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A Brief History of the Theory of Spontaneous Generation

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ABSTRACT

The belief in spontaneous generation was traced from the early Greeks to the present day. It was found that spontaneous generation has been almost universally accepted as true in the west, at least for so-called lower forms of life, until very recently. The work of Pasteur, Redi and others was highly influential in demonstrating that spontaneous generation does not normally take place today. Nonetheless, evolutionists often assume that some form of spontaneous generation occurred in the far distant past, even though they believe that it is unlikely that it could occur today.

A review of this history is important in helping present day researchers understand the importance of values and belief structures, even in areas of science, in influencing what a person accepts as 'scientific' or true. It was concluded that the debate still continues in a different form today, even though there exists no direct empirical evidence that spontaneous generation can take place today, or ever could have taken place.

INTRODUCTION

Historically, a specific challenge to the acceptance of 'pure creationism' which has also been one of the major obstacles in its acceptance was the theory of **spontaneous generation.** This belief held that life could and regularly did spring from non-living matter. Because the ancients did not realize the enormous chemical and biological complexity of life, they did not believe that spontaneous generation was a particularly unusual or amazing event.[1] It was accepted by Miletus (600 BC), Anaxagorus (510–428 BC), Epicurus (341–270 BC), Aristotle (348–322 BC), Basilius (AD 315–379) and even Augustine (AD 354–430), Paracelsus (AD 1493–1541), Van Helmont (AD 1578–1657), Descartes (AD 1596–1650), Harvey (AD 1578–1657), Needham (AD 1713–1781) and Buffon (AD 1707–1788).[2]

Belief in spontaneous generation was widespread up until as late as the 1850s and created a major roadblock to the full acceptance of a need for outside design and intervention for life to exist.[3] As Gardner noted,

> *'The theory of spontaneous generation was commonly accepted from the earliest periods of biological history until the middle of the last century* [around 1850].'[4]

In a classic study of cosmology, Collier went even further, concluding that the

> *'belief in the spontaneous generation of plants and of small animals from inanimate matter, not only at creation but also ever since, was almost universal to the end of the seventeenth century.'*[5]

We are not here concerned with the means or mechanism of the origin of life, **only with the historical belief that life can spontaneously generate** and the conflict of this belief with the basic concept of creationism. A problem with the creation concept is, as Bube notes, that it has a variety of meanings. Our use of the phrase here will be limited to the belief in an instantaneous and totally supernatural **fiat** act of God as opposed to, or as an alternative to, the belief in a process which expresses the creative activity of God as operating indirectly, such as setting up the conditions which allow life to come forth on its own from non-living matter by purely naturalistic means.[6] A scientist who observed what appeared to be a genuine event of **fiat** divine creation would have to conclude scientifically that an event of spontaneous generation had occurred, and to conclude that it was a divine creation event would require ruling out natural causes. This is what Pasteur and others did. The phrase **spontaneous generation** specifically refers to an event caused by known natural forces of the universe which under certain 'natural' conditions will always produce life if the necessary conditions are present.

These certain conditions were held for centuries to be both sufficient and common, regularly causing 'life' to spontaneously form from non-living matter. **A creationist** believes that 'natural' processes are not capable of creating or developing life on their own, and that some **outside living intelligence** is necessary to produce life. In other words, regardless of the amount of time, natural non-living conditions and laws are not capable of spontaneously producing life without outside intelligence.

EARLY BELIEFS IN SPONTANEOUS GENERATION

One of the oldest recorded explanations for the non-supernatural origin of living things was the theory of spontaneous generation. Many persons once held that

> '*plants and animals . . .* [arose] *. . . from mud in the bottom of a pool or from various other materials, rather than through reproductive processes of parent organisms or direct creation by a creator*.'[7]

Respected philosophers such as Anaximander (611–547 BC) taught that spontaneous generation took place in the residue of mud and mist on the earth while the water in the mud was being evaporated by the sun. Anaximander's theory was similar to the modern theory of evolutionary abiogenesis, the belief that life can develop from non-life without intelligent direction. He taught that after fish were spontaneously generated, *'their descendants left the water and reached dry land'* to later evolve into reptiles and mammals.[8,9]

That spontaneous generation was commonly accepted during most of history is evident from the following quote from Vallery-Radot:

> *'It is regrettable that Biot —whose passion for reading was so indefatigable that he complained of not finding enough books in the library at the Institute — should not have thought of writing the history of this question of spontaneous generation. He could have gone back to Aristotle, quoted Lucretius, Virgil, Ovid, Pliny. Philosophers, poets, naturalists, all believed in spontaneous generation. . . . In the sixteenth century, Van Helmont — who should not be judged by that one instance —gave a celebrated recipe to create mice: any one could work that prodigy by putting some dirty linen in a receptacle, together with a few grains of wheat or apiece of cheese. Some time later an Italian, Buonanni, announced a fact no less fantastic: certain timberwood he said, after rotting in the sea, produced worms which engendered butterflies, and those butterflies became birds.*'[10]

Once the spontaneous generation of life was accepted as valid, it was not difficult for Anaximander to hypothesize a series of developments which would account for the origin of higher forms of life. He concluded that the first animals were generated in water surrounded by a protective husk or shell. These animals later migrated to dry land, developed their shells and adapted themselves to their new circumstances. Sartan noted that Anaximander taught that *'man must derive from other animals, because his own period of immaturity is too long and too frail.*'[11]

Other aspects of his theory which were remarkably similar to modern evolution theory include the teaching that

> *'when the world's integument burst and conditions changed, these descendants modified their mode of living and became adapted to the new environmental situation . . . different kinds of living things came into being by transmutation. Man was supposed to have come from lower species of animals, probably aquatic.*'[12]

Other early Greek writers explained the existence of the living world in similar terms. Lucretius believed that the earth was 'mortal' and both existed and operated without a need for any divine intervention. It was therefore necessary to explain what caused all natural phenomena — the night-day cycle, the movements of the sun, moon and stars, and the existence of plant and animal life — solely in naturalistic terms.[13] To account for the existence of the living world, Lucretius, as did many ancient scholars, accepted the spontaneous generation explanation.

Up to the middle 1800s, the public and most scientists still believed that some organisms could spontaneously generate themselves. As late as 1852 *'the manner in which our earth was originally stocked with its organic* [life] *was still hotly debated among researchers.*'[14] It was held by many scientists that spontaneous generation was the only explanation for the existence of organisms in the air, the cold parts of the earth, and deep within the water. Martin states,

> *'One of the recent works of Ehrenburgh —a name that carries with it an authority second to none in that field —advocates the doctrine of spontaneous generation of the microscopic animalcules of the atmosphere by means of atmospheric agencies alone.*'[15]

He argued that spontaneous generation was also held by most scientists then to be the total explanation for the lower organisms both in the animal and plant kingdoms:

> *'The occurrence of the Alpine plants of Europe at the remotest point of the Andes, and the wide diffusion of the most humbly organized plants in similar localities throughout the globe, are regarded by this school as fact incapable of explanation by any other hypothesis than that which affirms their spontaneous generation there*.'[16]

Martin also claimed that by the middle 1800s this viewpoint had been confirmed by '*recent tendencies of investigation.*'[17]

Most religious and scientific authorities, many up to the 1850s, also supported the spontaneous generation doctrine. Maayen states,

> *'The exact observations which have been made, prove that nature is still able to create imperfect animals, as well as the lower plants, without seeds or eggs* [in other

words, by spontaneous generation]. *Only organic matter, water, and air, the essential conditions of living beings, are necessary, with sufficient heat, to produce animal forms.*'[18]

Martin comments that mould which forms on bread is *'a decisive instance of spontaneous generation.'* The question that Martin is concerned with is *'not whether or not animals can spontaneously regenerate, but up to what grade of animals and plants this creative energy of nature reaches.*'[19] Martin then spends the rest of his treatise trying to reconcile the then highly accepted theory of spontaneous generation with creationism, concluding that the '*power of an almighty Creator, through whatever the agencies of work the creation may accomplish* [is evident even though the creator may use several methods of creation] *since it is difficult to believe that the method of creation has not always been the same.'* In other words, God created certain kinds of animals as related in Genesis, but set in operation laws which enable organisms to be created naturally at later periods of time. Martin and others were in this way able to reconcile the prevailing scientific theory of spontaneous generation with the doctrine of creationism. A difficulty is that, once one allows the spontaneous generation of what they then wrongly believed were simple forms of animals, including moulds, yeasts, flies, insects and so-called simple plants, this doctrine can easily be extended to all living plants and animals, which is what many scientists did. Notable examples include Erasmus Darwin (1731–1802) in his book **Zoonomia** and later Jean Baptiste Lamarck (1744–1829) and of course Charles Darwin (1809–1882). If living things can generate themselves automatically when only water, air, heat and certain unknown but natural factors are present, higher forms of life could also be accounted for by natural explanations, laying the ground work for Oparin's theory of spontaneous generation of all original life forms.

Of historical note are the views that Charles Darwin had on spontaneous generation for much of his career. Probably the most succinct passage as to his opinion was in a letter to D. Mackintosh dated February 28, 1882, in which he stated,

> '*. . . though no evidence worth anything has as yet, in my opinion, been advanced in favour of a living being being developed from inorganic matter, yet I cannot avoid believing the possibility that this will be proved someday in accordance with the law of continuity.*
>
> *. . . If it is ever found that life can originate on this world, the vital phenomena will come under some general law of nature.*'[20]

Most of Darwin's writings on evolution concerned the origin of species, not the origin of life. In one of his few statements relative to this topic, he stated that he

> *'believed that all animals descended from at most only four or five progenitors, and plants from about the same number. He even speculated that all animals and plants have descended from only one prototype.*'[21]

Darwin also wrote a letter to Hooker in 1870, in which he stated,

> *'Spontaneous generation seems almost as great a puzzle as preordination. I cannot persuade myself that such a multiplicity of organisms can have been produced, like crystals, in solutions of the same kind.*'[22]

Aulie concludes that Darwin was actually somewhat skeptical about spontaneous generation for much of his career, and allowed for an original creation, which he discussed on pages 188, 189, 484 and 490 of the first edition (1859) of his **Origin of Species** and all other editions.[23] As Darwin's other views changed, so too did his conclusions in this area. As Davidheiser noted:

> *'In the last letter he is known to have written, three weeks before he died, Charles Darwin expressed the view that the origin of life would be found to be a consequence of some "natural law" and hence not by creation. Present-day evolutionists assume that Darwin's view of this is correct, and they are striving to explain how life came about.*'[24]

THE ACCUMULATION OF THE EVIDENCE AGAINST SPONTANEOUS GENERATION

One of the first scientists to seriously question the spontaneous origin of living things was the Italian physician and naturalist Francesco Redi (1626–1697). After studying medicine at the University of Pisa, he later became the court physician to Ferdinand Medici, the Grand Duke of Tuscany. Redi had read the writings of William Harvey (1578–1657) which speculated that spontaneous appearance of life may actually arise from seeds or eggs that were too small to be seen with the naked eye. Redi soon set out to answer by experimentation the question whether flies could reproduce spontaneously from mud, decaying organic matter or air. His early research involved placing freshly killed snakes in an open box where they were allowed to become putrid. Redi observed that adult flies, while hovering over the decaying meat, dropped 'tiny particles' on it while other flies remained on the decaying meat and deposited small egg-like material. He noticed that 'maggots' appeared on the decaying flesh soon afterward. During the process, Redi observed that the maggots thrived on the meat and grew rapidly. He also noted that after a period of rapid and continuous growth, the maggots became dormant. Then, after a few days, flies emerged from the pods which varied according to shape, colour and other factors.

Redi then repeated the above experiment with different kinds of animal flesh, both raw and cooked. He soon completed tests on the meat of rabbit, chicken, goose, swallow, buffalo, lion, ox, deer, tiger, duck, lamb and kid.[25] He reasoned that the flies might be dropping **eggs,** and so then conducted an experiment to test this hypothesis. First,

portions of eel flesh were placed in flasks, then the openings of some flasks were completely sealed and comparable flasks were prepared in the same manner **except that they were left uncovered to serve as controls.** He then observed the meat through the glass as it underwent decay. As Redi had observed before, he saw flies fly into the open flask and drop small objects on the meat. In a few days, maggots came from the small objects that they had previously dropped. The flies wiggled on the surface of the sealed flask, evidently trying to get through the glass to the meat. As Redi expected, the meat in the sealed container **never produced maggots.** Redi concluded from this observation that **flies came only from other flies and were not spontaneously generated on the decaying meat** as theorized by most scientists up to this date.

As he expected, his conclusions came under strong attack from those who believed in spontaneous generation. One of the main claims was that **sealing** the containers prevented entry of some unknown 'vital force' that was necessary for the spontaneous generation of life. Therefore life was not generated in the sealed flasks because this necessary 'natural' element was lacking, and not because life was necessary to produce life as Redi proposed. To meet these objections, Redi covered glass containers with a fine cotton veil that would let air through, but would stop all of the flies from reaching the decaying meat. He again found that the meat did **not** produce maggots. By these and other ingenious experiments, Redi laid the groundwork for refuting the long standing beliefs in spontaneous generation. In his book, **Experiments on the Generation of Insects** first published in 1668, Redi recorded the results of his experiments which finally largely disproved the spontaneous generation theory and validated the fact that life can come only from life.

With the advent of the discovery of microbes, the whole controversy flared up again, and more critical experiments were needed to solve this aspect of the problem. Those who still believed in spontaneous generation felt that, although flies or other animals may not spontaneously generate, microorganisms **must** come into existence this way. Theories with names like eobiogenesis or biopoiesis and neobiogenesis soon were proposed, all in contrast to biogenesis, meaning life comes only from life. The work of Louis Joblot (1645–1723) brought new popularity to the doctrine of spontaneous generation. He observed in 1710 that when common farm hay was infused in water and allowed to stand, it gave rise to large numbers of microorganisms which were for this reason at that time called **infusoria.** According to Gardner,

> *'Joblot's contemporaries, and many who followed, considered the presence of microorganisms in hay infusion to be conclusive evidence for spontaneous generation.'*[26]

In 1745, the English-Catholic priest, John T. Needham (1713–1781) completed a study that many of his contemporaries concluded supported the spontaneous generation view and refuted Redi's results. Needham heated his cultures and found that infusoria **still** appeared. Because his *'scientific evidence'* again bolstered the spontaneous generation view, the Royal Society of London elected Needham a member, and he later became one of only eight foreign associates of the French Academy of Science. This act by the Royal Society and French Academy illustrates the **degree of importance attached to the belief that life can spontaneously generate.** Scientists then, as now, are persistently looking for natural, non-supernatural explanations for the origin and development of life. Today we know that the infusoria appeared because Needham did not heat the hay to a high enough temperature necessary to kill the microscopic bacteria **spores.** It is now known that hay carries spores that are extremely resistant to heat, and must be heated to extremely high temperatures in order to kill them.

Georges Louis Buffon (1707–1788) accepted the spontaneous generation view through *'minute life units'* which he felt were scattered throughout the universe.[27] Because Buffon's views were supported by Needham's experiments, he used considerable space in his own publications to describe Needham's work in detail. Buffon even invited Needham to collaborate with him on the second volume of his **Encyclopedia of Scientific Knowledge.**

Not all scientists at this time accepted the spontaneous generation view — the famous early pioneer of the use of the microscope, the Dutch lens grinder Anton Van Leeuwenhoek (1632–1723), first observed many microscopic organisms which he called *'wretched beasties'*. Although he was *'against the idea of their spontaneous generation'*, he never developed a theory as to **where** microscopic animals might come from.[28] Others viewed his discovery of microorganisms as clear 'proof' of spontaneous generation: Needham's contemporaries believed that bacteria were very 'simple' life units, and partly for this reason they did not find it unreasonable to conclude that the bacteria spontaneously assembled themselves. Obviously, they at this time did not understand the tremendous complexity that exists even in the least complex organisms such as bacteria, or any other living cell. Even the fly was thought to be a relatively 'simple' animal until some time after the invention of the microscope. We are only now beginning to understand the **incredible complexity** of bacteria and all other life. The fly eye alone has been the subject of scores of scholarly articles, symposiums and a tremendous amount of scientific research. Realization of the complexity of even the so-called simple animals has rendered the idea of spontaneous generation untenable.

SPALLANZANI'S RESEARCH

Another scientist who entered the controversy against spontaneous generation was Italian biologist Lazaro Spallanzani (1729–1799). Spallanzani's experiments, although similar to those of Needham's, were conducted with

much greater care so as to ensure complete sterilization. Spallanzani boiled the growth medium for a full hour and hermetically sealed the container before the medium containing the meat had time to cool. He concluded that this had completely killed all living organisms and prevented later contamination. Under these conditions, no life appeared on the decaying meat. When Spallanzani published his paper in 1765, he considered the matter settled.

A major objection to the above line of research was that it kept out the mysterious forces which were believed to exist that were not unlike the 'forces' commonly evoked by some evolution theories today.[29] Spallanzani's results and conclusions were attacked by Reverend Needham who reasoned that heating meat for prolonged periods of time would destroy the mysterious *'vegetative force'* that was necessary for life to develop.[30] Needham accused Spallazani of *'torturing'* the *'vegetative infusions'* to the point where *'all the vital material was weakened or destroyed'*.[31] Needham even argued that the air which remained in the empty part of the vessels was *'completely spoiled by the heat treatment.'* The conditions which Needham felt would not kill the *'vegetative force'* Spallanzani did not consider sufficient to destroy all of the living organisms present in the flask. Evolutionists today use similar reasoning such as the argument of **syntropy,** an invisible force that pushes evolution to new heights, as discussed by Albert Szent-Gyorgyi.[32]

An experiment which reinforced Spallanzani's view was conducted by German physiologist Theodore Schwann (1810–1882). In 1837, Schwann used a system of tubes to pump air **which was heated before it entered a flask** that contained sterilized meat. This apparatus seemed to provide both the conditions that Needham argued were necessary to allow the *'vegetative force'* to exist, and also that which Spallanzani concluded were necessary to destroy living organisms.

Research by German anatomist Max Johann Schultze (1825–1874) also supported Schwann's work. Instead of heating the air, he passed it through solutions of potassium hydroxide and sulfuric acid. As with Schwann's research, no obvious living organisms appeared in the meat. Of course, some still objected, arguing that the sulfuric acid destroyed some *'vegetative force'* in the air. It was not until 1854 when Heinrich Schroeder (1810–1885) and Theodor Von Dusch (1824–1890) devised a method of filtering air through sterilized cotton wool that Spallanzani's results were clearly confirmed.[33] Filtering did nothing to the air that could be construed as destroying any invisible *'vegetative force'* that it may have contained, nor did it alter its fundamental properties. As primarily dust particles were filtered from the air, it was hard to argue that a supposed *'vegetative force'* was destroyed.

The work of Irish physicist John Tyndall (1820–1893) also was important in disproving spontaneous generation. Tyndall devised a method of identifying dust free air by optical lenses, which insured that the air was germ free without altering it by heating, chemicals or other ways. He purified air simply by allowing the suspended particles in it to settle in closed boxes. Following the settling, he introduced a light which would be reflected from any suspended particles. This test was used to evaluate the air primarily as to dust content, which is the major means that airborne bacteria are transferred. When this germ-free air was introduced into a medium capable of supporting living organisms, no organisms resulted. This supported the contention that the source of the contamination was bacteria that were transported on dust particles in the air. It also provided evidence against the view that a mysterious *'life substance'* existed in the air.[34]

PASTEUR'S WORK

An ingenious innovation of Pasteur's was to carry twenty sterilized sealed flasks high up the Swiss Alps, and then open them there. Another set of flasks was prepared in the same way, but these were opened in the dusty streets of downtown Paris, all of which soon *'produced life'*. Microorganisms grew in **only** one of the twenty on the Swiss Alps, producing convincing proof of Pasteur's position.[35] Pasteur concluded that his conviction was that:

> *'... my experiments all stand forth to prove that spontaneous generation is a chimera. . . . Havel not a hundred times placed organic matter in contact with pure air in the best conditions for it to produce life spontaneously? Have I not practiced on those organic materials which are most favourable, according to all accounts, to the genesis of spontaneity, such as blood, urine, and grape juice? How is it that you do not see the essential difference between my opponents and myself ? Not only have I contradicted, proof in hand, every one of their assertions, while they have never dared to seriously contradict one of mine, but, for them, every cause of error benefits their opinion. For me, affirming as I do that there are no spontaneous fermentations, I am bound to eliminate every cause of error, every perturbing influence, I can maintain my results on the contrary, profit by every insufficient experiment and that is where they find their support.'*[36]

Pasteur stressed that, if all living germs are destroyed and further access to them is prevented, even though air is allowed free access to the meat or organic matter, fermentation or putrefaction cannot take place. His discovery that a piece of cotton, or even a mere bending of the neck of the flask, was sufficient to keep most germs from entering and organic solutions could be kept quite sterile after sterilization, were all close to the last nails in the coffin of the spontaneous generation myth which dominated science for generations.[37,38]

In spite of the excellent extensive experimental work discussed above, *'the controversy concerning spontaneous generation had not been resolved to the satisfaction*

of everyone.'[39] Many scientists, reasoning that the only alternative was special creation, still believed in spontaneous generation. To further resolve the question, the French Academy of Science offered a prize to the best dissertation on the subject. The main competitors for the prize were the French naturalists Felix Pouchet and Louis Pasteur. Pasteur was able to show that different results were obtained when air was introduced from various sources, and some scientists soon concluded from this that it was not air alone, but something that was **in** the air (or **carried** by the air) which was responsible for the microorganisms which later grew inside of the flask.[40] The main problem at this time was the incredible degree of resistance to heat that some spores possess, especially those that lie dormant in hay, and the fact that many kinds of bacteria, the anaerobics family, did not need free oxygen for metabolism. Yet, in spite of these problems which Pasteur did not fully recognize until much later, Pouchet withdrew and Pasteur was awarded the prize.

THE IMPORTANCE OF THIS WORK

Pasteur's work is recognized today as crucial in large scale effective control of disease. If organisms spontaneously generated in decaying organic matter or other places, it would be very difficult to stop their natural formation unless one of the necessary ingredients, which were only hypothesized and never confirmed, were removed. This was felt to be impossible without killing the host organisms themselves. On the other hand, if only life begets life, it is only a matter of preventing life from reaching the organism which one wants to prevent from becoming contaminated. This is the purpose of sealing food in air tight containers such as glass jars, or for destroying the organisms which spread disease by methods that are strong enough to destroy most microorganisms, but not their host, such as is achieved by cooking. This technique is the ordinary and primary method used today to control germs, and thus disease.[41]

The practical applications of the *'only life produces life'* conclusion emerged primarily in the area of food preservation and disease control. Indeed, the modern science of food preservation and disease control **is a direct result of disproving the theory of spontaneous generation** at the microbe level. Even Lister's important work in controlling disease resulted from the controversy surrounding spontaneous generation.

Although the spontaneous generation controversy continued for several years after the work of Redi, Tyndall, Pasteur and that of other experimenters, a reading of the accounts today reveals that the scientists who advocated it were grasping at every possible straw to save it. They used dozens of new arguments, some plausible but many others were blatantly fanciful, to support their view. Some scientists invented mysterious 'humors' and 'forces' such as electricity, magnetism or other forces which were supposed to be the missing ingredient and, if supplied, would cause life to spontaneously generate. Some argued that the process of heating and sealing the container off from the air, or even putting gauze on the beaker, prevented these mysterious unknown forces from entering the beaker and adding the 'necessary missing ingredient' for life to spontaneously generate.

As with the related controversies today, much emotion was mustered by eminent scientists on both sides. But the creationist view eventually won out — even though spontaneous generation once had the support of virtually all of the '*scientifically educated*.'[42] The theory received support primarily from those who

> *'regarded spontaneous generation as a "philosophical necessity" indispensable for a natural-scientific explanation of the origin of life, which Pasteur, faithful Catholic as he was, naturally felt himself compelled to explain dogmatically*.'[43]

In other words, spontaneous generation supported the view that some life can originate from non-life without a creator, but Pasteur's beliefs were such that he felt compelled to explain the origin of **all** life according to creationism. One of the stronger criticisms of both Pasteur's theory and his research was that he was at least partly motivated to support his creation religious beliefs. Even though Pasteur's main *'philosophical belief'* was based on his religious belief structure, he was able to empirically demonstrate his assumptions. According to Walsh,[44] Pasteur above all could not understand the failure of scientists to recognize the unequivocal demonstration of the evidence for design that he saw in the world around us:

> *'he could not understand certain givers of easy explanations who affirm that matter has organized itself, and who, considering as perfectly simple the spectacle of the Universe of which earth is but an infinitesimal part, are in no wize moved by the Infinite Power who created the worlds.*'[45]

AROUND WE GO AGAIN

In spite of the above research, arguments for spontaneous generation, now called **abiogenesis** to reduce the connection to the now disproven older views, still periodically surface. A London physician, Henry Bastian (1837–1915) published a two-volume work entitled **The Beginning of Life** in which he cited difficulties with Pasteur's experiments. Bastian concentrated on the discrepancies between Pasteur's and Pouchet's research. It was in response to this and similar objections that Pasteur developed his long tube flask that was bent in such a way so that dust particles would settle in the tube without entering the flask. Since bacterial growth did not occur, this experiment demolished most of Bastian's major arguments against Pasteur's work.

Pasteur's work, plus that of Kock, Hansen and many other researchers, in the words of Nordskaiold, resulted in a state of affairs where *'spontaneous generation has entirely ceased to exist as a possibility to reckon with in*

modern biology,' nor does it come into serious question when trying to explain actual phenomena.[46] Nevertheless, its theoretical possibility *'still continues to be keenly discussed due to modern natural-philosophical speculation'*, namely philosophical speculation related to the theory of evolution.[47] Many biologists today believe that spontaneous generation has in fact occurred, but only once ora few times, and far back in history where conditions are believed to have been far different from today. The famous French biologist, Pierre-P. Grasse states that evolution today teaches that

> *'In all respects, evolution is a long story. Spontaneous generation occurred once and only once; life cannot be reinvented, it is transmitted, it "is" continuity. Our cells are daughters (to the ninth generation, but daughters nevertheless) of the first animal which appeared on the surface of the earth some eight hundred million years ago; this animal was itself partly reproducing the substance out of which the first living being, floating in the salt waters of the primeval ocean, was made.'*[48]

How scientists know that *'Spontaneous generation occurred once, and only once,'* and that *'life cannot be reinvented,'* is not stated, and it would seem that both of these statements are pure speculation. At any rate, the new theory of spontaneous generation, abiogenesis, is by no means dead, even today. As Gardner brings out:

> *'Spontaneous generation is now being considered in another setting against a different background. Modern naturalistic discussions concerning the origin of life have centered around the possibility of life developing once in the far distant past by a combination of inorganic materials present in primordial "soup". An energy source such as lightning has been suggested for promoting the chemical synthesis. Simple amino acids and nucleic acids have been produced in the laboratory by bringing together materials known to have been present in the early stages of the earth's history at a favorable temperature and introducing electrical energy. To be sure, there is some distance between these crude organic materials and the complex proteins and nucleic acids that occur in the bodies of living organisms, but the experiments have been provocative.'*[49]

Thus, the current belief is that spontaneous generation either does not regularly occur, or cannot occur today — but it did occur once at one time in the past. The arguments for spontaneous generation, in the far distant past, and claims as to the conditions which supposedly produced spontaneous generation, are similar to those used throughout history. One way to accept the evidence against spontaneous generation and still accept it as possible, was presented by Gardner who stated that,

> *'Pasteur showed that living things as complex as bacteria could not arise spontaneously in a short period of time under conditions of his experiments. The possibility is not excluded that much more simple organisms having the power of self-replication could have arisen by natural means in the long periods of the distant past.'*[50]

Thus, it is claimed that, although spontaneous generation of complex organisms is not possible, spontaneous generation of **less complex** organisms under **conditions differing from today** is possible. Consequently, with only a few differences, the arguments used today are very similar to those that raged from the 1600s to the 1800s. That the theory of a form of spontaneous generation is still accepted today by orthodox science is evident from the following quote. *'There are certain substances which, if they come together in particular combinations, will tend to generate life ...'*[51] As scientists have not currently been able to delineate the conditions under which spontaneous generation could take place, various *'mysterious forces'*, or unknown conditions are hypothesized, even though specifically what these are cannot be delineated.

Many researchers believe that it is unlikely that spontaneous generation could occur today because, it is hypothesized, a greater amount of oxygen now exists in the atmosphere which would immediately oxidize an unprotected protoplasmic mass, destroying the new organism. Gardner concludes that if the organism did spontaneously generate, *'It would surely be eaten or absorbed by some other form of life which is now so abundant in any place suitable for life to originate spontaneously.'*[52] This, of course, is largely speculation, obviously formulated in an effort to support the philosophical consideration that spontaneous generation did occur in the past. An excellent recent summary of the research on spontaneous generation which supposedly occurred eons ago concluded that:

> *'some scientists think life began with a protein droplet, perhaps on a volcano . . . the droplets also divide like bacteria and metabolize, or consume food to grow. Those whose proteins could metabolize best would survive . . . after these first vital steps toward life, which are still in the realm of conjecture and debate, the process becomes easier to explain. The first living things were probably single cells like fermenting bacteria. They scavenged and metabolized other molecules and reproduced accurately. When the cells developed photosynthesis to produce food for themselves, they released oxygen into the atmosphere. The oxygen destroyed the ancient gases that made the creation of life possible. Life on Earth can never again spring from the nonliving.'*[53]

This though, while logical, is purely conjecture and much evidence argues against it. Even if it is possible that this **could** have happened, it does not prove that it **did** happen. Since major problems exist with the aforementioned assumptions, biologist Norman Horowitz of the California Institute of Technology stated,

> *'we will probably never know exactly how it happened, but putting together an explanation coherent*

with science would be an intellectual triumph.'

It may be an intellectual triumph, but it would not demonstrate, scientifically at least, that spontaneous generation in fact occurred in the past.

The research today attempting to answer the question of whether life could have spontaneously generated eons ago may well take on the same character as the debate which raged in the 1800s. An examination of the events in the 1800s can help us to better understand the nature of the origins controversy which is currently growing. The major reason for belief in abiogenesis today is not the evidence, but because the only alternative to spontaneous generation is

> *'to believe in a single, primary act of supernatural creation. There is no third position. For this reason, many scientists a century ago chose to regard the belief in spontaneous generation as a "philosophical necessity".'*[54]

And that

> *'the only alternative to some form of spontaneous generation is belief in supernatural creation and* [this] *. . . view seems firmly implanted in the Judeo-Christian theology.'*[55]

And Wald is not unaware of the irony of this:

> *'As for spontaneous generation, it continued to find acceptance until finally disposed of by the work of Louis Pasteur —it is a curious thing that until quite recently professors of biology habitually told this story as part of their introductions of students to biology. They would finish this account glowing with the conviction that they had given a telling demonstration of the overthrow of a mystical notion by clean, scientific experimentation. Their students were usually so bemused as to forget to ask the professor how he accounted for the origin of life. This would have been an embarrassing question, because there are only two possibilities: either life arose by spontaneous generation, which the professor had just refuted; or it arose by supernatural creation, which he probably regarded as anti-scientific.'*[56]

Thus, most scientists in the field now favour the assumption that life **did once** spontaneously generate eons ago because the only other explanation is theism. Wald concludes that the evidence proves the only tenable scientific view is that *'life originally did arise by spontaneous generation'*, adding that the *'naturalistic view'* is held by *'the more rational elements of society'* and the theistic view by less rational persons.[57] The problem that atheistic scientists now face is that:

> *'With the failure of these many efforts science was left in the somewhat embarrassing position of having to postulate theories of living origins which it could not demonstrate. After having chided the theologian for his reliance on myth and miracle, science found itself in the unenviable position of having to create a mythology of its own: namely, the assumption that what, after a long effort, could not be proved to take place today had, in truth, taken place in the primeval past.'*[55]

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