Dawn of Science

18. The Questions of Life

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The idea of 'spontaneous generation' of life comes under rigorous scrutiny – with the help from an unexpected quarter, the advent of microscopy.

In Shakespeare's *Antony and Cleopatra*, there is a character, Lepidus, who, in a drunken mood, proclaims, "Your serpent of Egypt is bred now of your mud by the operation of your Sun; so is your crocodile." Neither Shakespeare nor the Romans believed that snakes and crocodiles came out of mud spontaneously; they had definitely seen eggs being laid and hatched. However, people were not so sure, in the sixteenth century, about smaller insects. The prevailing idea was that small creatures like worms and vermins do come out of filth and mud spontaneously.

Such a view accepted two different ways of creation of life. Every ancient civilization knew how horses and cattle, say, produced their offspring. Many of these civilizations also knew how to selectively breed these animals to enhance quality. It was never suggested that horses came out of mud or farmland. But ancient thinkers, including Aristotle, assumed that it was different when it came to much smaller creatures.

The reason for this dichotomy is not far to seek. It was almost an everyday experience to see maggots appearing in rotting meat. Bur nobody had ever seen a horse appearing out of earth. Thus arose the doctrine of 'spontaneous generation' which claimed that certain kinds of creatures could come up spontaneously.

Doubts about this doctrine first arose in the seventeenth century following the work of Francesco Redi (1626–1697), a physician (and poet!) from Tuscany, Italy. Around the time Redi was born, William Harvey had published a book in which he had suggested

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Previous parts:
Resonance, Vol.15: p.498, p.590, p.684, p.774, p.870, p.1009, p.1062. Vol.16: p.6, p.110, p.274, p.304, p.446, p.582, p.663, p.770, p.854, p.950.

Keywords
Francesco Redi, Antony Van Leeuwenhoek, Marcello Malphigi, Lazzaro Spallanzani, John Ray, Carl Linnaeus, microscopes.

Figure 1.

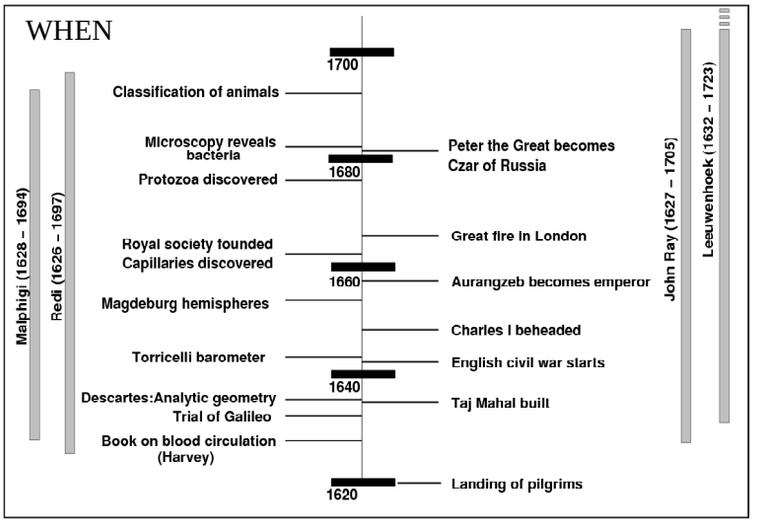


Figure 2.

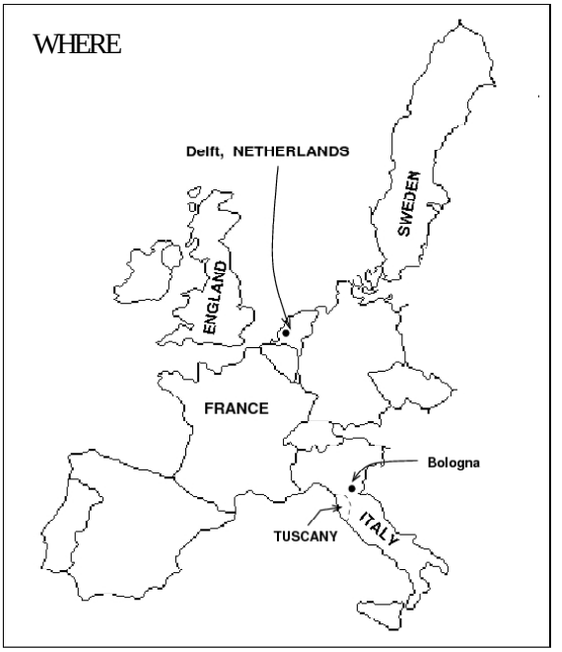


Figure 3. Francesco Redi.
Courtesy:
http://en.wikipedia.org/wiki/Francesco_Redi

that probably small creatures came from eggs too tiny to be seen. Redi read it and thought of a simple experiment to settle this issue. Redi had noticed that decaying meat not only produced flies but also attracted them in large numbers. It occurred to him that a first generation of flies could be laying eggs from which the second generation originated. He prepared eight different flasks with a

variety of meat in them. He sealed four of them airtight and left the other four open. The flies could now land only on meat in the open flasks and indeed only the four open flasks produced maggots. Meat in the closed flasks was as putrid and smelly but there were no living creatures. Redi even repeated the experiment by not sealing the flasks but covering them with gauze; this let in air but not the flies. And again no life form developed in the covered meat. This was probably the first clear biological experiment with a controlled sample.

Redi's experiment proved that flies originated from other flies and not spontaneously from decaying meat. However, this did not make people give up the older idea. Even Redi believed that there could be very small creatures, which actually came into life spontaneously even though flies were not born this way.

This idea, interestingly enough, gained support from the advent of microscopy allowing one to see very tiny creatures. Even when Galileo developed the telescope, he realised that there could also be an arrangement of lenses, which would magnify small objects. The theory of microscopes was developed by Kepler and Torricelli and by the mid-seventeenth century several investigators started using microscopes to study biological specimens.

The most famous among them was Leeuwenhoek[1] (1632–1723) from Delft, Netherlands. Making microscopes was Leeuwenhoek's passion and he used his lenses to observe virtually everything around him. His microscope consisted of a single lens which was ground to perfection so as to magnify objects as much as 200 times. In 1675, he discovered 'living things' in ordinary ditch water, which were too small to be seen by the naked eye. These 'animalcules' – now called protozoa – were as alive as an elephant or a man. He found that the yeast, used in making bread for ages, was actually made of tiny living creatures much smaller than even the 'animalcules'. Finally, in 1683, Leeuwenhoek observed still smaller organisms, which we now call 'bacteria'. (The first one to systematically study biological specimens using microscopes probably was Marcello Malphigi (1628–1694). He

Figure 4.
Antony van Leeuwenhoek.
Courtesy:
http://en.wikipedia.org/wiki/Antonie_van_Leeuwenhoek.

[1] See *Resonance,* Vol.16, No.1, 2011.

Figure 5. Leeuwenhoek's microscope.
Courtesy:
http://en.wikipedia.org/wiki/Antonie_van_Leeuwenhoek.

Figure 6. Marcello Malphigi.
Courtesy:
http://en.wikipedia.org/wiki/Marcello_Malpighi

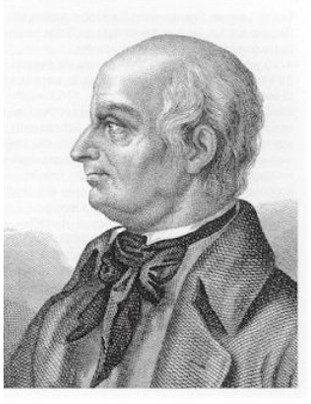
was an Italian physician who lectured in several Italian universities and especially in Bologna. He began biological investigations by studying the lungs of frogs and almost guessed the process of respiration. He also discovered very fine blood vessels allowing the transfer of blood from arteries to veins.)

These tiny living organisms made people believe once again in spontaneous generation. Meanwhile, Leeuwenhoek learnt how to make a broth (by soaking pepper in water) in which the protozoa could multiply. In fact, such broths seemed to produce protozoa on their own. Even when a broth was boiled and filtered to eliminate any sign of protozoa, it showed signs of these organisms within a short time thereafter. And many took this to be a clear sign of generation of life from non-life.

There were, however, a few sceptics. One among them, Lazzaro Spallanzani (1729–1799), repeated the experiment with the broth by sealing off the neck of the flask which contained the broth. He found the broth did not develop microscopic life; but the adherents of spontaneous generation maintained that the heating had removed the 'vital spirit' from the broth. The issue was not settled until much later, until the time of Louis Pasteur[2].

[2] See *Resonance,* Vol.12, No.1, 2007.

Figure 7. Lazzaro Spallanzani.
Courtesy:
http://en.wikipedia.org/wiki/Lazzaro_Spallanzani



Around the same time, biological understanding was growing on another front. The ancient world probably knew of only a few hundred species of living beings. Aristotle, the keenest observer among the Greeks, could list only about 500 species of animals and his student and famous ancient Greek botanist Theophrastus, knew of only about 500 species of plants. In the late medieval days, several naturalists attempted to enlarge the listing of animal species and also to produce a systematic classification of them.

The classification of animals is far more difficult than one would imagine at first sight. Consider, for example, the definition of a 'bird'. Calling it a 'two-legged' creature will make man a bird, while calling it a 'winged creature' will make the bat a bird. (Incidentally, an eighteenth century naturalist once told Voltaire that the briefest definition for a man would be a 'featherless

biped' to which Voltaire retorted that biologists have made a man out of a plucked chicken!) Given such dangers, it was not surprising that the English biologist, John Ray (1627–1705), had to spend nearly a life-time in classifying plants and animals. In 1667, after many years of painstaking travel and observations, he published a catalogue of plants found in the British Isles. Later, during 1686 to 1704, he published a three-volume encyclopaedia describing over 18,600 plants. He also published, in 1693, the first logical classification of animals based chiefly on the hoofs, toes and teeth of the animals. This classification survived for a long time, until the Swedish naturalist, Linnaeus[3] (1707–1778), produced a far more detailed classification.

Figure 8. John Ray.
Courtesy:
http://en.wikipedia.org/wiki/John_Ray

[3] See *Resonance,* Vol.5, No.6, 2000.

The greater understanding of the animal kingdom acquired in all these investigations paved the way for tackling much wider issues. The schemes of classification clearly showed two features: the number of species which inhabit the Earth was much larger than what the ancients had imagined, and there were some patterns of similarity between animals of very different kind when viewed from a fundamental basis. (One familiar example is between the domestic cat and the tiger.) It was not long before people started wondering where all these different species came from. Indeed, if different species produced only offsprings of their own kind, it followed that all the species must have existed from time immemorial. On the other hand, if species 'changed', it must have been at a very slow rate and it would have taken an incredibly long time to produce the kind of variety which we see. Questions of this nature were the ones which prompted Darwin to his remarkable discovery.

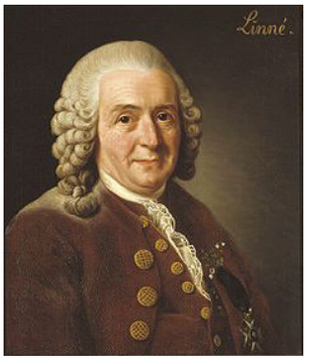


Figure 9. Carl Linnaeus.
Courtesy:
http://en.wikipedia.org/wiki/Carl_Linnaeus

Suggested Reading

[1] **Isaac Asimov, *Asimov's Biographical Encyclopedia of Science* and *Technology,* Doubleday, 1982.**

[2] **R Spangenburg and D K Moser, *The Birth of Science – Volume* I, Viva Books Pvt. Ltd., 2006.**

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