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Research Article

A Brief Historical Survey of the "Contagium Vivum) (From Marcus Terentius Varro's (116-54 B.C.) "Animalia Minuta" And Titus Lucretius Carus' (C.94-C.54 B.C.) "Semina" To Louis Pasteur's (1822-1895) and Robert Koch's (1843-1910) "Germs" and "Bacteria" -

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The insects were considered wonderfully perfect creatures since Aristotle (384 - 322 B.C.). Galen (c.129- 199 A.D.) deals with them with a greatest admiration. However nobody did ever either imagine, or suppose the existence of micro-organisms before Antony van Leeuwenhoek (1632 - 1723), perhaps only a brief passage of Marcus Terentius Varro's "De re rustica" (On agriculture) excepted. Even Lucretius' "semina morbi" and Gerolamo Fracastoro's (1478 - 1533) "seminaria morbi" cannot at all be interpreted as if they were "living creatures", although invisible to the naked eye. First the "insects" then the so called "infusoria"[1] became the protagonists during the 17th century thanks to the accession of the "microscope", so that their observation brought to the demolition of Aristotle's theory of "spontaneous generation" first by Francesco Redi (1626 - 1698) at macroscopical level, then by Lazzaro Spallanzani (1729 - 1841) at microscopical level, thank to whose experiments and discoveries we can affirm that modern microbiology started.

1 - Although there cannot be any doubt that the History of modern Biology starts from the discoveries made thanks to the invention and the use of the instruments of optical magnification, nonetheless it is no less true that the insects were the protagonists of the first stage. After all the first statement of an observation performed with the aid of a real magnifying instrument - if we exclude those performed by Giovanni Rucellai (1475 - 1525) surely having recourse to a concave mirror and described by him in his little poem "Le api" (On the bees), published by Gian Giorgio Trissino (1478- 1550) in 1539 - goes back to the year 1610, when Galileo Galilei (1564 -1642) not only published his brief and fundamental treatise "Sidereus nuncius" (The sidereal nuncio), but also modified his "occhiale" (spyglass), transferred his instrument from the observation of the infinitely big, to that of what - in that time - was considered to be infinitely little and described the characteristics he had observed "in the eye of a certain insect" through the particular instrument, which he later called "occhialino" (little glass) in the letter, with which he accompanied the gift of just an "occhialino" he sent to Federico Cesi (1585 - 1630) on September 23/1624

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2 - Galileo's "occhialino" was changed into "microscope" by the members of the glorious "Academia dei lincei" (1603 -1630) and the insects became the exceptionally fertile ground, in which the microscope fought its first and exceptional battles and let the scientists discover the marvellous organization of these littlest bodies. "Marvellous", this is true, but not "unsuspected"! Indeed Galen himself speaks of it[2] on the occasion of the description of a cameo adorning a precious nail with the figure of "Phaeton and the quadriga of the Sun" He states that an anonymous artist had realized the figure so perfectly that an observer could see "the bits, the mouths, the front - tooth that - to tell the truth - I did not succeed in seeing owing to the smallness unless I put that wonderful beauty in full light" and adds: "It was difficult for me to distinguish the sixteen legs of the horses clearly, but those, who succeeded in seeing them clearly could realize that the articulations of each leg appeared to be perfect. However none of these legs represented a workmanship more perfect than that of a leg of a fly! Moreover the art, which realized the leg of the fly, fills the entire insect, because the fly lives, eats and grows". This miracle that the Divine Craftsman performs in a lowermost animal like a fly, how more astonishing and wonderful will appear in the higher animals?

3 - Galen's observation is really wonderful! All the more so because he never performed observations of insects[3] and states: "I never dissected and would never try to perform dissections of fleas, worms, bees and ants. Indeed as I find a lot of mistakes made by the anatomists in the description of the parts of bigger animals, the legitimate and reasonable suspicion arises that they made even greater mistakes in observing the littlest ones". In these few lines one may surmise a criticism to Aristotle, although he respectfully doesn't quote his name!

4 - However Galen is quite wrong. Indeed one can find just in his works the first attempts at a systematic research on these "*littlest animals*", which represented to him -and will represent to all the biologist of the subsequent centuries till the 17th century -the lowermost class of the animals and were a kind of link between the animal and the vegetal world.

5 - It is really impossible to analyse here all the pages that Aristotle dedicates to the study of these even littlest living creatures. However we think that it is important to emphasize at least few of them, which we judge to be exceptionally interesting and such as to give the literally roaring measure of Aristotle's genius. First of all he succeeded in distinguishing male and female insects: "As for the insects -he writes[4] -the males are littler than the females; they service them at the back and it is difficult to separate them (during the sexual intercourse)". He did not succeed in seeing the eggs lied by the insects -this is true - however, after having correctly observed that "all the insects that copulate bear larvae"[5], he maintains that a particular kind of butterflies[6] "lay a hard body that looks like a seed of bastard saffron, but is full of humour", and it is worth observing that the average diameter of a bastard saffron seed is less than 0,002 inch!

6 - As for the larvae, Aristotle's statement is really exceptional: "the animal -he affirms - doesn't develop from a particular part of the larva, as it occurs in the hen eggs, but is the result of the growth and differentiation of the entire larva". Unfortunately he did not succeed in observing the insect's eggs and, by consequence, inherited from his predecessors the theory of "spontaneous" and "equivocal generation"[7], which survived till the 18th century, when

1. Micro - organisms that seemed to come into being "spontaneously" after "infusion" of herbs in water

2. Cf. De usu partium corporis humani (On the usefulness of the parts of the human body), XVII, 1, K. IV, 361- 362.
K. means "Claudii Galeni Opera Omnia, edited by Carl Gottlob Kühn, Lipsiae, 1921 ff. The Roman numbers correspond to the volume; the Arab ones to the chapter or the page

3. It is worth observing that the term "insects" was referred to all the lower animals, from the real "insects" to the worms, which, on their turn, also included the larvae.

4 Cf. De placitis Hippocratis et Platonis (On Hippocrates' and Plato's theories), V, 5, K. V, 540

5. Cf. Historia animalium (Description of animals), V, 19, 550b

6. On the other hand we nowadays know that are not so few the ovoviviparous and even viviparous insects

7. Most probably he is alluding to the Bombyx he deals with a little later, but which cannot be identified with the silkworm

8. It was supposed to occur when the offspring of a kind of spontaneously born insects derived from copulation

it was finally demolished by Lazzaro Spallanzani (1729 - 1799). Yet he had performed even more astonishing observations. Indeed few lines below[8] he states that "the female locusts lay their off spring into the earth where they insert in advance the tube their tail is provided with whilst the males are lacking in it" and proves to have correctly observed the so-called "ovipositor". But he went even further and observed[9] that the cicada "is provided with a bipartite genital organ" and that "it is the male, which penetrates into the female", although he generally affirms the contrary, perhaps mistaking the "ovipositor" for a sort of "female penis".

7 - The observation concerning the "bipartite genital organ" is really astonishing, if one considers that Aristotle performed it with the necked eye and that it will be only confirmed 20 century later first by Marco Aurelio Severino (1580 - 1636), who described and illustrated with the aid of a microscope the "uterus bicornis, praelonga cervice, cum ovibuset foetibus pusillis"(two - horned womb provided with a very long neck and full of littlest foetuses)[10] he observed in a female beetle (Figure 1), then by Marcello Malpighi (1628 - 1694), who described the two-horned womb of the female silkworm[11] having recourse - like Severino - to the so - called "anatomia artificiosa et subtilis" (artificial and subtle anatomy) we shall deal with shortly, although at the moment we feel bound to emphasize that Aristotle seems to have already given us a really exceptional document of it. All the more so -we repeat -if one considers that he performed his observations with the necked eye!!

8 - However Aristotle did not confine himself to the outstanding observations and descriptions we quoted above. He also succeeded in observing and describing[12] "an animal" that "forms into the old wax" and "seems to be the littlest of all animals and we call it "acares"[13]. It is little and white". This "acares" must be identified either with the Monieziella entomophaga, which may be found just in the wax of the old honeycombs and doesn't exceed a diameter of 0,006 inch, or the Acarapis woodii, whose diameter doesn't exceed 0,004 inch. But the surely most important passage may be read in the previous page[14], in which Aristotle describes what we call "acarus scabiei" (itch - mite), i.e. the Sarcoptes scabiei. "When the lice - he writes -are on the point of forming[15] little blisters appear, but without pus. Should one incise them the lice come out" and adds that "in some men this phenomenon causes a disease, should his body suffer from abundant humidity". Apart from the mistake of considering the lice as a product of the blisters, it is worth observing that Aristotle does not identify the disease just with the forming of the blisters and the consequent "spontaneous generation" of the lice, but identifies the cause of the disease in the mix "blisters - lice", surely not a footling observation!

9. Cf. Historia animalium, V, 28, 555b ff

10. Cf. Historia animalium, V, 28, 556a ff

11. Cf. Zootomia democrittea (Zootomy according to Democritus'theory), Nurnberg, 1645

12. Cf. De bombice (on the silkworm), London, 1669

13. Cf. Historia animalium, V, 557a ff

14. Literally "that cannot be cut". It was considered a sort of "living atom"

Figure 1: Severinus' illustration of the "uterus bicornis".

9 - During the subsequent centuries the animals that Aristotle called "insects" in general, did not interest at all, only flies, gadflies and mainly bees, which all the authors of treatises "On agriculture" dealt with and Virgil (70 -19 B.C.) in particular in the 4th book of his Georgics. However between the 1st century B.C. and the 1st A.D one meets with three authors, who deserve particular attention: Marcus Terentius Varro (116 -27 B.C.), the great poet Titus Lucretius Carus (c.94-c.54 B.C.) and Lucius Iunius Moderatus Columella (1st century E.V.). The first makes Gneus Tremellius Scrofa - the chief interlocutor in the first two books of the dialogues of his *De re rustica* (On agriculture), in three books -say: "It is also necessary to take precautions in the case that everglade areas lay near the farm because in those marshes certain littlest animals grow, which are invisible, penetrate into the body through the mouth and the nostrils owing to the breathed air and cause diseases that can be cured with great difficulty"[16].

10 - This is the only passage of the whole scientific literature preceding the 17th century in which the cause of diseases is ascribed to a living aetiology. The author was more than sure because he makes Fundanius - another interlocutor of the dialogue - ask Scrofa to let him know what he could do in the case of inheriting such a farm, to whom Gaius Agrius - a third interlocutor - responds: "I can only give you this answer: sell it as dearest as possible. Should you not succeed in selling, leave it!"

11 - However what one can read in the 5th chapter of the 1st of the 12 books De re rustica (On agriculture) written by Columella most probably in 60 A.D is worth a certain appreciation. He too - like Varro - recommends avoiding as carefully as possible marching areas near the farm because stagnant water "produces - as a consequence of the heat - poisonous fumes and generates animals provided with irritating aculei, greatest swarms of which assault us"[17]. Moreover stagnant water gives birth to any kind of "pestiferous animals" that the muddiness of the ground and the filthiness of the stagnant water make poisonous so that they "often cause mysterious diseases, the origins of which cannot be identified even by the physicians". What he writes few lines after is no less interesting: "Should the farm - he writes - lacking in both sun and favourable aeration nothing else can succeed in drying and cleaning the nocturnal frosts, the rusty damp and the mould, which damage not only the men, but also the animals, the trees and the harvests". Although he doesn't deal with Varro's "littlest and invisible animals", nonetheless we think that what he says about the mould that damages not only the harvests but also the animals and even the men is exceptionally interesting. In fact Columella moves - so to say - the causes of the "mysterious diseases"

15. Cf. Historia animalium, 556b

16. A clear allusion to "spontaneous generation"

17. Cf. De re rustica, I, 12, 2.

18. He is clearly alluding to the mosquitoes

from the "invisible animals" to the "invisible vegetables", although he surely did know nothing at all about the nature of the moulds, which only in the 17th century Malpighi's genius began understanding.

12 - At any rate, Varro's passage - we repeat - remains the only one that recognizes the "invisible animals" as causes of diseases. Indeed it is absolutely impossible to recognize anything similar in those that the poet Lucretius calls "semina morbi" (seeds of diseases). As a matter of fact not even the faintest idea of something like a pathogenic germ can be found in any passage of his poem De rerum natura (On Nature). Suffice it reading what he writes when fronting just the problem of the diseases in general and of epidemics in particular: "I will explain now -he writes[18] - which are the causes of the diseases or whence a morbid and suddenly born power can cause slaughters not only of men, but also of herds. First of all I have already proven[19] that there are seeds[20] that form a lot of vital things for us. By consequence it's inevitable that many of them fly in the air and cause diseases an even death. When these seeds incidentally are born and have spread all through the sky, the air becomes morbid and that whole morbid power as well as that whole pestiferous virtue either reach the outside like the clouds and the nimbi come on high through the sky, or start from the ground, which putrefies when it has been damped by unseasonable rains and struck by the sun". Should one find an even faintest allusion to something looking like the idea of pathogenic micro-organisms in these words he is surely endowed with a "divinandi peritia", which we are lacking in! Yet Lucretius had guessed - so to say - the wonder of the infinitely little! Suffice it to read the following brief passage[21]: "There are living beings so little that it is impossible to see even 1/3 of them. Which must we suppose to be any of their internal parts? How must we imagine being the globule of their heart or of one of their eyes? How little are their limbs and their joints? How little must they necessarily be the primordia that form their life and their soul? Do you not realize how thin and how little they are?" Marvellous intuition, which Galen echoed two centuries later when he prised the Divine Craftsman for having created the leg of a fly!

13 - However this intuition did not suggest to Lucretius as well as to Galen the idea that those marvellous "littlest animals" could be just the causes of the diseases. Indeed Galen agreed with Aristotle and maintained[22] that many abscesses "once incised revealed that they contained not only different humours, but also many different and solid bodies" that is to say "bodies that look like mud, urine, clots, a viscous mucus, hard calluses, nails, hairs" and "sometimes even littlest animals were found quite similar to those that form in cases of putrefaction"[23].

14 - Aulus Cornelius Celsus (1st century B.C.-1st century A.D.) in his turn had observed 1 century before Galen littlest larvae that formed -obviously by "spontaneous generation"! - in the earwax of patients suffering from otopyosis and writes[24]: "When the larvae have formed, should they be in the external ear they must be extracted by an ear probe; by contrast should they have formed in the inner tract of the ear they must be killed with medicines...preventing them as carefully as possible from forming again".

15 - However "worms" can also form into the teeth. Scribonius Largus -a little younger than Celsus -informs us about. Indeed he maintains[25] that in cases of wide and deep dental caries, after fumigations with henbane seeds and mouth rinsing with cold water littlest "worms" come out from the cavity of the caries, which, obviously, formed "spontaneously" as a consequence of the putrefaction of the organic matter that has accumulated just into the cavity of the caries.

16 - All the subsequent biologists were faithful followers of Aristotle's theory of "spontaneous generation", Gerolamo Fracastoro (1478 -1533) included. Indeed, although we feel bound to approach this great personality with greatest humility, nonetheless we must confess that after having repeatedly read and reread all Fracastoro's treatises as carefully as possible and with a real "Franciscan patience", we did not succeed in finding even the faintest description of a living "germ" and therefore of any foundation of modern epidemiology[26]. Indeed we can only find a rather absurd mixture of "flabby and viscous humours", "melancholy", "sympathies and antipathies", "viscosity and heat", "putrefactions", accompanied with a jumble of "dissolutions", "evaporations", "sourness and sweetness", "dryness and dampness", "hot and cold", "spirits", "corruption of air and water", finally but mainly "negative and poisonous influences of the stars". In few words: should the germ theory be founded on such Fracastoro's chaotic mass of nonsense we could only cry![27] [5,7,8,9].

17 - Perhaps Athanasius Kircher ((1602 - 1680) proposed an idea of the "contagium vivum" a little nearer the truth, although still founded on a little modified sort of "spontaneous generation". Indeed in his treatise Scrutinium Physico-medicum contagiosae luis quae pestis dicitur (A physical and medical research on the contagious plague which is called pestilence)[28] he maintains that "such corpuscles are generally not living...but owing to the external and environmental heat quickly open in numberless offspring of little worms that are invisible by the necked eye, so that it is sure that as many corpuscles are contained into the efflux, so many littlest worms come into being. Therefore we cannot define them "lifeless scents" but must consider them to be "living scents".

18 - Only Francesco Redi's (1626 - 1698) "Esperienze intorno alla generazione degl'insetti" (Experiments concerning the generation of insects)[29] and "Osservazioni intorno agli animali viventi che si trovano negli animali viventi" (Observations concerning the living animals that may be found into living animals)[30] and most of all Giovan Cosimo Bonomo's (1666 - 1696) and Giacinto (or Diacinto) Cestoni's "Osservazioni intorno a pellicelli del corpo umano" (Observations

19.CF. VI, 1090 ff

20. In the 1st book in particular

21."Seed" in Lucretius means "atom"

22. Cf. De rerum natura, IV, 116 ff

23. Cf. De tumoribus praeter naturam (On the unnatural tumours), K., VII, 705 ff

24.Most probably he is alluding to the itch-mite

25. Cf. De Medicina, VI, 7, 5

26. Cf. Compositiones (Compound medicines), chapter 53rd

27. Cf. Sergio Musitelli & Ilaria Bossi, On Girolamo Fracastoro's alleged foundation of modern "epidemiology" in De Historia Urologiae Europaeae, XIX (2012), p. 125 ff. Cf. also [2 and 3]

28. Ch. Singer and E. Ashword Underwood are right in maintaining that Fracastoro's "conception bore a superficial resemblance to the modern germ theory". Cf. A short History of Medicine, Oxford, At the Clarendon Press, 1962; 106

29. Printed in Rome in 1658. Cf. 1st section, 7th chapter, p. 37 ff

30. Printed in Florence in 1668

31. Printed in Florence in 1684

concerning the itch-mites of the human body)[31] paved the way for the modern theory of "contagium vivum". Indeed Redi demolished the "spontaneous generation" at the level of insects (Figure 2). Whilst Bonomo and Cestoni proved that the itch - mite is not the result of the "putrefaction" of the pustules, but their cause and succeeded in observing first of all how it penetrates under the skin: "we observed - they write - that it walks and doesn't stop before having found either a wrinkle or a fissure of the skin, like, for instance, between the fingers of the hand. There it begins penetrating with its sharp head and goes on penetrating until its body has completely entered so that it cannot be extracted without having recourse to the point of a needle"; second they also succeeded in observing how it lays the eggs: "During many months -they write - we never stopped trying as carefully as possible to discover their eggs, which we were sure that they lied". At last Isacche Colonello[32] -the exceptionally skilful engraver Bonomo and Cestoni charged with the task of illustrating the itch-mite - while observing it through a microscope had the luck of "seeing a certain littlest and nearly invisible egg come out from the bottom of one of those itch-mite", which he immediately drew"[33] (Figure 3).

19 - We are -so to say - in broad "microscopical climate", which was the consequence of the renewed "atomistic" perception of all the phenomena[34] and in which it triumphs what the great historian of Medicine Luigi Belloni (1914 -1989) called "microscopy-idea", in few words we are in the climate, which -started by Galileo Galilei -has its first witness in the famous "Lyncean bee" (Figures 4, 5, 6). in verso sciolto e dichiarato (Persius (34 - 62 A.D.) translated in blank verse and explained), printed in Rome in 1630. The plate was engraved by Mathew Greuter (1564 -1638). Moreover the recourse to the "microscope - instrument" caused the necessity of perfecting a new technique for the preparation of the objects to be observed, that is to say the creation of what Marcus Aurelius Severino called - as pointed out above -"anatomia artificiosa et subtilis" (artificial and subtle anatomy), thanks to which it is possible to discover and observe the "latentes mechanismos" (hidden mechanisms) which the genius of Francis Bacon (1561 - 1626) postulated, and the microscope nearly miraculously went on revealing. Thanks to this technique -which Marcello Malpighi was an outstanding master of and whose subsequent developments and improvements will lead to the modern goals - from the rather superficial image of the eye of a bee as it appears, for instance, in Cesi's illustration printed in 1625[35], to the eye of a fly as it is represented by Giovanni Battista Odierna (1597 - 1660) in his booklet L'occhio della mosca (The eye of the fly)[36] (Figure 7). In which the eye appears both complete (B and C) and dissected (D) in order to emphasize the nearly numberless crystalline lenses that form its second layer. It is compared with both a mulberry (E) and a strawberry (F).

32. Printed in Florence in 1687

33. Unfortunately we could not succeed in finding his birth a death dates

34. This is the original text, whose manuscript Redi revised as carefully as possible and improved with his own observations, among which the most important are those concerning the identification of the sexes of the itch-mite and the discovery of the cheese - mite (Tyrogliphus siro) and of its eggs. Redi generously ascribed his own discoveries to his disciple Bonomo.

35. Due to Poggio Bracciolini's (1389 -1459) discovery of Lucretius' De rerum natura, whose "atomistic theories" spread rapidly throughout the whole European culture

36. Cf. Figure 4

37.Printed in Palermo in 1644

Figure 2: Redi's illustration of the stages of the development of the cherry - fly.

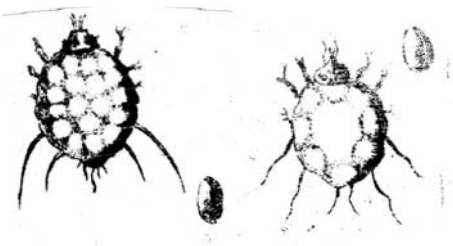

Figure 3: The itch-mite from the dorsal (left) and the ventral (right) side, and its eggs engraved by Isacche Colonnello.

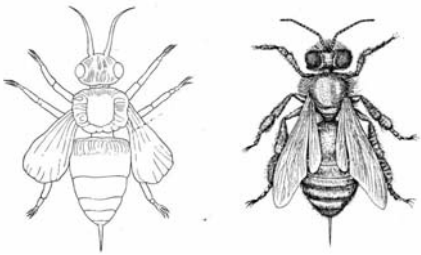

Figure 4: The "Lyncean bee" (right) observed through a magnifying lens and compared with the bee (left) as it appears in Gianlorenzo Bernini's (1558-1680) base of the baldachin (1633) of St. Peter's Basilica in Rome.

Figure 5: The plate of Cesi's *Apiarium.*

20 - Moreover in 1679 Marcello Malpighi observed, described and illustrated the sporidia of the moulds in the chapter De plantis quae in aliis vegetant (On the plants that vegetate into other plants) of his treatise Anatomes plantarum (On the anatomy of the plants), a clear example of which is this illustration of a "penicillium" (little pencil) discovered by him (Figure 8). As for the origin of the moulds Malpighi obviously refused the "spontaneous generation" and hypothesized that they spread thanks to "frustula" (frustules) "quae ventis deferuntur" (that are transported by the winds), and in his Anatomes plantarum pars altera (Second part of the anatomy of the plants)[37] had identified a pathological phenomenon caused by the sting of a gall - midge and the laying of the eggs, from which the larvae of the insect would develop (Figure 9). So Bonomo's and Cestoni's discovery joined with Malpighi's ones and paved the final way for the modern idea of "contagium vivum" concerning both the animal and the vegetal world.

21 - Malpighi's hypothesis concerning the propagation of the moulds was confirmed -as we shall see later - by Lazzaro Spallanzani and first endorsed by Pier - Antonio Micheli (1679 - 1737), then developed and improved by his disciple Giovanni Targioni -Tozzetti (1712-1783), whose Alimurgia, ossia modo di renedr meno gravi le carestie proposto per sollievo dei poveri (Alimurgia, i.e. a method to relieve famine proposed for help of the poor) published in Florence in 1767) (Figure 10) as well as Felice Fontana's (1730 - 1805) *Osservazioni sopra la ruggine del grano* (Observations on the blight of the wheat) published in Florence in the same year (Figure 11), fit perfectly the Enlightenment climate in which health is no more an only individual, but becomes a social wealth: the ancient "hospices" transform into the modern "hospitals" and Johan Peter Frank (1745-1821), while advocating the foundation of a "Medical Police", dared to read on May/5/1790 at the University of Pavia his inaugural lecture De populorum miseria morborum genitrice (On people's poverty mother of diseases), at the presence of the Emperor Leopold II himself.

22 - And it is just in this climate that Agostino Bassi (1773 - 1856), saddened by the slaughter occurring in the silk - worms farming - that was one of the few sources of income for the Lombard countrymen -strived after studying the cause and discovered - as he writes -"a quite new fact: a living vegetal matter, which, once introduced into a

38. Published in London in the same year

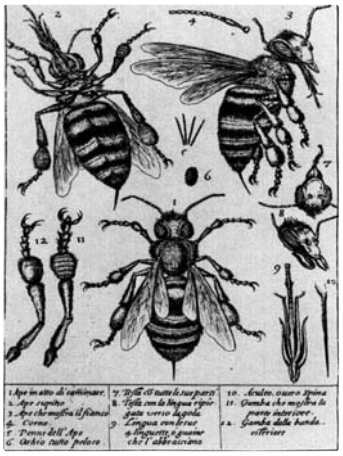

Figure 6: The plate illustrating the bee in Francesco Stelluti's (1577-1652) Persio tradotto.

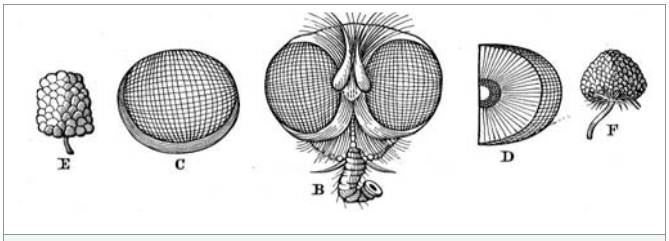

Figure 7: Odierna's plate of the fly eye.

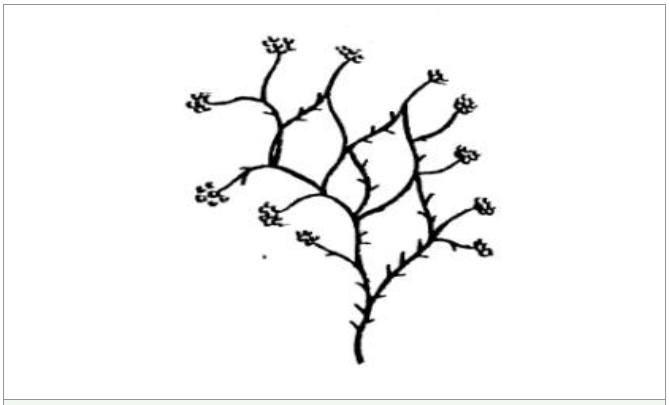

Figure 8: Malpighi's drawing of his "penicillium".

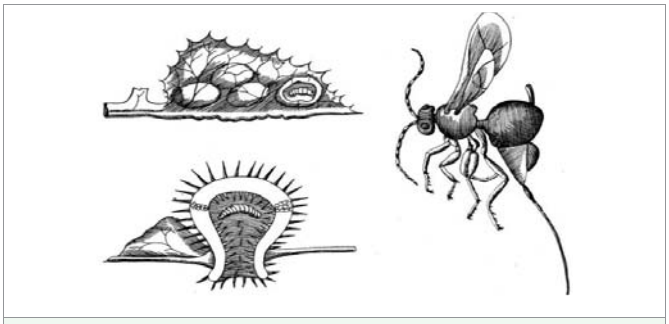

Figure 9: Malpighi's illustration of the gall-midge together with the eggs (left above) and the larvae (left below).

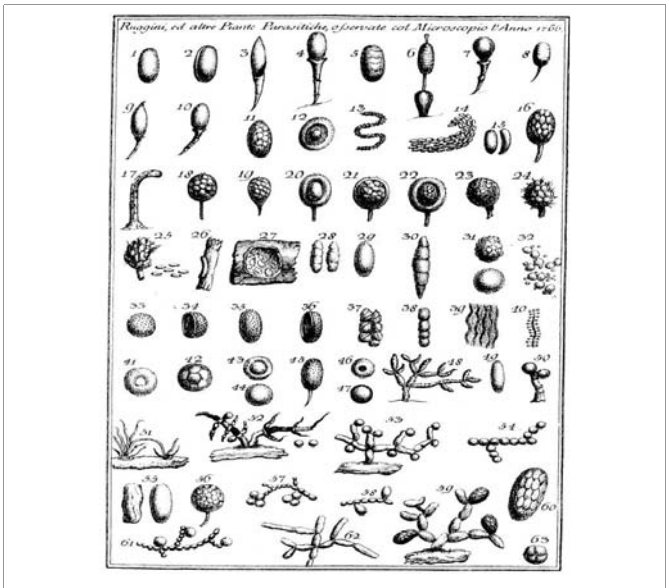

Figure 10: Targioni - Tozzetti's plate.

living animal, causes a disease". He is referring to the fungus, which just for this exceptional reason was called first Botrytis paradoxa, then Botrytis bassiana in honour of the discoverer. Bassi announced his discovery in the first part (theoretical) of his treatise Del mal del segno, calcinaccio o moscardino, malattia che affligge i bachi da seta (On the disease of the sign, rubble or dormouse, a disease, which plagues the silk - worms) printed in Lodi in 1835, which was followed a year later by the practical part, i.e., the study and the description of the means to fight against the scourge (Figure 12).

23 -1841 Jean -Victor Audouin (1797-1841) - following the way opened by Malpighi and improved by Lazzaro Spallanzani with his few, but no less fundamental Osservazioni e sperienze intorno all'origine delle piantine delle muffe (Observation and experiments concerning the origin of the little plants of the moulds) published in Pavia in 1776) - succeeded in discovering and describing the different stages of the development of the fungus, which he proved to derive - to use Spallanzani's words - from "que' granellini in che si sciolgono le piccole teste della muffa matura" (those little grains, into which the little heads of the ripe mould scatter) (Figures 13,14).

24 - Nearly all the European researchers followed the way genially paved by Bassi, who sent the calcined little corpses of the silk-mites to Paris and Zurich, so that Johann-Lucas Schonlein (1793 -1864) discovered just in Zurich that an organism "of fungal nature", that is to say the "Achorion", was the aetiological agent of the tinea favosa. He informed the great physiologist Johannes Muller (1801-1858) about his discovery in a letter sent in 1839. Muller, on his turn, not only published the letter[38], but also improved the research and succeeded in observing the "Achorion" of which he gave the first graphic image (Figure 15). This means that the researches started from the silk - mite were transferred to the man, along the new way paved by Carlo Francesco Cogrossi (1682 -1769) with his treatise Nuova idea del male contagioso dei buoi (New theory of the contagious disease of the oxen), which he printed in Milan in 1714 (Figure 16) and communicated to the great Antonio Vallisnieri (81661-1730), who, in his turn, subscribed fully Cogrossi's idea about the nature of a real "contagium vivum" of the terrible epizooty that was imported in 1711 in the Venetian territory by a Hungarian ox and caused for three years a real slaughter in all the Italian oxen farming. According to Cogrossi the contagion was caused by both the faeces and the foams strewn on the pasturages by the contaminated animals. However Vallisnieri did not confine himself to subscribe Cogrossi's theory: he also developed it genially to the point of hypothesizing the poisonous substances we call "toxins".

39. Cf. Archiv für Anatomie, Physiologie und wissenschaftlische Medicinm, 1839, p. 85, fig. 5 of the III plate (Figure 13).

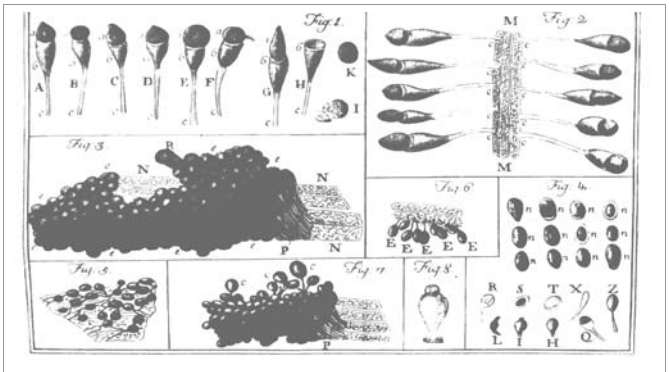

Figure 11: Felice Fontana's plate.

Figure 12: The front page of the first part of Bassi's treatise.

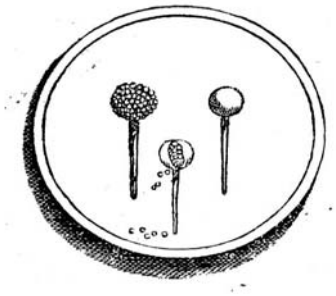

Figure 13: Spallanzani's illustration the little plants of the moulds.

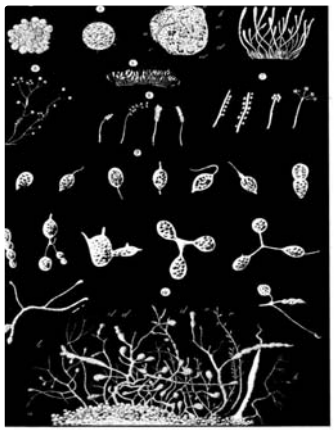

Figure 14: Audouin plate illustrating the different stages of the development of the fungus.

25 - Proceeding along the highway baldly paved by these genial researchers -from Galileo to Bassi, Vallisnieri and Cogrossi -the second era of microscopy started, mainly thanks to the recourse first to the achromatic lenses, then to the immersion objectives[39], that let the biologists develop the modern theories of "contagium vivum", whose fundamental stages will be achieved by Filippo Pacini (1812 -1883), who discovered the comma bacillus in 1854; by Atto Tigri (1815 -18759, who discovered the typhoid bacillus in 1863; by Gaetano Salvioli, who described the diplococcus pneumoniae in 1833;

40. Giovanni Battista Amici's (1786 - 1863) glory!

by Theodor Schwann (1810 -1882), who - independently from other researchers -discovered that the saccharomyces was always present in the acoholic fermentation of beer.

26 - Starting just from the studies on fermentations, wonderful subsequent achievements followed each other and culminated with Louis Pasteur's (1822 -1895) and Robert Koch's (1843 -1910) outstanding discoveries, which finally transferred the conquest of the "contagium vivum" to the level of germs and bacteria.

27 - However let us make a final remark: all the geniuses are always condemned to be followed and sometimes even surrounded by two armies. The first consists of the cohorts of the obtuse idiots; the second of the no fewer cohorts of the cunning hangers-on, that is to say the charlatans. These being the sad facts, even the geniuses we have dealt with above -although briefly - could not succeed in escaping this condemnation. Indeed the literally astonishing and revolutionary discoveries made by the microscopists of the 17th and 18th centuries[40] were not only relentlessly blamed, but also stupidly ridiculed by a gang of idiots, among whom Nicolas Andry (1658 -1742) occupies a place of honour with his Systeme d'un Medicin Anglais (System of an English Physician)[41], in which he -with absolutely groundless mockery - assembled a sort of repertoire of odd and teasing "animalcula" (Figure 17).

28 - As for the hangers - on there was a real glut of charlatans, the very pleasant portrait of one of whom is described by Vallisnieri. A strange person, who boasted the prestigious name of Boyle, extolled in public his specific, which - according to him - had the exceptional virtue of killing all the pathogenic micro - organisms. He promoted his cure-all with leaflets and booklets[42] in Paris and touted the public with an alleged practical proof of the efficacy of his remedy with the aid of a particular microscope, which he boasted to be a descendant of Isaac Newton's (1642 - 1727) catadrioptical telescope and the figure of which Vallisnieri adds to his very humoristic description (Figure 18).

Vallisnieri's passage is the following: according to the charlatan the objects placed in C were to be observed in A, thanks to a multiple set of reflections obtained by concave mirrors placed in D and E. Indeed the tube AB was the only optical part with its ocular in A and its objective in B. Vallisnieri's very amusing description of the procedure of the charlatan reads as follows: "The impostor placed before you a blood or urine drop in C and made you believe that it reflected the image first in D, then in E and finally in A. But indeed you could only see the object hidden in B, and this was a drop of corrupted liquid into which there were actually many insects because it was enough to water - ret some herbs. The skill of the charlatan consisted first in letting you see the microscope void, then in putting visibly the blood drop in C and giving an unperceivable turn of hand and disclosing the glass hidden in B. At this point he feigned throwing a liquid full of animal that killed the former ones, but in the meantime inserted skilfully in B something that either killed or at least befuddled the contained insects, a result that was not so difficult to reach either by turpentine or by other means. By consequence you saw the insects either resting or even looking like if they were dead.

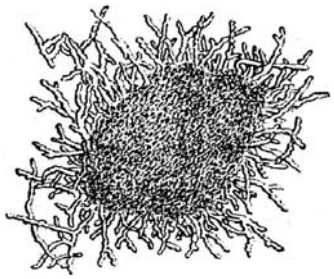

Figure 15: Muller's illustration of a fragment of a pustule.

Figure 16: The front page of Cogrossi's treatise.

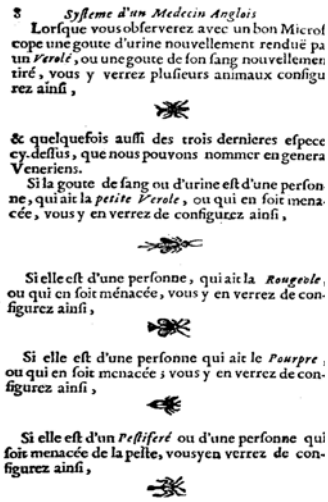

Figure 17: Andry's plate.

However only the impostor master enjoyed the privilege of seeing the battle because he was the first to observe it and the carnage occurred in a flash, so that when you looked at it, the battle had already ended and by consequence you could not distinguish the victorious from the vanquished insects because - according to the impostor - they were infinitely little an therefore adhered tightly to their victims and you could do nothing else than taking his words for it". Obviously the charlatan "only strained for the public sake" and expected more handsome profits once his specific obtained the well deserved triumph! "However he could not reach his goal" because, having his

41. Mainly by Antony van Leeuwenhoek (1632-1723)

42. Published in 1726

43. That have surely been preserved but we unfortunately didn't succeed in finding them

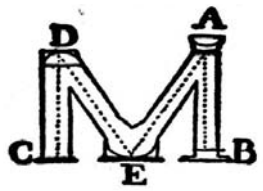

Figure 18: Charlatan Boyle's alleged microscope44.

fraudulent contrivance been discovered, "he decided to move house without playing the trumpet", like we too "for the readers' sake" will "move house" mainly "without playing the trumpet!"!

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