Charles Bonnet (1720-1793) [1]

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Charles Bonnet [5] was a naturalist and philosopher in the mid eighteenth century. His most important contribution to embryology [6] was the discovery of parthenogenesis in aphids, proving that asexual reproduction of offspring was possible. In his later life, he was an outspoken defender of the theory of generation now known as preformationism, according to which offspring exist prior to conception [7], preformed in the germ cell of one of their parents.

Bonnet was born 13 March 1720 in Geneva, Switzerland. His parents, Anne-Marie Lullin and Pierre Bonnet, were members of the aristocracy. A private tutor educated Bonnet until he enrolled in the Calvinist Academy in 1735 to study classics. Bonnet's love of the natural world was inspired by a book he read in 1736 by Noel Antoine Pluche entitled *Le Spectacle de la Nature* (The Spectacle of Nature). He began performing experiments with insects [8] on his own while studying both philosophy and physics, but abandoned these academically at his father's urging to obtain a doctorate in law. His interest in the sciences, however, never waned; upon reading René Réaumur's *History of Insects* in the spring of 1738, he decided to write to the famous French scientist.

With Réaumur's encouragement and advice, Bonnet took on the experiment that the older scientist had attempted unsuccessfully in the past. By isolating a single aphid [9] and keeping it from mating with any other aphid [9] for the duration of its life, Bonnet hoped to determine whether or not generation of offspring without copulation was possible. In May of 1740 Bonnet successfully confined a spindle tree aphid [9] from the moment of its birth until it gave birth itself to ninety-five live young aphids, eleven days later. He wrote of his success to Réaumur, who read Bonnet's letter to the French Academy of Sciences, which then named Bonnet an official correspondent. This discovery of the process that is now called parthenogenesis (clonal asexual generation by a female without fertilization [10] by a male) was Bonnet's greatest discovery but only the first of his many important contributions to science.

Bonnet followed his work on aphids with research on regeneration, encouraged by his correspondence with Abraham Trembley [11] who first discovered regeneration in hydras. Bonnet investigated insects [8], including respiration in caterpillars and behavior and locomotion of ants, and published *Traite d'insectologie* (Treaty on Insectology) in 1745, one of the earliest comprehensive books on entomology. Unfortunately, due to failing eyesight, Bonnet's forays into insect research came to an end around 1750 and he switched his interests to plant physiology.

In 1754 Bonnet published *Recherches sur l'usage des feuilles dans les plantes* (Research in the Usage of Leaves of Plants), in which he wrote of his numerous observations of plant life. He noted that plant leaves produce bubbles of gas when submerged, indicating gas exchange of some kind. He discovered the epinastic phenomenon in plant leaf movement (a bending towards one direction caused by growth of cells on the opposite side) and made a large number of observations on plant anatomy including leaf shape and position on the stem, and the movement of sap.

As his eyesight failed completely, Bonnet focused more on theoretical biology and less on active research. His *Contemplation of Nature* [12], a textbook-like synthesis of all knowledge of the life sciences, appeared in 1764. The book was partly written to discredit John Needham [13] and Georges Buffon's theories of spontaneous generation [14] and epigenesis [15]. A great deal of Bonnet's influence on the science of the time was in the form of correspondence with other naturalists, most famously Albrecht von Haller [16] and Lazzaro Spallanzani [17], the latter of whom he encouraged in experiments on artificial insemination [18].

Bonnet became a great defender of the reproductive theory of ovist preformationism, owing in part to his discovery of parthenogenesis, which was proof to him that offspring existed preformed in the female gamete. He published a book in 1769 called *Palingénésie philosophique* (Philosophy of Palingenesis) in which he made persuasive arguments for preformationism and against epigenesis [15], the competing idea that the embryo is formed from materials from both parents that become organized and take shape in the mother's womb [19]. Bonnet described the preformed embryo as an organized collection of all of the parts it would have at birth, and using appeals to reason rather than empirical observation, told how those parts unfold and come together as gestation [20] proceeds. *Palingénésie philosophique* also outlined Bonnet's theory of palingenesis [21], an idea similar to the theory of recapitulation proposed by Ernst Haeckel [22] more than a century later. This theory was based partially on the old theory of "the great chain of being," which places all organisms in a hierarchy with the simplest organisms (plants) at the bottom and the most complex and noble organisms (humans [23]) near the top, just below angelic beings. Having observed the different states an embryo goes through as it develops, Bonnet reasoned that in the process of unfolding into its pre-determined form, the embryo assumes successively higher forms of animals below it in the hierarchy.

Bonnet's discovery of parthenogenesis laid the ground-work for many later scientists who investigated the phenomenon to learn more about conception [7] and embryo development. He is considered by many to be one of the founders of modern biology due

to his focus on observation as a vital component of natural philosophy and his leadership in experimental design. His influence on the history of science stems both from his prolific and meticulous research as a young man and his well-connected network of correspondents in the scientific community in his later years. Bonnet died in Geneva on 20 May 1793.

Sources

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