai* are concerned, for example, health can be caused by the art of medicine, but it can also happen spontaneously. If we consider heat to be, for example, a part of health, it or a part of it may be obtained and activated thanks to movement. When he comes to speak about generation, Aristotle says:

> *And it is the same with natural formations as it is with the products of art. For the seed produces just as do those things which function by art. It contains the form potentially, and that form which the seed comes has in some sense the same name as the product (for we must not expect that all should have the same name in the sense that man is produced by man, since woman is also produced by man, unless the product is a freak. This is why a mule is not produced by a mule. Those natural objects, which are produced, like artificial objects, spontaneously, are those whose matter can also initiate for itself that motion which the seed initiates. Those whose matter cannot do this cannot be generated otherwise than by their proper parents*[20].

Therefore, comparing natural beings with artificial ones, according to the Aristotelian text, there are some that are born or produced spontaneously due to matter's ability to carry out a specific movement. I believe this is one of the more problematic and interesting points about spontaneous generation: if there is a lack of a seminal impulse in living organisms or the lack of a thought for artistic and technical matters, a material necessity seems to come into play.
In a much debated passage in *Hist. anim.,* for example, Aristotle discusses little animals generated in wool, in books, or in other dusty and dry material, that is, "anything which contains life [*zoe*]"[21].
What *zoe* is he talking about in this case? Is he referring to living conditions or to the ability of material elements to move themselves in specific conditions? Could we think, in this case, of the presence of a mechanical element that is not telelogically guided? Would it work if it was placed in specific conditions? Even in this case, however, we are looking at a process that does not foresee the actualization

of a form. A "material" environment, so to say, exists that possesses the necessary requisites for the birth of these organisms. The most astounding point is the discrepancy between the descriptions of matter capable of moving itself in some way and the massive teleonomy that, without a doubt, dominates the *De gen. anim.* This teleonomy regarding reproductive processes, which always foresees the action of the formal cause that "informs" the matter since the latter is receptive, passive, and in need of movement. It is a matter of fact that the discrepancy here has to do with two different Aristotelian works: *Hist. anim.* and *De gen. anim.* In the latter, the finalistic setting dominates without question. Yet, as we have seen, there is no shortage of references to some sort of driving power here or movement embedded in matter that does not rely on the realization of a form[22].

If we consider again the discussion on *automaton* and *tyche* from Book II of *Physics*, we know that whatever comes about via *automaton* is accidental. In relation to the only two truly specified types of reproduction, even this type of generation can be similarly considered, to have a logical autonomy: natural *genesis* and *poiesis* as a consequence of the action of an artisan, doctor, or architect. Despite these evaluations, we must recognize two things. The first is that in the work dedicated to generation as a finalistic process par excellence, Aristotle dedicates a long discussion to spontaneous generation. The second is that entire groups of living beings are involved in this type of mechanism, and they behave with certain regularity in comparison. Can the concept of casualness be considered comprehensive when speaking of a phenomenon that happens so regularly and concerns more than an entire genus of organisms? As stated above, I think this is a case in which we must simply recognize that Aristotle may be observing the existence of a function based on natural mechanicalness founded on elements of material necessity.

Now I would like to take a step forward in the direction I indicated at the beginning of this article. That is, I would like to attempt to use

my reflections on spontaneous generation and on the *automaton* to examine sexual reproduction according to Aristotle, as described in *De gen. anim.*

Once fertilization is achieved, that is, once the formal impulse has been transmitted through the male sperm into the female matter/ovulation, the process of fetal formation begins inside the maternal uterus. The start of the process is described with reference to the concept of *automaton*. The different parts of the body, which are forming while remaining in the same position, change and undergo alterations regarding softness, hardness, colour, etc. The process here is similar to a chain effect:

> *As the parts of animal to be formed are present potentially in the matter, once the principle of movement has been supplied, one thing follows on after another without interruption, just as it does in the "miraculous" automatic puppets*[23].

It is clear that this is a process that keeps going as long as the formal/efficient cause permits its actualization for a purpose, which is the formation of a being whose formal replication within its genus is quite evident.

It is interesting, however, to note the use of the concept of *automaton* to talk about the process once it has begun, with all of the implications that I have highlighted up to this point, and the assertion that, in matter, the parts exist potentially. It is important to trace and analyse, when possible, elements of material necessity in sexual reproduction as well, in addition to an undeniable teleological orientation. As I said at the beginning, if we consider entelechy and material necessity to be two aspects present in natural processes, both aspects coexisting within reproduction have to be taken into account . Matter potentially has the parts that are put into motion as *ta automata*. Once the process begins, it seems to follow its own mechanicalness. The potentiality itself of the parts is no less important. In fact, Aristotle

frequently points out that form does not have an effect on matter that is completely unspecific and undifferentiated, as if a part of the process was embedded in this potentiality that actually needed to be realized, because, as he said "that which is potentially will not be brought into being by a motive agent which lacks the appropriate actuality" and, conversely, "that which possesses the actuality will not produce the article out any casual material"[24].

Therefore, a certain type of bonding reciprocity exists between an agent and a patient. Moreover, to speak of matter being a specific and determined type, I believe, may suggest the idea of a functionality or material mechanicalness that, in this case, is waiting to be actualized.

Just as every being realizes its own essence solely in the realization of its own functions, the reproductive function can be understood in the same way as starting with a form that moves determined matter. Obviously, this matter needs to be pushed by the efficient cause that the formal impulse is transmitted through. Once this happens, in the case of reproduction and the formation of the embryo, the parts of the body begin to become differentiated from one other. Aristotle uses the example of automatic puppets to describe this chain of change. In my opinion, this implies recognition of a certain type of mechanicalness, a material necessity even in reproduction, due to the fact that the process' progress does not entirely depend on the impulses coming from the formal push, and I assume that the use of *automaton* has to be intended in this sense. The existing compensation between the end and the material necessity does not permit the first to be inevitable. The sublunar world must always take into account the approximations specified by matter as well as the necessity of the material mechanicalness in order to guarantee the existence of natural processes.

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1. Vitruvius, *De arch*., VI, 4. Pliny the Elder, *Nat. Hist*. IX, 74. Athaeneus of Naucratis, Atheneus, *Deipn,* VII.
   In the XIII Century the Aristotelian thought reaches its greatest diffusion with St. Thomas Aquinas even though, centuries before, the Christian world had already accepted the idea of life spontaneously generated, as it is testified by St. Augustinus's work. He believed in the existence of two seeds, one implanted in animals, the other existing in the elements and becoming active under certain conditions. He carefully did not attribute any power to the material creation to bring forth life. Only what had been made the first day could spring forth (see *Augustine: The Literal Meaning of Genesis*. In: QUASTEN J. AND PLUMPE J. C., eds., *Ancient Christian Writers*. vol 41–2. Westminster, Maryland, Paulist Press International, 1982; 1,I,23: 2, IX, 29. Augustine, *The City of God Against the Pagans*. *Cambridge Texts in the History of Political Thought*. Trans Robert W. Dyson. Cambridge, Cambridge University Press, 1998, XV, 27- XVI, 7.
   The 16th century was particularly interested in the theory of spontaneous generation, Jean Baptiste van Helmont, for example, with his experiments with grains of wheat and human sweat, tried to prove the transformation of the inactive matter into living matter.
   PAGEL W., *Joan Baptiste van Helmont*. *Reformer of Science and Medicine*. Cambridge, Cambridge University Press, 2002.

The theory of spontaneous generation of the animals died at the hands of Francesco Redi whose main scientific interests were insects. He showed the inconsistence of the theory of self-generating organisms, producing evidences for the necessity of eggs to produce new living beings on the surface of rotten flesh.

2. ROBBINS L. E., *Louis Pasteur and the Hidden world of Microbes*. Oxford, Oxford University Press, 2001, p. 46.
3. "Dieu comme auteur de la vie devient inutile. La matière le remplace". PASTEUR VALLERY-RADOT L., *Oeuvres de Pasteur, reunites par Pasteur Vallery-Radot*. Paris, Libraire de l'Académie de Médecine, 1922, vol. VII, p. 29.
4. We could also consider a third category of final cause: the objects of desire as aims of our deliberative actions.
5. Actually, as it is well known, the Aristotelian etiological theory discusses four types of causes: material, efficient, formal and final. In *De part. anim.* I, 1, 642a 1-3 Aristotle distinguishes between two types of causes, those related to finality and those related to necessity. As clarified soon after, in this case the reference to necessity is a reference to the material cause. See, for example, *De part. anim,* I, 1, 642 a 33-35/ *De part. anim,* I, 1, 639 b 2-30/ IV, 13, 695 b 17-25, *De gen. anim.,* II, 1731 b 20-23; V, 1, 778a 7-10; V, 8, 789b 2-15.
The problem of the relationship between material necessity and teleology has been widely discussed by the scholarship. Some scholars think that they are incompatible with each other (see, for example, BALME D., *Teleology and Necessity.* In: GOTTHELF A., LENNOX J., *Philosophical Issues in Aristotle's Biology*. Cambridge – New York, Cambridge University Press, 1987, pp. 275-85); some others admit their compatibility, but they affirm that material necessity is not capable of producing regular outcomes, without the action of the final cause (BRADIE M., MILLER F.D., *Teleology and Natural Necessity.* In: LLOYD P.G., *Aristotle, Critical Assessments*. London, Routledge, 1999, pp. 75-89. COOPER J., *Aristotle on Natural Teleology.* In: SCHOFIELD M., NUSSBAUM C., *Language and logos*. Cambridge, Cambridge University Press. 1982, pp.197-222. Gotthelf A., *Aristotle's Conception of Final Causality*. In: GOTTHELF A., LENNOX J., *Philosophical Issues in Aristotle's Biology*. Cambridge – New York, Cambridge University Press, 1987, pp. 204-242. IRWIN T., *Aristotle's first principles*. Oxford, Clarendon, 1988, pp. 109-112. Lennox J. G., *Aristotle's Philosophy of Biology. Studies in the Origins of Life Science*. Cambridge, Cambridge University Press. 2001. WATERLOW S., *Nature, Change and Agency in Aristotle's Physics: a philosophical Study*. Oxford, Oxford University Press, 1982). A third position assigned a mere explanatory role to the teleological pattern in order to make natural processes

intelligible, whereas, in terms of causation, natural phenomena are provoked just by material and efficient causes (NUSSBAUM M. C., *Aristotle's de motu animalium*. Princeton, NJ, Princeton University Press, 1978. SORABJI R., *Necessity, Cause and Blame: Perspectives on Aristotle's Theory*. Ithaca, NY, Cornell University Press, 1980. A recent new position has been offered by LEUNISSEN M., *Explanation and teleology in Aristotle's science of nature*. Cambridge, Cambridge University Press, 2010. She distinguishes between two kinds of teleology, primary and secondary. The first "involves the realization of a pre-existing potential for form through stages shaped by conditional necessity, where the fully realized form constitutes the final cause of the process." (p. 18) The second one "involves a formal nature of an animal using materials for something good, where those materials "happen to be available" in the animal, as the result of material necessity, but not, strictly speaking, as the result of conditional necessity". (p. 19). To this regard, see also BOTTER B., *La necessità naturale in Aristotele*. Napoli, Loffredo, 2009.

6. See *Meter.* IV 12, where this process of compensation that continues in a hierarchical fashion (as far as non-homeomerous and homeomerous parts is concerned) is quite clear.
7. *De somn. et vigil*.. 2, 455b 17.
8. As we know, the form of every being is identified in its essence. Granted nature never operates in vain, its fulfilment would be for the better. If we are speaking of living beings, this last note is given within an array of possibilities connected to the animal genus in question. However, among these, one cannot ignore those connected to matter. As Lennox (LENNOX J. G., see note 5) well explains, material aspects can concur with the fulfilment of a *telos*, or at least they guarantee the possibility of its actualization. Furthermore, we must remember the fact that, as far as natural beings are concerned, realization of essence is achieved through the exercising of their functions. Function is also realized due to the presence of matter, which, rightly so in my opinion, Gill defines as "functional matter" (GILL M. L., *Aristotle on substance. The paradox of Unity*. Princeton, Princeton University Press, 1989, p. 128).
9. In regards to teleological explanations, Lennox (LENNOX J. G., see note 5, pp. 225-298) maintains that Aristotle may not always be as clear as possible in determining when they may not be entirely appropriate, and highlights the way Theophrastus, in his commentary on Metaphysics, pays particular attention to some problematic examples. According to Lennox Aristotle's position could stand between the platonic Timaeus' finalism (the world as a product of divine intervention realizes its own purposes through its order and

harmony) and the materialism of a vast number of Ionic naturalists. As far as Theophrastus and, in particular, the problem of spontaneous generation, see BALME D. M., *Development of biology in Aristotle and Theophrastus: Theory of spontaneous generation*. Phronesis 1962; VII, I: 91-104.

10. See BOLTON R., *The material cause: matter and explanation in Aristotle's natural science*. In: KULLMANN W., FÖLLINGER S., *Aristotelische Biologie*. Akten des Symposions über Aristotelisches Biologie vom 24 - 28 Juli 1995 in der Werner – Reiners – Stiftung in Bad Hamburg, Stuttgart, 1997, pp. 97 – 124. See also LEUNISSEN M., see note 5, p. 210. For the different meanings of "necessity" in Aristotle *Met,* V, 5, 1015a 20-b15/ XII, 7, 1072b 12-13.
11. According to the etymological dictionary the second part of the word (*matos*) is connected with the same root of the greek *menos*, which indicates strength and force in the Homeric language. Consequently, *automatos* would express the idea of an inner source of force (CHANTRAINE P., *Dictionnaire étymologique de la langue greque. Histoire des mots*. Paris, Editions Klincksieck, 1968-74, s.v.).
12. I, 1: p. 338, 3-6; 1,7: pp.340, 23 – 342, 4.
13. *Met,* I, 2, 983 a 12-19.
14. SPOERRI W., *Incommensurabilit*ät, *Automaten und philosophisches Staunen im Alpha der "Metaphysic"*. In: WIESNER J. (ed.), AA.VV., *Aristotle Werk und Wirkung*. Paul Moraux Gewidmet. Berlin, New York, De Gruyter, 1985, pp. 239-272.
15. *De gen. anim*., III, 11, 762 a 10-24. See HULL D., *The conflict between spontaneous generation and Aristotle's Metaphysics*. Proceedings of the inter-American Congress of Philosophy; 1967-68; 7- II: 245-250. LENNOX J. G., see note 5, pp. 229-49. LOUIS P., *La génération spontanée chez Aristote,* dans *Actes du XII Congrès d'histoire des sciences*. Paris, Blanchard, 1970, pp. 291-305. SISSA G., *La génération automatique*. In: ROMEYER DHERBEY G., CASSIN B., LABARRIÈRE J. L., *L'animal dans l'antiquité*. Paris,Vrin, 1997, pp. 95-111.
16. "*Both luck and chance, then, as we have said, are causes that come into play incidentally and produce effects that possibly, but not necessarily or generally, follow from the purposeful action to which in this case they are incident, though the action might have been taken directly an primary for their sake*." *Phys,* II, 5, 197 a 33-36.
    On the theory of causation in the Aristotelian biology, see PELLEGRIN P., *De l'éxplication causale dans la biologie d'Aristote*. Rev Metaphys Moral 1990; 2: 197-219.
17. According to LEUNISSEN M., see note 5, p. 210 "The regular coming into being and presence of natural beneficial outcomes cannot be accidental and

matter of chance (…) in addition to material and efficient causes operating from the "bottom up", there must be overarching formal and final causes at work that from the "top down" guarantee the regularity of those outcomes by ordering, timing, and limiting the complex sequence of natural events in general and of the stages in biological development in particular." (p. 210). Nonetheless, in the case of the regularity of spontaneous generation it is not evident any regulating presence of a final cause.

18. GOTTHELF A., see note 5, p.226.
19. See *De gen. anim.,* I, 2, 716 a 4 – 7. Living beings that sexually reproduce are, therefore, mainly blood beings capable of movement (see *De gener. anim.,* I, 2, 715 a 26 – 30).
20. *Met.* Z, 9, 1034 a 34-35/1034b 1- 8.
21. *Hist. anim.,* V, 32, 557b 1-13.
22. See CONNELL S. M., *Toward an integrated Approach to Aristotle as Biological Philosopher.* Rev Metaphys 2001; 55,2: 297-322, where all these kinds of organisms, which spontaneously reproduce, are described as lacking of a proper form. In my opinion the lack of any replicated pattern doesn't necessarily entail that every living being, implicated in spontaneous generation, is formless or, as Connell says, aiming **"**toward a better existence and as striving to emulate the more ideal situation, such that the whole of lower life appears to be embryonic." (p.26).
23. *De gen. anim.,* II, 5, 741 b 8 – 15. In *De mot. anim.* 701 b 1-13 the same expression is used to explain movement. See NUSSBAUM M. C., *The text of Aristotle's de motu animalium.* Harvard Stud Class P 1976; 80: 111-159. The scholar makes a reference to this passage as an example "to illustrate the principle that the real cause may act at some remove, touching off a chain of events that culminates in the one we observe: one thing moves another in sequence, because the parts in their state of rest possess a certain potential" (p.147). Of similar thought, Gotthelf (GOTTHELF A., see note 5), sees an instrument in this analogy to demonstrate how the male parent may be an efficient cause without coming in contact with the embryo (see p. 219) A similar opinion is expressed by SISSA G., see note 5. BALME D., see note 5) instead maintains the argument of the presence of a mechanical cause (p. 18).
24. *De gen. anim.,* II, 6, 743 a 16 – 27.

Correspondence should be addressed to:

marzia.soardi@gmail.com