THE SPONTANEOUS GENERATION OF LIFE - A HISTORY OF IDEAS.

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A naturalistic idea is testable, as opposed to a supernaturalistic idea, and therefore resides within the realm of science. There have been only three naturalistic theories of the origin of life since the time of Aristotle. These theories are:- the traditional theory of spontaneous generation, panspermia, and chemical evolution. The current scientific consensus as to the origin of life is the theory of chemical evolution, culminating in the spontaneous eruption of life.

The theory of panspermia (i.e. that pre-formed life was seeded on Earth from elsewhere in the universe) remains a respectable, if a small-minority opinion. Although the general theory of spontaneous generation was finally disproved over 100 years ago, it had a long and interesting history which I will outline in this article. Interestingly, the modern theory of the origin of life is also a special case of spontaneous generation.

Spontaneous generation is the name that was given to the general idea that life can spontaneously and continually arise from non-living matter - from mud, refuse, etc. The idea also claimed that one form of life could directly change into another form, e.g. seeds could turn into mice, etc. Spontaneous generation of plants and animals was commonly accepted as a fact until the middle of the 17th century. The theory survived until the middle of the 19th century in a slightly modified form, with microbes replacing higher forms of life as the end-products of spontaneous generation.

The Medieval Church accepted the doctrine of spontaneous generation. St. Thomas Aquinas (1225-1274) pronounced on the exact mechanism of spontaneous generation - it was all done by angels acting through the agency of the sun. The 16th century was particularly enthusiastic about spontaneous generation. Jean Baptiste van Helmont (1577-1644), a disciple of Paracelsus (the Father of Modern Medicine) published a well known method for breeding mice - place grains of wheat in a jar, add an old vest, and wait. Two hundred years later Pasteur commented on van Helmont's recipe: 'This proves it is easy to do experiments, but hard to do them flawlessly'. If Pasteur made any comments on St. Thomas Aquinas's theoretical work on spontaneous generation, they were not recorded (or perhaps not repeatable).

The theory of the spontaneous generation of animals finally died during the Renaissance, at the hands of Francesco Redi (1626-1697). Redi was one of the first modern biologists. He was also a physician and a popular poet - a formidable 'Renaissance-Man'. Insects were his main scientific interest, and his clever and careful experiments brushed aside the convictions of twenty centuries regarding spontaneous generation.

Redi first of all carefully observed what happened when dead eels were allowed to decay in an open box. He noted that the flesh quickly became covered with worms, which gradually increased in size and numbers. Redi described how these worms changed into pupae and finally into adult flies. He carried out many such experiments using the flesh of a wide variety of animals and found that the same thing happened in every case. Redi also noted that, in addition to the worms, the decaying flesh was also peppered with eggs from which the worms hatched. He reasoned that it was most likely that these eggs were dropped onto the meat by flies, and that all the worms found on decaying meat came directly from fly-droppings.

Redi tested his hypothesis with an experiment. He divided fresh flesh into two lots. He placed one lot in a flask, which he then sealed. He placed the other lot in a separate flask, which was left open to the air. After a short while the flesh in the open flask became wormy, and flies were readily seen entering and leaving the flask. Worms were not seen in the closed flask. In a further refinement of this experiment Redi allowed air to enter both flasks, but he protected one flask with a fine veil that prevented flies (and their accompanying eggs) from entering, while still allowing air to circulate. The other flask was not protected with any veil. No worms developed in the flask protected against the flies, while worms quickly appeared in the unprotected flask.

Redi's account of his experiments was published widely and killed off belief in the spontaneous generation of animals amongst educated people. However, the doctrine of spontaneous generation was revived at another level. About 1675 micro-organisms were discovered by the Dutch microscopist Anton Leeuwenhoek (1632-1723). Microbes are so small and simple that it was widely believed they existed in a grey area between life and non-life, and it seemed intuitively 'logical' that they could arise spontaneously as the products of decay. An English clergyman, J.T. Needham (1713-1781) claimed that, for example, mutton gravy, heated to kill all existing micro-organisms, and sealed in a vessel with some air, would, after a few days, spontaneously generate new micro-organisms and decompose. These experiments were repeated by the Italian physiologist Spallanzani who showed that, if the flasks were heated after sealing, the contents did not putrefy and nothing grew in the flasks no matter how long they were kept. Needham replied that heating the sealed flasks destroyed some vital element in the air which was necessary for spontaneous generation.

There the matter lay until Louis Pasteur (1822-1895) eventually solved the problem. In a series of technically brilliant experiments Pasteur eventually closed the long history of the spontaneous generation doctrine. He clearly showed that the 'vital principle' in air responsible for the 'spontaneous' appearance of microbial life in sterilised broths is microbial life itself, hitchhiking on dust particles. Pasteur proved that life can only arise from pre-existing life. The modern theory of the spontaneous origin of life on Earth about 3 and a half billion years ago is considered to be a unique exception to the principle established by Pasteur.

In one of Pasteur's simplest experiments he placed a yeast extract plus sugar into a glass flask and, using a flame, extended the neck of the flask to form a long narrow tube which he bent in various ways, for example into a U-shape. The bore of the tube was very narrow, but open. He next heated the medium in the flask to the boil for a few minutes and then let the flask cool down. The yeast extract remained sterile indefinitely, even though it was in contact with air.

Pasteur explained that the air in the long narrow neck acts as a buffer, damping down rapid movement of air, so that any dust attempting to enter the flask falls out and is held on the walls of the neck before it gets into the liquid contents of the flask. To demonstrate that the boiled yeast extract would actually support micro-organism growth in the presence of dusty air, Pasteur cut the necks off some flasks and they soon sprouted microbial growths. Pasteur had succeeded in repeating the Redi experiment at the level of the micro-organism.

At that time, between one quarter and one half of patients receiving amputations in British hospitals died, mainly from infections. Joseph Lister (1827-1912) was familiar with the work of Pasteur. He reasoned that if he prevented micro-organisms in the air from reaching incisions in his patients he would lower the incidence of infection. Up until then no special precautions were taken to exclude germs from wounds because it was believed they would be generated

spontaneously in the wound anyway. Lister decided to kill bacteria before they reached patients incisions and he used carbolic acid as an antibacterial agent. He sprayed the surgery and his instruments, and he applied carbolic acid to his patients dressings. These measures were quite successful. Antiseptic surgery was born.

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