Parasitic Worms: Their Role in Medicine and Science in Modern Europe

by

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DEDICATION

To all of my family, without which I wouldn’t have survived college, let alone be the person I am today.

PREFACE

Despite the vast research into medical developments of the eighteenth century by historians, woefully little is known about the role that worms played in the lives of modern Europeans. This research strove to combine a multitude of primary sources to shape a cohesive depiction of the role of parasitic worms in modern Europe 1700-1800. Worms played a key role in the advances of science that took place during the Scientific Revolution. The Scientific Revolution opened the door to a world of new questions that had previously been veiled in darkness by ancient by the accepted truths of ancient philosophers. Natural philosophers. Using the scientific method and new technology began the process of debunking Galenic and Aristotelian philosophies. Natural philosophers studying the life cycle of worms inferred that contrary to Aristotelian tradition; small animals did not arise from inanimate matter, but from parents of the same species. Eighteenth century physicians were primarily concerned with the symptoms, treatments and the demographic of the individuals affected by parasitic worms. From journals and letters we can gain an oblique insight into how some families dealt with illness and the death of a child. Eighteenth century physicians knew that worms were ingested, and did not arise spontaneously in the guts of their patients. With this in mind, physicians undertook the task of cataloging the symptoms and treatments for individuals who suffered from parasitic worms.

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INTRODUCTION

In the seventeenth century, many physicians, natural philosophers and thinkers still held the belief that living organisms generated spontaneously from matter. Insights gained during the Scientific Revolution helped to shed light on how generation occurred and largely acted to quiet the heat of the spontaneous generation controversy. Natural philosophers used different types of larva or worms in their experiments on spontaneous generation to learn about the worms' life cycles. Natural philosophers understood the life cycle of worms by the eighteenth century, but knowledge of the symptoms and treatments for individuals who suffered from parasitic worms was not well studied. In the eighteenth century several natural philosophers made efforts to fill in the gaps of knowledge about the effects of worms in the human body. Natural philosophers cataloged diverse sets of symptoms that accompanied gastrointestinal worms, the types of treatments used, and the demographic details of individuals affected by the illness. The implications of childhood mortality left a lasting scar on the psyche of modern Europe, which can be seen in the diaries and letters written during this time period.

The Spontaneous Generation Controversy

The spontaneous generation controversy pitted natural philosophers who argued that organisms generated by inanimate substances without parents, against philosophers who believed that organisms arose from natural reproduction by parents of the same species.[1] John Ray (1627-1705), an English naturalist, conducted studies on the generation of plants, and from his research became an advocate against spontaneous generation. Ray argued that equivocal or spontaneous generation did not exist among any living creature.[2] This was in contrast to many natural philosophers in the seventeenth century who were "patrons" of spontaneous generation.[3] In the seventeenth century both scientists and philosophers, centered the debate on how worms got into one's alimentary system. Before the Scientific Revolution, many natural philosophers believed that worms arose equivocally because of the observable appearance of maggots on rotting foods, and the precedents set forth by Aristotelian traditions.[4] In Aristotle's (384 BC-322 BC) *History of Animals,* he stated that plants could arise without parent plants, and theorized that so too could animals.[5] Aristotle argued that while some animals arose from parent organisms, others "grow spontaneously and not from kindred stock."[6] Aristotelian philosophy remained the foundation of the scientific community until the eighteenth century when the innovations from the Scientific Revolution, such as the microscope, were used by natural philosophers to explore the microscopic world, and dismantle the arguments in favor of spontaneous generation.

The Scientific Revolution did not happen overnight, but rather developed over the span of a couple hundred years and slowly changed the dynamic between science, physics, philosophy and mathematics. The changing dynamics challenged the teachings of Galen (129 AD-200 AD), Aristotle, and the Catholic Church. Nicolas Copernicus

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[1] Peter McLaughlin, *Annal of the history and philosophy of biology 10/2005.* (Germany: Universitatsverlag Gottingen, 2006), 80.
[2] John Ray, *The Wisdom of God manifested in the Works of Creation.* (London: William Innys and Richard Manby Printers to the Royal Society, 1691), 221.
[3] Ray, 325.
[4] McLaughlin, 80.
[5] Aristotle, *History of Animals, Book V, Part 1.* (Australia: University of Adelaide, 350 BC).
[6] Aristotle *Book V, part I.*

(1473-1543), a Polish astronomer and mathematician, came to the conclusion that the long-held belief that the Earth was the center of the universe was not true and that the Sun was the center of the Universe.[7] A heliocentric universe broke from Aristotelian philosophy and directly challenged the Church, as it reduced the Earth and man from their "privileged position" in the center of the universe and reduced it to the same status as the rest of the planetary system. Copernicus' questioning of indoctrinated ideas helped to set the tone for the Scientific Revolution and ushered in an era of natural philosophers who questioned everything that had previously been believed as truths.

New Science

The Scientific Revolution was a great time of questioning, and philosophers, such as the Frenchmen René Descartes (1596-1650), and the Englishmen Francis Bacon (1564-1626) discussed scientific subjects.[8] Both men concluded, according to Hays, that "all past knowledge was uncertain and that the human mind must begin anew on different epistemological principles."[9] Descartes, most famous for his discourse on *The Method of Rightly Conducting the Reason* (1637), which contains the famous statement, "I Think, Therefore I Am," advocated the use of deductive reasoning and observation as means of gaining knowledge.[10] Bacon, on the other hand, believed that the advancement of learning should be done through inductive reasoning only. Bacon reasoned that one should start with one fact that they have found to be true, and use that truth to make

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[7] J.N. Hays, *The Burdens of Disease: Epidemics and Human Response in Western History* (New Brunswick: Rutgers University Press, 2009), 88.
[8] Hays, 89.
[9] Hays, 99.
[10] Perry M. Rogers, *Aspects of Western Civilization: Problems and Sources in History*. (New Jersey: Prentice-Hall Inc, 1988), 9.

broader generalizations about their subject. This method is in contrast to Descartes, who started his studies with general axioms and narrowed them down to discover a single truth. Despite having different theories of how to observe and gain information, both men agreed that using one's reason was the key to understanding nature, rather than relying blindly on faith in one's predecessors.

Many natural philosophers contributed to the creation of the "experimental method," which radically changed the way scientific knowledge was gained and interpreted. The "experimental method" created conditions in which an experimenter controlled the variables within the experiment and witnessed the forthcoming results firsthand.[11] This method was the foundation of experiments conducted during the Scientific Revolution, and allowed natural philosophers to gain better understanding of the different trials conducted on the subject.

This change in attitudes and methodologies during the sixteenth and seventeenth centuries affected and expanded medical knowledge; there was an increasing movement to overturn Aristotelian and Galenic teachings. The humoral theory was the standard treatment therapy practiced in early modern Europe, and stems from the Roman physician, Galen. Galen believed that the four humors: blood, phlegm, yellow bile and black bile, were the fundamental constituents of the human body.[15] Planets, elements and seasons were closely associated with the humors. Disease occurred when the humors were imbalanced, so the best way to remain healthy was to keep the humors in their

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[11] Davis C. Lingberg, The beginnings of western science. (Chicago: University if Chicago Press, 2007; 362)
[15] Davis C. Lingberg, The beginnings of western science. (Chicago: University if Chicago Press, 2007; 125)

natural state.[16] As every person is different, the humoral theory created a very individualistic approach to disease, treatment and preventative medicine.

The works of Vesalius and Paracelsus were prominent in the movement to dispel the inaccuracies of ancient philosophers such as Galen and Aristotle. Andreas Vesalius (1514-1564), a Flemish anatomist, spearheaded the standardization of anatomical terminology and accurate illustrations of the human body in his great work *De humani corporis fabrica,* published in 1543.[17] A student at the leading schools of Aristotelian and Galenic studies, Vesalius was "eager and willing to find Galen's mistakes," a trait he passed on to his successors.[18]

Paracelsus (1493-1541), a Swiss physician, denied the authority of teachings remaining from the Middle Ages, and rejected the humoral approach to disease. Rather, Paracelsus believed that the best approach was through experimentation and experience with nature.[19] The systematic destruction of historical teachings by Vesalius and Paracelsus combined with the work of other scientific reformers and culminated in weakening the hold of superstition, religion, and ancient traditions in early modern Europe.

The invention of the microscope opened a new world of discovery to seventeenth century natural philosophers.[20] Antonie Van Leeuwenhoek (1632-1723) a Dutch scientist, Jan Swammerdam (1637-1680), a Dutch biologist, and Robert Hooke (1635-1703), an English natural philosopher, each used microscopes to observe and describe single-celled microorganisms. Natural philosophers sought insight on how organisms came into being,

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16 Lindberg, *Western Science*, 125.
17 Hays, 90.
18 Hays, 91.
19 Hays, 94.
20 William S. Keezer, "Spontaneous Generation, Pre-formation and Epigenesis" Bios, Vol. 36, No. 1 (1965), 26.

and the microscope provided a means to such insights. Robert Hooke, a member of the Royal Society of London founded in 1660 for the purpose of the "promotion of natural knowledge," was the first to publish observations of microorganisms. Robert Hooke used a simple microscope to observe and illustrate sixty microorganisms in his 1665 *Micrographia*, which served as a foundation for future scientists using microscopes to observe nature.[21] After extensively observing blue mold, Hooke found no evidence of 'seed,' and thus concluded, in contrast to Leeuwenhoek's conclusion, that the mold generated without 'seed' or spontaneously.[22] Nineteenth century historian Howard Guest agrees with Clifford Dobell's (1886-1949) assessment that Hooke's *Micrographia* was a "major trigger" for Antoni Van Leeuwenhoek's lifetime of microorganismic research and experiments.[23]

Leeuwenhoek designed high-quality lenses for his simple microscope that allowed him to magnify objects more than 250 times. With his microscopes, he was able to observe protozoa, bacteria and insects. Leeuwenhoek observed the generation of worms in water and sent his findings to the Royal Society of London, where Hooke was charged with replicating Leeuwenhoek's experiments. Hooke confirmed Leeuwenhoek's discoveries of microscopic living organisms in a single drop of water. Leeuwenhoek termed these organisms 'animalcules' or "little eels." Using a microscope Leeuwenhoek was the first to describe the sperm cells of animals, and recognize that in the process of fertilization a sperm enters an egg cell. Leeuwenhoek gathered proof against spontaneous generation by viewing the life cycle of microorganisms under a microscope.

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21 Howard Guest, "The Discovery of Microorganisms by Robert Hooke and Antoni van Leeuwenhoek" Notes and Records of the Royal Society of London, Vol. 58, No. 2 (May, 2004): 199.
22 Guest, 190.
23 Guest, 199.

He cataloged the life cycle of insects, and demonstrated that organisms did not arise out of nonspecific matter, and proved that organisms arose from eggs of the same matter as their parent organism.[24]

Similar to Leeuwenhoek, Jan Swammerdam was interested in the generation of insects, specifically the life cycle of caterpillars and nymphs. Observing the foundational changes of insects helped explain the manner in which eggs could became worms, and how worms or maggots could, in turn, transform into flying insects.[25] Swammerdam's study supported the argument against spontaneous generation by providing proofs that insects arose from eggs, rather than inanimate material.[26]

Italian natural philosopher Francesco Redi (1626-1697) studied the life cycle of insects. Redi hypothesized that maggots did not arise naturally out of putrefying meat, as advocates of spontaneous generation hypothesized.[27] Rather, Redi hypothesized that worms arose from some other means. Redi designed and carried out one of the first cataloged usages of the experimental method. A fundamental element of the experimental method was to conduct an experiment that contained a control group in order to better distinguish the differences between it and the group that was the object of experimentation. In 1668 Redi conducted his famous jar experiment, in which he allowed meat to putrefy under different conditions. Redi sealed half of his test jars with gauze or parchment, and the other half he left uncovered. In jars that were sealed from the air and insects, maggots did not arise from the meat. In the jars left exposed**,** maggots

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[24] Guest, 188, 190, 192, 199.
[25] Jan, Swammerdam, *The book of nature; or the history of insects: reduced to distinct classes, confirmed by particular instances, displayed in the anatomical analysis of many species and illustrated with copper-plates, including the generation of the frog, the history of the ephemeras, the changes of flies, butterflies and beetles; with the original discovery of the milk-vessels of the cuttle-fish, and many other curious particulars* (London, 1758), 35.
[26] G. H. Parker, "Anthony Van Leeuwenhoek and his Microscopes" *The Scientific Monthly*, Vol. 37, No. 5 (Nov., 1933): 435.
[27] Keezer, 26.

developed. Redi's experiment provided proof that maggots arose "not as a result of putrefication" but arose from "eggs laid by the flies which alighted on the overripe meat." To confirm his results, Redi conducted his experiment in different seasons, conditions, and containers. All of his results supported his original findings. Redi's jar experiment settled the question of spontaneous generation of animals that were visible to the naked eye, but the debate continued over animals that could not be observed. Spontaneous generation remained a hot topic until Louis Pasture conducted his pasteurization experiments in 1862.

The culmination of works from Redi, Swammerdam, Hooke, and Leeuwenhoek provided ample proofs against Aristotelian traditional theories about equivocal generation. The controversy surrounding spontaneous generation was largely diminished as an increasing number of natural philosophers believed that generation could not be spontaneous. Despite these findings, intestinal worms presented a problem to natural philosophers. Naturalists, and physicians endeavored to explain how worms got into the body, reproduced, and caused illnesses.[28]

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[28] Joseph, Sant, (2012). Francesco Redi and Controlled Experiments.Retrieved from http://www.scientus.org/Redi-Galileo.html accessed February 10, 2012

THEORIES OF DISEASE

Contending theories on disease causation in the seventeenth and eighteenth centuries included ontological, physiological, and contagion theories.[29] Ontological theorists believed that the source of disease came from outside the body. Sources of disease included chemicals, filth and dirt. Supporters of physiological causes theorized that disease stemmed from a state of being. One does not "catch" an illness, rather the body cycles through an ill state of being. The most prominent physiological theory was the humoral theory. Physicians used the humoral theory to both diagnose and treat illnesses well into the nineteenth century. Contagionists arose as a subgroup of ontological theorists, and hypothesized that diseases act the same in every afflicted individual, and the source was the same chemical or biological specimen. Contagionists held the belief that disease causing agents could be transferred from person to person. Anitcontagionists advocated against contagionists, sticking to traditional ontological proofs.[30] In the eighteenth century there were combinations of these contending theories of disease causation. As will be seen later in this essay, physicians sifted through the aspects of each theory, and combined their preferences with traditional teachings.

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[29] Anita Guerrini, "Oregon State University: History of Medicine lecture" (Corvallis, Oregon, Spring Term 2012)
[30] Guerrini, 2012.

Miasma Theory

A prominent ontological theory of disease was the miasma theory.[31] Miasmas were "bad air," and when inhaled could make one ill. Natural philosophers pictured miasmas as "intangible substance capable of making others sick…the sick person's breath, skin, evacuations, and clothing would all harbor the "seeds" of disease and spread them to all who were well."[32] Once an illness, such as worms entered the body, adherents argued, the worms multiplied and caused damage to the afflicted individual.

Humoral Theory

Physicians who practiced the humoral theory prescribed a variety of treatments. The most common treatment was bloodletting. Humoralists believed that changing the balance of blood in the body cured blood ailments, and realigned the body's humors to a natural state. Purging treatments expelled harmful excesses of whatever humor was causing a disease. Herbal drugs were of particular significance to humoralists, as some herbs induced vomiting, excretion, sweating, and fever as means to rid the body of disease-causing fluid imbalances. Galen proposed six non-naturals, which included things that every individual could control in order to stay healthy. People could control the air that they breathed; bad smells had the potential to cause illness, so one should try to breathe only clean fresh air. The type of food or drink put into one's body allowed diet-based treatments. Any type of body movement was considered exercise. This idea allowed a lot of freedom in the types of exercises that one could preform. Other factors

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[31] Guerrini, 2012.
[32] Judith M. Bennett, *Medieval Europe: A short history*. (New York: McGraw Hill, 1998), 3.

that influenced the humoral health of an individual included: amount of sleep, type of evacuations and one's emotions.[35]

[35] Anita Guerrini, 2012.

PARASITIC WORMS

Eighteenth century naturalists knew that four types of worms existed in the human body. George Armstrong (1719-1789) wrote that the four known types of worms were: *lumbricusters* which are long worms or earth worms; *ascaris* which are small round worms; *tenia* which are long white worms or tape worms; and *curcurbitina which* present as short white flat worms.[36] According to Black, these types of worms differed in "shape, in length, in the different portions of the intestinal canal in which they grow" and in their incubation periods.[37] Psuedo-Aristotle wrote that the worm most commonly found in afflicted individuals in the eighteenth century was the earthworm; however, the most dangerous kind of worms were the parasitic *Tenia.*[38]

Psuedo-Aristotle, a physiological theorist, concurred with the other eighteenth century natural philosophers that worms did not spontaneously generate. His primary concern was then focused on how worms entered the human body. Pseudo-Aristotle is the umbrella term designated to philosophical or medical treatises written by authors who attributed their work to the Greek philosopher Aristotle discussed earlier in this easy.[39] The Pseudo-Aristotle referred to in this essay is the author of a medieval treatise on Midwives.[40] He used the humoral theory to explain the causation of diseases, including worms. Pseudo-Aristotle, stated that worms entered the body through specific types of food. In his book, *Aristotle's compleat and experience'd midwife in two parts*, he argues

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36 George Armstrong, *An account of the diseases most incident to children, from birth till the age of puberty; with a successful method of treating them*. (London: T. Cadell, 1783), 149.

37 Black, 172.

38 Pseudo-Aristotle, 117.

39 Steven J. Williams, *The Secret of Secrets: The Scholarly career of a Pseudo Aristotelian Text in the Latin Middle Ages* (University of Michigan: 2003), 1.

40 Williams, 377

that "mixing milk with other meats" and that eating in "hot and moist environments" contributes to individuals getting worms.[41] Adherents of this tradition also believed that the breeding of worms could be regulated by diet.[42] People who followed diets that were low in sugar, fats, milk, fruits and filmy meats and high in meats, juice, and pomegranates were less likely to become ill with worms. Psuedo-Aristotle hypothesized that fruits high in acid were able to ward off worms, or create uninhabitable internal environments in which a worm could not survive.[44]

Black

From ancient Greek times until the nineteenth century, healers and natural philosophers accepted the humoral theory and taught that a hot and moist environment would cause an imbalance of the humors, which inevitably would cause illness if left untreated. William Black (1749-1829) an Irish physician, accepted the ideas of ontological theories of diseases in many of its aspects, but despite this, the historical traditions of the humoral theory penetrated some of his ideas on the causation of worms. He claimed that worms caused "evil humors" to develop against nature, and thus caused an imbalance of the natural humors. Black also cataloged the symptoms and treatment for gastrointestinal worms in eighteenth century England.

In light of the Scientific Revolution of the previous century, an increasing number of scientists including Black rejected aspects of the humoral theory in favor of the hypothesis that the cause of worms was external. For example worms could manifest due

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[41] Pseudi-Aristotle, *Aristotle's compleat and experience'd midwife in two parts.* (London: Booksellers, 1782), 117
[42] Pseudi-Aristotle,118.
[44] Pseudi-Aristotle, 118.

to "improper diet…such as cheese, farinaceous, legumes, fruits, saccharine, putrid diet or unwholesome aliment, hereditary weak condition, air." Black knew that worms appeared in rotting foods, and advised patients away from food items that were prone to easy decay.[45]

Black noted in his research on mortality that acute diseases such as worms generally affected children under the age of two. Black believed that the leading cause of infant mortality was intestinal worms or secondary illnesses contracted after being infected with worms. In London alone, infant mortality accounted for "nearly one third of the whole mortality in the metropolis." Infants and young children were not able to articulate their symptoms, of which there were many. Black relied on his personal experience and the London mortality registry to infer that worms most often attacked children. Without a description of their discomforts, physicians such as Black relied on cataloging every little display out of the "ordinary" for an infant or child and linking that symptom to those associated with all cases of worms. Although children were the most common age group afflicted with worms, Black notes that some adult mortality did exist. Older children also suffered from worms; however, if they showed no symptoms, they continued to "peruse their usual amusements, and are rarely confined to bed." Unless worms could be seen in voided excrement, diagnosis and treatment could only be hypothesized.[46]

The symptoms Black associated with worms were: nausea, indigestion, vomiting, acidity, flatulence, lack of appetite, diarrhea, colored stools, skin eruptions, pustules,

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[45] William Black, *An Arithmetical and medical analysis of the diseases and mortality of the human species.* (London, 1789), 172, 221-222.

[46] Black, 172, 222.

disturbed sleep and a rapid pulse. He argued that the symptoms of worms varied widely along a spectrum that more often than not were mistaken for other diseases. Worms acted as a catchall cause for many illnesses. In Black's *An Arithmetical and Medical Analysis of the Diseases and Mortality of the Human Species* (1789), he cites worms as the underlying cause of twenty-two illnesses. Of these illnesses, eight deal directly with the alimentary system, and include the following: vomiting blood, hemorrhoids, colic, diarrhea, cholera, stomach diseases, deglutition interrupted, and consumption. Another prominent category of disease associated with worms**,** was convulsions such as St. Vitus' Dance, leprosy, epilepsy, and hysterics.[47] Based on Black's research it appears that the lack of precision in defining symptoms and having a multitude of illnesses that presented with similar symptoms, allowed for many illnesses to go untreated, or mistreated. In the eighteenth century confusion existed as to how to determine who did and did not have worms. Black notes that London's mortality registrar for worms was likely defective, because the symptoms of worms were often confused with other diseases. As often as a death went unattributed to worms, it was just as likely that a diseased individual was said to have worms when they did not.

How worms survived and breed inside the body remained an educated guess, as much more had been learned about the symptoms of worms than the internal maturation process.[51] French physician Nicolas Andry de Bois-Regard (1658 -1742), argued that once a worm had depleted its environment of nutrients it deposited its eggs. Upon hatching, the worm found itself in a nutrient-poor environment, and had to either move to

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[47] Black, 120-123.
[51] Jean Astruc, *A general and compleat treatise on all the diseases incident to children from their birth to the age fifteen.* (London: John Nourse,1746), 191.

find more nutrients or was “drag’d out…with the excrement.”[52] Bois-Regard stated that the eggs within a single worm were so numerous that the point of a pin could come away with a microscopic pile of eggs.[53] Each egg once mature had the potential to wreak havoc upon the alimentary system, and potentially cause death. Eighteenth century physicians John Arbuthnot and George Armstrong studied intestinal worms, and came to conclusions about the prevalence, and treatments for individuals afflicted with worms that differed from William Black and Nicolas Bois-Regard,

Arbuthnot and Armstrong

Physicians John Arbuthnot (1667-1735) and George Armstrong (1719-1789) concurred with Black and other ontological theorists that the only reasonable explanation of abdominal worms was that they were ingested, nourished, and reproduced within the body.[54] Eighteenth-century physicians suggested several ways worms could invade the body: one could ingest worms by eating contaminated foods; for example, Armstrong theorized that worms deposited their eggs on food, especially fruit, and were then ingested by unsuspecting humans.[55] Arbuthnot on the other hand advocated that children should be encouraged to not eat “milk, cheese, or ripe fruits, nor take much sugar,” because he thought that insects laid their eggs in these substances, and when ingested they would hatch into worms.[56]

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52 Nicolas Andry de bois-regerd, *An Account of the breeding of worms in the human bodies; the nature, and several sorts. Their effects, symptoms and prognostics. With the true means to avoid them, and med'cines to cure them.* (London: H. Rhodes, 1701), 113.
53 Bois-regerd,, 113.
54 Armstrong, 71.
55 John Arbuthnot, *An Essay concerning the nature of ailments, and the choice of them, according to the different constitutions of human bodies.* (London: J. Tonson, 1732), 433.
56Arbuthnot, 308.

George Armstrong focused his studies on childhood mortality, and in his *Account of diseases in Children* (1732), he shares a few cases in which a child presented with symptoms of worms, and voided worms, but died from a secondary illness. In these cases each child presented with a different set of symptoms. A three-year-old boy was sick for ten days when a physician diagnosed him with worms. This child suffered from convulsions, dilated pupils, labored breathing and a fast pulse. He voided two round worms before his death. During his autopsy, Armstrong discovered a single worm in his intestine. Another child presented with a fever, swollen belly, and dark green stools. This child voided three worms prior to his death. The first was five inches long, and the second and third were between two and three inches long. Upon examining the body post mortem, Armstrong searched the intestinal canal and found no worms.[57] After many cases similar to these, Armstrong came to the conclusion that despite worms being the principal cause of a child's symptoms he could not help but think that "worm cases more rarely occur than commonly imagined."[58] Armstrong seemed to feel that many children had worms, but very few actually perished from them. Of the many children brought to his dispensary, he wrote, "there was not one in ten that has ever voided any, nor do any make their appearance during the whole time of the cure."[59] Both of these patients presented with different symptoms, and despite having worms, it is interesting that Armstrong doubts that worms were truly the cause of these children's deaths.[60] Armstrong accepted ontological theories, but simultaneously still relied on the traditional beliefs taught by Aristotle. For example, Armstrong believed that infants were infected

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57 Armstrong, 151-152.
58 Armstrong, 150.
59 Armstrong, 151.
60 Armstrong, 71.

with worms if one or more parent had worms in their infancy, or if the mother was infected while breast-feeding.[61]

Based on Armstrong's attitude towards these patients, it appears that worms were a prevalent problem in modern Europe. Despite the commonality of worms in the population, the cause of death in Armstrong's patients is often due to a secondary or co-occurring illness. Armstrong's conclusions appear accurate if current medical knowledge is taken into account. Worms in the alimentary system would weaken the host and make them more susceptible to other illnesses that were abundant during the eighteenth century. Armstrong performed autopsies on some of his patients diagnosed with worms, and hypothesized that there was not one child in ten, that was diagnosed with worms and also voided or had worms found during the course of the illness.[62]

Arbuthnot drew on ideas present in ontological theories in his diagnosis and prevention tactics. Arbuthnot wrote that the best way to kill worms was to ingest, or receive via an enema a substance that expelled the worms from the body, either orally, or anally. Medicinal treatments were thought to contain "small pungent and sharp particles" that targeted the worm without harming the individual afflicted with worms.[63] Both Armstrong and Arbuthnot concurred that the primary goal of treatments was to prevent the worms from breeding. Arbuthnot prescribed a treatment of ingesting oils and honey, as a means to kill off worms in the intestines. Arbuthnot believed that fats and sweets would starve worms of nutrients.[64] Some animal byproducts contained properties, that when ingested acted as laxatives and purgatives, or treated the symptoms associated with

[61] Armstrong, 150.
[62] Armstrong, 151.
[63] Arbuthnot, 308.
[64] Arbuthnot, 307.

alimentary diseases. Hartshorn powder, the ground antlers of a male red deer, was ingested to decrease diarrhea.[65] The gallbladder of animals, when combined with Mercury, was used to "kill worms and destroy their nests."[66] From Arbuthnot's insights on the variety of treatments a physician could prescribe, it appears that there was some degree of trial and error in perfecting herbal remedies.

Lysons

Daniel Lysons (1727-1800), an English physician, wrote extensively on treatments available for sufferers of worms. He advocated the usage of the laxative Calomel, or horn quicksilver, which was a Mercury (I) chloride compound.[67] Calomel could produce two to three stools a day, in each stool "so incredible a quantity of worms, as fifty-one in number" could be passed.[68] The usage of purgatives is a remnant of the humoral theory which had remained a part of Armstrong's, Black's and Arbuthnot's treatment plans.

Lysons used Calomel in most of his treatment recipes, as it was a tasteless laxative and could be combined with other compounds to change its virtue. Calomel's effects were "determined by the propensity of its companion," and thus calomel could be used to treat worms on more than one level. According to Lysons, by joining calomel and a purgative, the tincture affected the intestines and destroyed the worms. Moreover,

[65] Arbuthnot, 308.
[66] Arbuthnot, 434.
[67] Daniel Lysons, *An essay Upon the Effects of Camphire, and Calomel, in Continual Fevers.* (London: 1772), 199.
[68] Lysons, 199.

he argued, if given to an individual with a fever, it can be combined with the camphire plant to decrease the fever.[69]

In addition to mineral and animal products that could be used by physicians to treat worms, botanists advocated the usage of "new" herbal remedies to cure diseases. After Columbus' discovery of the New World many scientists traveled abroad and returned home with manuscripts on the medicinal uses of plants. The plants of the New World were different than the ones that could be found in Western Europe. Most of the new plant's medicinal purposes were fabricated or used incorrectly to cure illnesses.[70] John Chambers (1780-1852), a botanist, described a wide variety of herbal treatments for intestinal worms in his 1772 guide book*, A pocket herba;; containing the medicinal virtues and uses the most esteemed native plants.* Chambers references Doctor Samuel Tissot, a Swiss physician, for a treatment where half an ounce of powdered aloe, rue, wormwood, calomel, and gall are combined and applied to a cloth and laid on the abdomen.[71] The dressings were changed every twelve hours. With each changing the cloth was said to "bring vast quantities of worms away, some burst and some alive."[72] Other herbal remedies he recommended included: factitious cinnabar, Jalap, Bear's foot leaves, *Petasites Vulgaris, Fraxinella, Filix mad Vulgaris* , and garlick.[73] Plant material was combined with non-herbal substances to create strong purgatives, which would force worms out of the intestines with the feces.[74]

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69 Lysons, 199.
70 Anita Guerrini "Oregon State University: History of Medicine lecture" Corvallis, Oregon, Spring Term 2012.
71 John, Chambers, A pocket herbal; containing the medicinal virtues and uses the most esteemed native plants; with some remarks on bathing; electricity. (London: Bury, 1800), 118.
72 Chambers, 118.
73 Chambers, 119.
74 Chamers, 119.

ALTERNATIVE MEDICINE

When no means of medicinal treatment cured people of worms, some individuals turned to God. Prayer was still a source of comfort to some people whose loved ones suffered from diseases. Magdalena Behaim, a sixteenth century mother and wife, turned to God when her son, Balthasar, became sick. In letters to her merchant husband Balthasar, one could see her need to hold onto religion as an anchor and a hope for her ailing child. To Magdalena, "religion is a constant remedy and cure of last resort…especially to be invoked when all else fails". In the end, neither medicine nor God saved her child from death. There are few records that indicate a parent's point of view after the death of a child from worms, but the correspondences between Magdalena and Balthasar offer a little bit of insight. These letters indicate that when medicine failed her son, Magdalena turned to God as a means of healing her grief.[75]

The death of one or more child was a harsh reality for parents in modern Europe. One fourth to one third of all children died before the age of fifteen, and between 123-154 of every thousand infants did not live to their first birthday. In early modern historian Hannah Newton's book, *The Sick Child in Early Modern England 1580-1720*, she explores the relationship between families and their coping mechanisms for the death of a child. Despite having only oblique sources for inference of modern English views towards death, Newton attempts to give her readers insights into the practical "repercussions of child illness and death." She demonstrates that families were heavily involved in caring for, and preparing their ill children for death. Newton uses letters, and

[75] Steven Ozment, *Magdalena & Balthasar: An Intimate Portrait of Life in the 16th Century Europe Revealed in the Letters of a Nurembery Husband and Wife* (New Haven: Yale University Press; 1986), 116.

diaries to prove the link between sickness and religion. Modern Europeans believed sickness was a punishment from God, and that pious activity by the afflicted and their family would gain God's forgiveness, and God would save the child. As was seen with Balthasar and Magdalena, Newton proves that parents stayed up all night nursing their ailing children, and engaging in "passionate prayer" for God to remove the illness from their child. If God did not remove the sickness, religion offered the patient and their family a way to prepare themselves for death.[76]

Directing their faith inward allowed individuals to dream of salvation, rather than impending death. Five-year-old Joseph Scholding, who suffered from worm fever asked his mother how his "soul shall get to Heaven" when he died, and his mother replied that God would provide "Angles, and they shall carry it to Heaven." The parents that Newton studied believed that children were the most innocent because they had less time to commit sin. Parents needed to believe in salvation for their children, and the hope that one day they could be reunited in God's kingdom.[77]

[76] Hannah Newton, *The Sick Child in Early Modern England 1580-1720* (United Kingdom: Oxford University Press: 2012), 2, 4, 6.
[77] Newton, 2

CONCLUSION

The Scientific Revolution of the seventeenth century set the stage for major medical developments to occur in the eighteenth century. The works of Copernicus, Vesalius and Paracelsus ushered in an era of natural philosophers who questioned everything. With the use of the scientific method, seventeenth century philosophers set about righting the misconceptions, or mistakes of their predecessors. The use of the microscope by Hooke, Swammerdam, and Leeuwenhoek allowed natural philosophers to, for the first time, investigate minute matter. These philosophers exposed microscopic organisms, and sparked enthusiasm among their colleagues for the pursuit of new knowledge. Swammerdam's and Leeuwenhoek's proofs on the life cycle of insects, Leeuwenhoek's description of the semination process of eggs in animals, and Redi's jar experiment combined to quiet the debate over spontaneous generation. The spontaneous generation controversy over animals that could not be seen with the naked eye, however, continued until Pasteur's experiments in 1862.

Despite advances in science and medicine, the study of parasitic worms remained woefully unexamined. In the eighteenth century physicians such as Black, Armstrong, Arbuthnot tried to discover and catalogue the symptoms, treatments, related diseases and outcomes of some of their patients who suffered from worms. Combining the results of these physicians, it appears that the symptoms documented for cases of worms were eclectic to say the least. The majority of patients were unable to voice their complaints and as such, every minute action was seemingly catalogued as a symptom of worms.

They symptoms ranged from the ridiculous: itching ones nose, grinding of teeth, and stinking breath to the plausible: distended abdomen, vomiting, bowel issues, and crying.

There were a number of cases in which children who were diagnosed with worms never voided any, or were worms found in autopsy. Armstrong seems to have a hard time coming to terms with how children diagnosed with worms appeared to die of other diseases. It is clear that Armstrong is in the process of putting together the hypothesis that despite worms being a common feature of children's alimentary system, children did not often die from them. The commonality of this seen in Armstrong's book, and the vast number of other diseases that Black links to worms, leads one to conclude that worms acted as a scapegoat for illness. Real cases of worms were under diagnosed, and in general worms were diagnosed far more often then they should have been. Parasitic worms were common in eighteenth century Europe. Black believed worms were the root of twenty-two different diseases. Black's easy acceptance of worms supports the idea that worms were a part of daily life during this time. It is probable that, if a child presented with any symptoms that Black associated with worms, and he was unable to diagnose the patient with a different disease, it would have been easy to give a diagnosis of worms because it was likely true. Armstrong's work corroborates this conclusion. Armstrong noted that many of his patients never died of worms, but rather of secondary illnesses that took hold after worm fever had weakened the patient.

In addition to physicians who studied the symptoms of worms, other philosophers were working to develop comprehensive treatment programs for worms. Chambers, a botanist favored a herbal approach to killing worms and treating the symptoms. His most common remedy included wormwood, and aloe. Other treatments focused on mineral or animal products. Lysons' treatments depended on the purgative effects of Calomel, which functioned to flush the worms from the intestines.

Parasitic worms were a childhood disease, striking down those who had not had the chance to strengthen their immune systems. While it cannot be inferred that all parents felt a particular way in the seventeenth and eighteenth centuries, Ozment and Newton were able to display the feelings of select parents and children who were faced with impeding death, by studying their diaries and letters. When treatments produced no cure, these families turned to religion. Magdalena prayed constantly for her son Balthasar to recover from worm fever, while little Joseph wondered how he would get to Heaven if worms had eaten his body. These few oblique glimpses demonstrate, that at least to some degree, some parents cared deeply and grieved passionately for the loss of a child.

With the exception of Newton and Ozment, the primary sources of this research are English. Taking into account continental sources would give more insight into the role of parasitic worms in science and medicine during the eighteenth century. Widening the scope of this research could raise different questions beyond those dealt with in this research. Much more research needs to be done one on the treatments of individuals who suffered from worms, specifically, the herbal remedies beyond the traditional calomel. Further research needs to be done on eighteenth-century attitudes towards spontaneous generation and the origin of worms in the body. The physicians in this research appear to understand that worms do not generate equivocally, but they struggle to understand the origin of worms in the body and how they survived and procreated within the body. Spontaneous generation was not completely refuted until Louis Pasteur (1822-1895) a

French chemist, conducted fermentation experiments in 1862. In experiments strikingly similar to Redi's, Pasteur proved that the microorganisms that grew in fermented broths were due to biogenesis. It was not until the turn of the nineteenth century that

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