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"Fanciful but Not Forgotten: a Historical Examination of the Study of the Flea, 1840-1930"

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FANCIFUL BUT NOT FORGOTTEN:
A HISTORICAL EXAMINATION OF THE STUDY OF THE FLEA, 1840-1930

by

Andrea Buhler

A Thesis Submitted in
Partial Fulfillment of the
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in History

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May 2017

ABSTRACT
FANCIFUL BUT NOT FORGOTTEN:
A HISTORICAL EXAMINATION OF THE STUDY OF THE FLEA, 1840-1930

by
Andrea Buhler

The University of Wisconsin – Milwaukee, 2017
Under the Supervision of Professor Helena Pycior

Although the Victorian and Progressive periods saw a rise in entomological research, fleas were not a priority for scientific investigation. The discovery of fleas as disease vectors in the late nineteenth century marked a turning-point in interest in fleas. Expanding this standard history of fleas, the thesis probes flea research conducted outside the confines of disease during 1840-1930. It documents and analyzes the contributions of Louis Bertolotto, William Heckler, Charles Rothschild, Karl Jordan, and L. O. Howard. Whereas those working in the new profession of entomology saw fleas as disease vectors, these men had different relationships with fleas: Bertolotto and Heckler engaged with fleas as entertainers, Rothschild and Jordan viewed fleas as collectible commodities to be catalogued, while Howard pursued fleas as household pests. Each relationship determined methods of study and questions asked. The thesis argues that the variant relationships provided impetus for substantial contributions to scientific understanding of fleas.

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To
Rasmo

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I dedicate this thesis to the best dog to have ever lived, Rasmø Mortimer. He was my best friend and provided valuable and endless emotional support when I did not think I would or could finish my research. He was a great listener and gave me much needed inspiration and motivation.

Introduction

The FLEA

Little hind'rer of my rest

Thus I tear thee from my breast

Bosom traitor! Pinching harm!

Wounding me, who kept thee warm!¹

The unnamed author of this poem, published in July 1795, succinctly summed up the prevalent perception of the flea as a pest, which has prevailed from antiquity to modernity. Rarely has the beauty of the flea been mentioned, in poetic or scientific works. Seldom has it been thought of as relatable to humans or seen as worthy of extensive research. The flea, for most of history, has been a pest. Close scientific study of the flea, like other insects, became possible with the invention of the microscope in the sixteenth century, during the Scientific Revolution. The prevalence of the microscope in scientific endeavors would combine with the increase of the study of the natural world during the Victorian and Progressive periods to give rise to the study of insects and the development of the entomological profession. Despite the professionalization of entomology in the nineteenth century, fleas were not originally a high priority for scientific investigation. The flea was an undervalued and understudied insect. The discovery of the flea as a vector of disease in the late nineteenth century marked a turning-point in the interest in fleas. This is typically the context surrounding the history of the modern study of the flea.

But, as this thesis argues, the history of the study of the flea is more complicated. During the Victorian and Progressive periods there were three select groups of flea enthusiasts who studied fleas outside the context of disease and made important contributions to the appreciation and understanding of the flea. This thesis explores the important contributions made to the study of fleas, outside of the context of disease, between 1840 and 1930, by examining three

exceptional kinds of relationships humans had with fleas and how those human-flea relationships contributed much new and different information to the body of knowledge surrounding the flea. Louis Bertolotto, William Heckler, Charles Rothschild, Karl Jordan, and L. O. Howard viewed fleas differently, as entertainers, objects for collection and classification, and household pests which needed to be eradicated. These different kinds of relationships affected their methods of study, the questions asked, the information discovered, and the results of their research.

The thesis begins with an examination of the scientific contributions to flea knowledge made before and during the Victorian and Progressive periods, with a focus on early pioneers in flea discoveries, the impact of the microscope, and Harold Russell's *The Flea*. The second chapter explores the relationship that flea "circus" masters, Louis Bertolotto and William Heckler, had with their fleas. Bertolotto and Heckler saw their fleas as trained performers. Through their entertainment-related research with fleas, they discovered new and useful information while contributing to the discourse about insect intelligence and their capabilities for learning. The third chapter explores the contributions of the Rothschilds, with a specific focus on Charles Rothschild and his colleague, Karl Jordan. Charles had a massive flea collection, which was due to his wealth and the availability of specimens throughout the vast British colonial empire. Karl Jordan was an expert taxonomist. Charles's vast collection and Jordan's cataloguing and classification skills combined to provide the circumstances needed for them to discover the Oriental rat flea, one of the species that is a major plague vector. The fourth chapter turns to an examination of flea contributions from the United States. During the American Victorian and Progressive periods, the U.S. saw an increase in westward expansion, agricultural production, and indoor pet keeping. These circumstances allowed for the proliferation of insect pests in the U.S. Fleas evolved from mostly harmless nuisances to serious household pests that needed to be

eradicated. Emanuel Lyon and L. O. Howard, whose interest in fleas was born from their perception as pests, responded to this new view and worked diligently to promote eradication efforts. Research with fleas as entertainers, collectible commodities, and endless pests demonstrated that contributions to the study of fleas did not always have to come from within entomological and scientific circles. Nor should the study of fleas be limited to their capacity for carrying diseases. Exploring these different relationships deepens understanding of the history of the study of fleas in addition to understanding the development of the entomological field during those periods.

The first chapter examines early flea researchers, the importance of the microscope, and a later work, Harold Russell's *The Flea*. This chapter begins in antiquity, with Aristotle, and moves through the Middle Ages, with a discussion on Albertus' work with fleas. The invention and subsequent refinement of the microscope are highlighted with a focus on Robert Hooke and Antoni van Leeuwenhoek, two scientific pioneers in microscopy. The microscope was crucial to studying minute creatures like the flea. A discussion of Russell's breakthrough work, published during the Progressive Period, closes the chapter. Russell's work on the flea was remarkable because it was completely dedicated to the flea. *The Flea* is an example of how fleas became part of mainstream entomological research during the Progressive period. Russell's book, however, was written in response to the discovery of fleas as carriers of disease and thus will not be a major component for examination in this thesis. As scientific study and human curiosity blossomed, knowledge of the flea increased. The research highlighted in this chapter paved the way for future flea research, which, although still scant, improved and increased in the Victorian and Progressive periods.

The second chapter discusses two prominent flea “circus” masters, Louis Bertolotto and “Professor” William Heckler. Bertolotto and his fleas performed during the Victorian period, primarily in England. “Professor” Heckler and his fleas performed during the Progressive period in New York City. They both published pamphlets meant to promote their shows. Significantly, both pamphlets contained accurate information about the flea and its life cycles. Although some of this information originated from easily available reference materials of the time, Bertolotto and Heckler added information about the flea which did not exist in Victorian and Progressive era scientific literature. In addition to highlighting the information discovered by Bertolotto and Heckler, this chapter questions the immediate dismissal of fleas as trained or educated. Bertolotto and Heckler divulged a few of the training methods they used to explore the idea of insect intelligence. The Victorian period saw an increase in discussion about animal intelligence, with the intellectual capabilities of insects questioned. In addition to providing new and useful information about fleas and their habits, Bertolotto and Heckler attempted to prove that their fleas were capable of being trained.

The third chapter centers on the Rothschilds, with specific attention to Charles and his colleague, Karl Jordan. Additionally, Walter, Charles’s brother, and Miriam, Charles’s daughter, are discussed. Charles was employed in the family banking business, N.M. Rothschild & Sons, until his early death. Employed as a financier by day, he was a flea fancier in his leisure. Due to wealth, leisure time, and a vast British colonial empire, Charles had amassed an extensive collection of thousands of fleas. With the help of Jordan, a recognized talent in classification and taxonomy, Charles discovered the Oriental rat flea, responsible for transmission of the bubonic plague. This chapter explores how the Rothschilds’ great wealth provided them with the leisure time and the financial means which enabled them to collect and classify thousands of specimens.

There is a theme of empire which, in conjunction with their fortune, enabled Charles to study and collect many more species than were found in the British Isles. Charles's and Jordan's contributions to the knowledge of fleas were remarkable.

The fourth chapter examines negative attitudes towards fleas and the obsession with them as household pests. Middle-class Victorian ideals held that a woman's place was in the home and it was her responsibility to ensure that her domestic sphere was properly maintained and free from dirt. The Victorian period also saw a rise in the number of pet dogs kept indoors. In the U.S. the American Victorian and Progressive periods saw rapid expansion westward and an increase in agricultural production. The combination of these social, political, and economic events brought humans into closer contact with more insect pests. Since England did not experience the rapid expansion and increased agricultural production seen in the U.S., this chapter will focus on the U.S. Emanuel Lyon and L. O. Howard took notable interest in insect control, based on their perceptions of them as pests. Emanuel Lyon created and specifically advertised insect control powders for flea eradication. He was one of the first in the U.S. to market insect powders directly for the eradication of fleas. Although he did not contribute anything new to the study of the flea, Lyon is worth mentioning because of the prevalence of his ads which were early Victorian period representations of the view that fleas were pests. Lyon was one of the first to capitalize on the perceived need for flea eradication. Lyon was also representative of the unregulated chemical industry in the U.S. Eventually the U.S. Department of Agriculture intervened in insect control efforts. Howard was one of the first well-known government entomologists and this chapter closely examines his work with fleas. Howard published many bulletins on the flea, and examination of his work demonstrates how his knowledge of the flea advanced during his tenure. Moreover, his work brought the study of fleas

out of relative obscurity and into mainstream entomological research. This was important as his research did not typically center on their ability to carry diseases. Howard was notable for much of his entomological work, however, his research on fleas is usually overlooked. His work demonstrates the changes in entomological studies and professionalization in the U.S. during the Victorian and Progressive periods.

To the best of this author's knowledge, there has not been any serious historical discourse analyzing the development of the study of fleas, within the context of human-flea relationships. This research attempts to fill voids in historical studies of human-animal relationships, scientific advancement, and the development of entomology as a field of study and profession. This thesis highlights three different kinds of relationships humans had with their fleas during the heyday of entomological and naturalist pursuits, the Victorian and Progressive periods, 1840 through 1930. Through examination of these relationships, a better understanding of the Victorian and Progressive periods can be gleaned. Furthermore, understanding how humans and fleas interacted in those periods sheds light onto how humans interacted with other animals during that time, human and non-human. Most importantly, this thesis is about the fanciful and frequently forgotten flea, and how they influenced humans as much as humans influenced them.

Literature Review

Although there are no works that specifically examine fleas beyond the context of disease in human history, there are works covering the history of other insects. Reaktion Books, a publishing company founded in 1985, has produced several notable works on insects. These include *Ant*, *Bee*, *Moth*, and *Cockroach*. Unlike entomological, biological, and ecological works concerning insects, each of the Reaktion books examines an insect from a cultural and societal context, while acknowledging the scientific body of work surrounding the insect. For example, in Cockroach Marion Copeland attempted “a biocentric reading of the human record as it relates to the cockroach, whether in the sciences or in the arts, translated to reflect the cockroach’s own point of view.”² Although Cockroach and the other Reaktion books provide excellent overviews on a wide array of specific insects and their history, as of this writing, a work on fleas has yet to be published.

First and foremost, this thesis expands the coverage of fleas in the history of entomology, specifically during the Victorian and Progressive periods. There are a few notable works on the history of entomology. E. O. Essig’s article, “A Sketch History of Entomology,”³ was published in 1936 and was used in conjunction with his 1972 work, A History of Entomology.⁴ Essig’s History included a ten-page section on the history of fleas. Although Essig’s flea history focused on California, the section contained pertinent information. In 1973, Ray F. Smith and Thomas E. Mittler published their History of Entomology.⁵ Although their flea information was useful, especially concerning Aristotle, Albertus, Robert Hooke, and Antoni van Leeuwenhoek, it was missing a discussion of Charles Rothschild. Charles Rothschild, the focus of the third chapter, had a collection of thousands of fleas and helped discover the Oriental rat flea which is instrumental in the transmission of the plague. His work and flea collection were world

renowned and it is curious that he is missing from these works. Smith and Mittler discussed the study of fleas briefly, with reference to antiquated solutions for flea control. They also mentioned attempts to properly classify fleas. These overviews of the history of entomology were useful, however, in providing much needed background information which served as the basis for a deeper look at the Victorian and Progressive periods.

The most important work on entomology during the Victorian period is John Finlay McDiarmid Clark's Bugs and the Victorians. In his introductory material, Clark stated that this book was a history of insects and those who studied them, in the context of the Victorian period.⁶ For the history of the study of the flea, this work falls short. First, there is only one indexed reference for the flea, a turnip flea. This is not a flea but a beetle. Second, as with other materials, the contributions made by Rothschild and Jordan were ignored in this work. Where this work proved beneficial was that it provided context for the discussion of entomological study and development in the Victorian Age. Although material on fleas is missing, this work is the closest overview to the study of insects in the Victorian period. Other work, such as Michael A. Salmon's the Aurelian Legacy, centered on the study of one insect, the butterfly.⁷ The Aurelian Legacy, despite specifically addressing butterflies, provided much information about entomology and naturalist pursuits in the Victorian period. The work centered on that period and was beneficial to this thesis. Clark's work was published nine years after Salmon's, in 2009, which could be indicative of an attempt to fill a much-needed void in the history of the study of entomology.

Additionally, the literature on the history of entomology during the Progressive Age is scant. Connor Sorensen's Brethren of the Net⁸ details the development of the entomological profession in the U.S. between 1840 and 1880. This work provided information on and historical

context for the development of the profession, its connection to agricultural production, the intervention of the federal government in insect control, and the founding of the United States Department of Agriculture (USDA), which would take the lead in applied entomology. Still, Sorensen omitted the USDA's efforts at the control of household insects. For example, he offered no information on fleas as household pests. In his article, "History of Ecological Sciences, Part 45: Ecological Aspects of Entomology During the 1800s," Frank N. Egerton did not mention fleas in his discussions of humans and insects. He argued that the U.S. led the world in applied entomology because England did not face the agricultural crises and westward expansion that the U.S. did.⁹ Again, Egerton's analysis explored agricultural rather than household pests. James T. McWilliams' article, "'The Horizon Opened Up Very Greatly': Leland O. Howard and the Transition to Chemical Insecticides in the United States, 1894-1927,"¹⁰ contributed vital information about Howard's entomological studies, goals, and tenure at the USDA but, like other sources, omitted a discussion of Howard's important flea eradication research. Lastly, Gustavus A. Weber's work, The Bureau of Entomology: Its History, Activities, and Organization,¹¹ gave an overview of the Bureau, which was an agency within the USDA. Weber's work was published in 1930. Weber's work, meant to be an objective history of the Bureau, established the foundation for discussion of the USDA. More importantly, Weber did not refer to any works on fleas undertaken on behalf of the USDA. Although these sources tackled specific decades of the Victorian and Progressive periods, and the 19th-century, the lack of a definitive work on entomology in the Progressive period proved frustrating. Still, these works proved integral to developing the major arguments of the thesis.

In summary, there are no major historical works on the history of the study of fleas. Moreover, the works that have addressed the contributions to the development of entomology,

such as the Reaktion books, Clark's Bugs and the Victorians, and Sorenson's Brethren of the Net, mostly ignore fleas. Furthermore, the Rothschilds, Jordan, and Howard, who viewed fleas as commodities and pests, and who studied fleas outside of the scope of disease, have escaped serious historical examination. Similarly, these works omit analysis of flea circus masters, such as Bertolotto and Heckler, during the Victorian and Progressive periods.

Flea Formulations

Fleas and humans have coexisted together for thousands of years. From antiquity into the Victorian and Progressive periods, how fleas were being defined, used, and conceptualized by humans were important measures of scientific progress associated with their relative periods. This chapter traces definitions, classifications, and thoughts about fleas, from antiquity through the early Progressive period. Scientific discovery made by those armed with early incarnations of microscopes played a prominent role in early revelations about fleas, what they were, and how they functioned. Ancient flea researchers and the invention of the microscope during the Scientific Revolution provided the foundation for later Victorian interests in entomology. This interest persisted and strengthened after the Victorian age, especially after the discovery that fleas were disease vectors, which marked a turning-point in the scientific interest in fleas. Harold Russell's book, *The Flea*, was a breakthrough work which was devoted to the flea, albeit in the context of disease. These advancements paved the way for future research, especially studies that removed fleas from their role as plague vectors.

The *Oxford English Dictionary* gives the earliest known use of the term "flea," dating from an 8th-century *Epinal Gloss*. Glosses were etymological works which functioned like dictionaries. The *Oxford English Dictionary* states that the flea is "a small wingless insect (or genus of insects, *Pulex*, the common flea being *P. irritans*), well known for its biting propensities and its agility in leaping; it feeds on the blood of man and of some other animals."¹² These are the basic characteristics associated with fleas, which have historical roots that date back thousands of years.

The influential philosopher Aristotle recorded some of the earliest observations of fleas. According to Smith and Mittler's *History of Entomology*, Aristotle "may be called the founder of general entomology and of entomology as a science." The volume noted that Aristotle was the first to attempt to systematize and classify insects.¹³ Sources from antiquity that reference insects and their habits are thin but Aristotle's *On the Generation of Animals* provides a relevant and necessary starting point for a discussion on insects, and more importantly, fleas.

Aristotle lived during the fourth century BCE. He wrote *On the Generation of Animals*, a work concerned with the generation, or procreation, of living beings. Aristotle attempted to explain the origins of humans, plants, mammals, and other creatures, such as insects. After several centuries, more advanced scientific discoveries would disprove many of Aristotle's findings. This was partially because Aristotle arrived at his conclusions through naked-eye observation. Scientific technology during his lifetime had not produced a microscope with which to view miniscule creatures. Naked-eye observation was the best scientific method available.

In Book I of *On the Generation of Animals*, Aristotle discussed the origin of insects, including fleas. He determined that some insects, "although they copulate and generate, generate not creatures of the same kind as themselves but only larvae; and these insects moreover are not produced out of animals at all but out of putrefying fluids (in some cases, solids); instances of this are fleas, flies, and cantharides."¹⁴ The *History of Entomology* summed up his argument succinctly; "fleas originate from the lowest degree of putrefaction, e.g. dry manure."¹⁵ Although that was not the case, it was Aristotle's best argument for how fleas procreate. Perhaps his argument for the spontaneous generation of fleas from manure and dirt stemmed from the fact that fleas were known to be blood-sucking pests. Only lowly creatures would feed off the blood

of others. Therefore, it would stand to reason that they originate from lower life giving forms. Flies, who also congregate around dung and filth, had a similar reputation.

Aristotle's work on insects went virtually unrivaled for almost 2,000 years.¹⁶ That does not mean, however, that others were not investigating insects, specifically fleas. According to James Ronald Busvine, in his work *Insects, Hygiene, and History*, Albertus Magnus, "despite the danger of being attainted heretic, ... quoted Aristotle extensively, and even showed signs of original observation, in his great work *De Animalibus*."¹⁷ Albertus, during the 13th century, made some flea discoveries of his own that built on Aristotle's findings. He determined that

Fleas originate from moist warm sand when it suddenly comes into touch with the warm bodies of animals. They suck blood with their proboscis so that the skin swells in these spots. They have long saltatorial legs besides six legs for walking. As they are very small they jump very quickly. They suck so much blood that they drop it continually as a blackish, dry secretion. Their eggs are lentiform. Always a small male and a big female are found together.¹⁸

His original observations included his notations on the number of legs possessed by the flea. His language is unclear but he mentions that they have long legs for jumping "besides six legs for walking."¹⁹ It reads as though he meant that the fleas have two legs for jumping and six legs for walking, which would be incorrect as they have only six legs. Although the wording is murky, it demonstrated Albertus Magnus' attempt at describing the flea, which was more detailed than Aristotle's observations. Aristotle briefly mentioned their larval stage but Albertus furthered the description by describing flea eggs and their shape. He continued with his additions by recording the difference in size between male and female fleas which was later corroborated by entomologists and others who studied the flea, such as the flea circus masters.

Compared to Aristotle, Albertus' description of the flea was more informative and scientific. Although information on Albertus' findings on the fleas was gleaned from a secondary history, there was no mention of his or Aristotle's thoughts on fleas beyond mere description. Despite their findings and notes about their blood-sucking nature, neither Aristotle nor Albertus directly referred to them as pests. Their descriptions were more factual rather than a commentary on their nature or perceived personalities. Their work on insects revolved around their biological habits and descriptions thereof. Flea discussions were handled, at least by Albertus, in a straightforward manner without much reflection on what the fleas' capabilities could or did mean for humans.

The invention of the microscope in the late 1500s, during the Scientific Revolution, was a turning-point for scientific investigation and discovery. The microscope was particularly vital in improving human understanding of the minuscule, such as the flea. In 1664, a Fellow of the Royal Society, Robert Hooke, published *Micrographia*. This work was one of the earliest known writings in which the author utilized the microscope in his scientific endeavors. Hooke took whatever matter he found, living or otherwise, and put it under his homemade microscope. He examined flint sparks, sand, fish, metals, glass, cloth, and whatever else he could locate. In addition to detailed descriptions, he included illustrations of the images he saw under the microscope lenses. Eventually he resorted to investigation of insect life.

In his preface, he stated, almost in awe, that "by the help of microscopes, there is nothing so small, as to escape our inquiry; hence there is a new visible World discovered to the understanding."²⁰ Being an educated Englishman during the Scientific Revolution and the height of English exploration may have influenced his language, especially when he associated the microscope with opening a "new visible World" of possibilities. Furthermore, it is difficult to

ignore his enthusiasm for this advanced scientific machinery. His enthusiasm carried over to his notes on the flea as viewed through this new miracle invention. He began his observation on the flea with the declaration that “the strength and beauty of this small creature, had it no other relation at all to man, would deserve a description.”²¹ Already the language is different than others who produced notable work on the flea. Neither Aristotle nor Albertus used the terms “strength” or “beauty” to describe the flea. Hooke was captivated by the minute creature he saw with his microscope, yet, given a reading of his other entries, he was enthralled by almost everything examined under his microscope; he had a passion for nature. His entry on a bookworm enthused, “I cannot chuse but remember and admire the excellent contrivance of Nature.”²²

The rest of the observation is short but extremely detailed. He noticed that the flea was “all over adorned with a curiously polish’d suit of sable Armour, neatly jointed,” and proclaimed that its “strength, is very plainly manifested, such as no other creature, I have yet observ’d, has anything like it.”²³ His descriptions denoted a sense of awe and admiration towards this little creature. In the same manner as Albertus, he told of the red spots left behind after the flea is done feasting. Although the detail of his descriptions was unrivaled by those before him, he also chose to depict the observed flea in an illustration. The illustration is a fold-out, encompassing four pages, with the various appendages and parts of the flea labelled. It is probable that Hooke was not the first to see a flea under a microscope but he was one of the earliest to publish his findings. Moreover, the tone and way he imagined and depicted the flea are rare in that they reflected fascination with the flea as its own entity, possessing strength and beauty. His scientific curiosity was strong but his glowing remarks about the flea provide a different perspective about his thoughts.

Antoni van Leeuwenhoek, a Dutch microscopist, published works in the 1670s about his microscopic discoveries. Leeuwenhoek's works are cited more than Robert Hooke's although Hooke's discoveries likely influenced Leeuwenhoek. Howard Gest's "The Discovery of Microorganisms by Robert Hooke and Antoni van Leeuwenhoek, Fellows of the Royal Society" compared the language found in Leeuwenhoek's and Hooke's works. Gest referred to their discussions of the louse and mentioned that "in this regard, the Dutch scientists say: 'In all probability, there is a reference here to R. Hooke.'" Gest continued with his assessment: "there is little doubt that Leeuwenhoek had access to information in *Micrographia*."²⁴ Frank N. Egerton also noted the influence that Hooke had on Leeuwenhoek: "Leeuwenhoek saw a copy of Hooke's *Micrographia* (1665) and – though he could not read the English text – became intrigued with the illustrations of microscopic investigations."²⁵ Although probable that Leeuwenhoek eventually received a translated version of Hooke's work, it was the illustrations that first attracted him to *Micrographia*. Both Gest and Egerton noted Leeuwenhoek's lack of education but eventually Leeuwenhoek's more advanced discoveries eclipsed Hooke's. With this perspective in mind, Hooke's earlier microscopic investigations should not be underrated, dismissed, or forgotten.

Leeuwenhoek's legacy includes, but is not limited to, being known as the father of microbiology and microscopy. He was neither the inventor of the microscope, nor the first to use the instrument in scientific research, although he was the first to see tiny life such as bacteria and protozoa.²⁶ In 1807, Samuel Hoole translated into English and published both volumes of *The Select Works of Antony van Leeuwenhoek*.²⁷ Much like Hooke a few years prior, Leeuwenhoek examined everything he could under his microscope, including fleas. His microscope was more powerful than Hooke's, and Leeuwenhoek, in comparison to Hooke, devoted a substantial amount of space in his work to the flea.

In his second volume, Leeuwenhoek penned over ten pages of observations and experimental notes about the flea. His most important contribution was his revelation that fleas, contrary to what Aristotle, Albertus, and others believed, did not originate through spontaneous generation, but rather from eggs laid by female fleas.

I have now for several years observed Fleas to lay eggs, and from such of the eggs as were fruitful, maggots produced, which maggots were afterwards changed into Fleas as before described.

Since we see then so plainly, that the Flea is endowed with as great perfection in its kind, as any large animal, all whose limbs may be seen with the naked eye, can any one give credit to the idle tales of old? one asserting that Fleas are produced from sand; another, from dust; and another from the dung of pigeons; and lastly, from urine: for that Fleas can be produced from dust and filth, I utterly deny, as appearing to me impossible.

He was probably referring to Aristotle and Albertus, at least, when he expressed his incredulousness at the notion that humans could still believe such nonsense about the spontaneous generation of fleas. This knowledge was vital to the advancement of information known about the flea. Whereas Hooke had a brief description of the flea that he saw under his microscope, Leeuwenhoek's writings were in-depth and thorough. Although Leeuwenhoek's language suggests that he was not as inspired by the flea as Hooke, in the previously cited passage, he emphatically wrote "that the Flea, is endowed with as great perfection in its kind, as any large animal."²⁸ Leeuwenhoek's enthusiasm for the flea was muted in comparison to Hooke's but he was not completely unmoved.

Botanist Carl Linnaeus, the father of taxonomy, played a minor role in the classification of fleas. In 1758, in his tenth edition of Systema Naturae, he classified fleas as Insecta within the kingdom Animalia.²⁹ It was not until 1825 when fleas were ordered as Siphonaptera. It was even

longer before they were assigned to the phylum, arthropoda. Linnaeus appeared to have solidified the species name for the human flea, *Pulex irritans*, given the way in which *Pulex irritans* is referred to in a bevy of scholarly articles and flea research. The author of an article discussing differences between species, for example, noted that “it is essential that there should be a firm basis for our concept of *Pulex irritans* Linnaeus, 1758, for his description mentions both Europe and America and therefore may well have applied to a mixture.”³⁰ Other literature adds “Linnaeus, 1758,” after *Pulex irritans*, clearly illustrating Linnaeus’ small contribution to the body of knowledge surrounding the flea.

Humans have studied insects long before the Victorian period, yet it was not until the mid-1800s that there was a sharp increase in interest in the study of insects. Eventually this interest evolved into a discipline, entomology. Additionally, it was not until the early 20th century that entomology became a part of formal education and legitimized as a profession. During this period of heightened entomological fascination, attention given to fleas and to understanding them was relatively sparse, especially in comparison to other insects. That did not mean that fleas were completely ignored; there were reference materials that offered new information about the flea. Insect collecting and amateur naturalist pursuits of insect knowledge contributed to more definitive classifications and discoveries, even of the flea. In addition to the rise in publications seen as natural history reference materials, thoughts about insects changed. Charles Darwin produced some of this period’s most important works about humans, animals, and their behaviors. Despite this period’s heavy contributions to entomological discovery, some insects, particularly fleas, still suffered from a dearth of biological and scientific information that focused on them.

In 1849, an updated and revised edition of Oliver Goldsmith's *History of the Earth and Animated Nature*, first published 1774, was released. An entry on the flea, less than a page in length, was included in this volume. Unlike Robert Hooke's more romanticized description of the flea, this entry portrayed a negative view of the flea. Additionally, some of the descriptive language was derivative of Hooke's *Micrographia*. The entry began with the statement that "there are few but are well-informed of the agility and blood-thirsty disposition of the flea; of the caution with which it comes to the attack; and the readiness with which it avoids the pursuit."³¹ A few sentences later, the author directly referred to the flea as the enemy of man and animals alike.

The second paragraph of this entry described the flea physically. "The body appears to be all over curiously adorned with a suit of polished sable armour, neatly jointed, and beset with a multitude of sharp pins, almost like the quills of the porcupine."³² This was almost the same wording used by Hooke, centuries earlier, to describe the flea. The entry stated that the physical description of the flea is what would have been seen if examined under a microscope. It is probable that the author of this entry was familiar with Hooke. What is unclear is why Hooke's work was not cited as it seems too improbable to be coincidental that the wording was practically without variation. Perhaps Goldsmith did not think there was room for improvement on Hooke's work.

Goldsmith's entry briefly mentioned the strength of the flea. The entry referred to the flea's strength in the same context as Hooke, in relation to its legs and great jumping abilities. "When it leaps, they all spring out at once, whereby its whole strength is exerted, and the body raised above two hundred times its own diameter."³³ Hooke's words were similar; "these six leggs he clitches up altogether, and when he leaps, springs them all out, and thereby exerts his

whole strength at once.”³⁴ Goldsmith’s entry, again, has seemingly borrowed from Hooke’s work. Leeuwenhoek, though his wording was different, also noticed the power of the fleas’ legs, “now if we reflect on this wonderful and complicated formation of joints in a Flea’s leg, we shall cease wondering that it can leap to so great a height as we see.”³⁵ The raw jumping power within the legs of the fleas captivated all those who studied them.

What was newer to Goldsmith’s entry, at least in relation to earlier works from Aristotle, Albertus, and Hooke, was the description of young fleas. Although Leeuwenhoek offered an illustration of the fleas’ eggs, he was less concerned with their physical description and more interested in where they originated. Goldsmith’s entry described the eggs and the worms that sprung from these eggs. The passage mentioned: “if they are touched at this time, they will roll themselves up in a ball; soon after this they begin to creep like silk-worms that have no legs.”³⁶ The rest of the paragraph, and entry, detailed the changes from a young flea into an adult. This information on the eggs and larvae was important. Aristotle recognized that fleas laid eggs but he did not understand from where the fleas’ eggs originated. Goldsmith’s description omitted Leeuwenhoek’s crucial revelation that fleas did not spontaneously generate although that information was known for over fifty years. Although the information included was not entirely new or groundbreaking in 1849, it seems to have been more accepted as it made its way into a popular and long-running series like *A History of the Earth and Animated Nature*.

Entries on fleas appeared in many reference materials from the Victorian age but a body of work devoted to the agile insect was still lacking, especially in comparison to research surrounding other insects. In 1833, the Entomological Society of London was formed. “Within the sciences, the spirit of reform often manifested itself as an increasing self-consciousness and a desire to secure a collective identity for expert talent.”³⁷ Entomologists wanted to legitimize their

profession and to be taken seriously. Many had focused their research on insects years earlier and thought it was time to associate professionally. J. F. M. Clark, in *Bugs and the Victorians*, gave several reasons for the increase in interest in bugs, especially during the latter half of the 19th century. The reasons included renewed discussions relating to science, nature, and religion. “As the post-Enlightenment faith in science grew in the nineteenth century, systematic knowledge of the natural world became associated with objective authority, shorn of obvious political and religious sectarianism.”³⁸ Science quickly became more of an authoritative voice in regards to how the natural world functioned while faith in religious teachings, regarding the history of the natural world, began to wane. Additionally, there was an increase in literacy; more powerful printing presses; and an increase in leisure time, at least for the upper classes.³⁹ Scientific pursuits during the Victorian Age were typically undertaken by those with the wealth and leisure time necessary for such research, travel, and collection development. Those elites, who most likely did not live in crowded, dirty areas, may not have been exposed to fleas as much as the lower classes. This might be why fleas were not an insect of interest to them.

Clark’s work gave a few possible explanations that could be used to understand why there was interest in some insects over others, such as fleas. There were two main arguments. First, studies relating insects to agricultural practices were the focus during much of this period, especially the mid-1800s. Second, insects that were social creatures and reminiscent of humans were studied with more fervor. Clark combined both points in his third chapter on bees and ants; “in the early nineteenth century, naturalists discerned the practice of slavery within certain species of ants and thereby further confirmed the insects’ proximity to humanity.”⁴⁰ Bees were studied for similar reasons although they had agricultural and economical value as well.⁴¹ Later,

flies and beetles would become foci, due to their environmental impacts and the flies' perceived abilities to transfer disease.

In 1893, a few years before the discovery of fleas as vectors of disease, the *Encyclopedia Britannica* published its newest edition. In one of the lengthiest reference entries regarding fleas to date, it gave the classification history and biological details of this under-examined insect. The entry said as much too; “much attention does not appear as yet to have been paid to the *Pulicidae* by naturalists, except as regards the anatomy of the common species.”⁴² At the beginning of the entry, *Pulicidae* is described as the family which fleas belong to, possibly stemming from *Pulex irritans*, which was the name for the common, or human flea. The order to which fleas belonged was still up for debate; “its position in classification has long been somewhat undecided; a separate order was erected for it and its allies under the various names of *Suctoria*, *Siphonaptera*, *Ropheteria*, and *Aphaniptera*, by De Geer, Latrielle, Clairville, and Kirby respectively.”⁴³ Fleas were also associated with the order which included flies, *Diptera*. *Siphonaptera*, though contested, eventually became the accepted terminology for their order. This lack of a commonly accepted classification for fleas reflected the lack of attention paid to fleas by naturalists and entomologists.

The entry did not solely refer to fleas but also discussed them in conjunction with other insects, such as flies and jiggers, and their orders. Additionally, the entry mentioned naturalist William Dall and his take on flea circuses. Encyclopedia Britannica noted the powerful jumping capabilities of the flea and mentioned that circus fleas were “trained” not to jump. The entry sent the reader to Dall for more information on the “training” of these fleas while maintaining a skeptical attitude towards the idea of “educated” and “trained” fleas. Although the entry referred to additional sources concerning taxonomical information about fleas, Dall was the only

reference given for flea circuses. Despite the slowly expanding knowledge about fleas, their ability to jump great heights was relatively unexplored and it was not known how their saltatorial appendages biologically functioned. Moreover, the language used in this entry varied from previous works, most notably Robert Hooke and Oliver Goldsmith. This indicates that more original work was being done on the flea while previous works were emphasized less. This transition reflected ideas culled from the Scientific Revolution and a more widespread interest in natural history during the Victorian era.

A turning-point in the study of fleas was reached during the final years of the Victorian period. For the first time in flea history, their role as vectors of disease was scientifically determined and recorded. The *History of Entomology* gives a brief history of that discovery. These discoveries were not made until the 1890s; “it was 3 years after Kitasato and Yersin independently in 1894 described the bacilli, that Ogata in Formosa confirmed suspicions that rat fleas were carriers by infecting mice with suspensions of fleas from plague rats.”⁴⁴ That these discoveries were made in the East and not the West is telling. English scientists, as shown in Clark’s work, were concerned with insects that affected their location of residency, England. Climates vary between eastern Asia and England and although the plague had affected Europe during various periods, England was having more problems during the 19th century with flies and beetles. Fleas were accepted as pests but they were not worthy of much serious attention until it was determined that they were responsible for the transmission of certain diseases.

The slow rise of entomological studies before the Victorian period, combined with the professionalization and rapid increase of scientific disciplines during the later 19th century, added to scientific and biological knowledge about the flea. Although the flea was under-researched in comparison to other insects, more were recognizing this lack of interest. Following the Victorian

era, naturalists and entomologists during the Progressive period continued to add to entomological studies and explore the world of fleas.

With the discovery of the connection between fleas and disease came an invigorated interest in fleas. This interest was less about their historical and cultural significance and more about determining and classifying the individual species, especially concerning the species who could transmit the plague to humans. Rennie W. Doane and Harold Russell both produced works that discussed the flea, in part and in an entirety, that were innovative and examined fleas on a level of depth not commonly seen before. Doane gave an overview of some of the insects that transmit disease as well as the diseases they carried. Russell focused more broadly on fleas.

Rennie W. Doane was Assistant Professor of Entomology at Stanford University. Doane, a professional entomologist, wrote that “the subject of preventative medicine is one that is attracting world-wide attention to-day. Looking over the titles of these articles and books the reader will at once be impressed with the importance that is being given to the subject of the relation of insects to some of our common diseases.”⁴⁵ A quick search of “the flea,” through WorldCat, an online database with access to materials from over 10,000 libraries, proves his point. Searching through their available archival material shows a lack of published materials about the flea, in any context, before 1906. After 1906, listings for materials on the flea jump dramatically. In 1906, there were eight listings. In the following years, 1907 and 1908, there were a handful less but there were more listed for those three years than for most of the 18th and 19th centuries. Most of these works focused on specific species and their abilities to transmit diseases.

The ninth chapter of Doane’s work, “Fleas and Plague,” focused on the fleas’ capabilities for transmitting diseases. There is a brief discussion on the habits and physical appearance of the

flea. Compared to previous language used to describe fleas, the language used by Doane was tailored to illustrate the recent pathological discoveries. He started with, “a study of the structure and habits of fleas shows that in many respects they are particularly adapted for spreading such a disease as bubonic plague.”⁴⁶ The rest of the descriptions discussed their physical features, such as their proboscis and mandibles, in relation to how fleas use those features to bite and feed on humans and other mammals. There was no discussion of the beauty, strength, or intelligence of the flea, nor was there whimsy in the tone of the author. If the author saw any inspiration coming from the flea, it was hidden. Discourse about fleas had taken a sharp biological, taxonomical, and anthropocentric turn during the early 1900s.

“So far as I am aware, no book, devoted to what is known about fleas, has ever been published in English. The statement about these insects in the general text-books of entomology are frequently antiquated and inaccurate.” The previous statement comes from Harold Russell’s book, *The Flea*, published in 1913. A few paragraphs later, he argued that “the scientific study of fleas has, however, received much impetus since it has been ascertained that they are active agents in spreading plague.”⁴⁷ Harold Russell was a fellow of the Zoological Society in England, yet he attempted to write without using overly esoteric scientific jargon. He wanted to write not solely for entomologists but for others who may not have been intimately acquainted with the existing work on fleas.

Russell was correct in his assumption that no books about fleas had been published in English prior to 1913. There were entries in reference materials but not much else. He commented that “the naturalists now living who have devoted any time to the special study of fleas may almost be counted on one’s fingers.”⁴⁸ He expressed a special gratitude towards Charles Rothschild, who had one of the largest flea collections in the world. Rothschild, along

with colleague Karl Jordan, had been credited with the discovery of the plague flea, the Oriental rat flea. Russell's reasoning for writing the book on fleas involved their connections to disease; he thought that "a knowledge of the different species has suddenly become useful."⁴⁹ The work is roughly 100 pages and features eight different chapters. These chapters included "the external structure of a flea," "the mouth-parts and sense-organs," "the internal organs of a flea," "the Human flea and other species," "the Chigoes and their allies," "fleas and Plague," and "rat-fleas and bat-fleas." The selection of chapters demonstrated the anthropocentric shift in the study of fleas. Although Russell described the internal and external structures of certain fleas, the information was presented in the context of the ability of fleas to infect humans with diseases. The specific species of fleas were those that were closest in proximity to humans. This was the most complete work focused on fleas to date.

Russell mentioned a German work entitled *Die Flohe*, authored by Otto Taschenberg and published in 1880, and remarked that "although the author only describes 30 species, his book forms the basis of all subsequent scientific work."⁵⁰ Curiously, neither Aristotle's nor Robert Hooke's works were listed in Russell's bibliography. There were no listed references to encyclopedias or other such materials. He did list a variety of works by Charles Rothschild as well as Doane's book. This is an indication that the information known about fleas was evolving and that those omitted works were outdated and unnecessary to reference in his book.

Russell mentioned the order to which fleas belonged, based on previous works by Taschenberg and Pierre Latrielle. He credited Latrielle with giving fleas their own class, Siphonaptera, in 1825. In his introductory chapter he referred to the ordering of fleas and offered his opinion on how they should be further classified within the hierarchy of the class, Insecta.

The position which should be assigned to the order Siphonaptera in the general

scheme of insect classification is a question on which the most learned modern entomologists have disputed with considerable vigour. Some see the nearest relatives among the beetles, others among the flies. The majority, as we shall see later on, would place them near the Diptera: but since no convincing arguments have been produced on either side it may be wisest to regard the question as still at present unsolved.⁵¹

The ongoing discourse about orders suggests that amateur and professional entomologists did not know as much about fleas, their origins, and similarities as they knew about bees, ants, and beetles. Due to the writings of those in the field, such as Doane and Russell, more scientific information was being disseminated. More importantly, this information was being discussed and debated in a professional and scholarly atmosphere.

By the end of the Victorian period, fleas could no longer be overlooked by humans or thought of as harmless but inevitable pests. From antiquity through the Victorian period and into the Progressive era, scientific discoveries about the flea had advanced. After fleas were discovered as vectors of disease, scientific study of these insects and their life cycles was undertaken with more enthusiasm by entomological professionals. Fortunately, neither the plague flea nor the human flea was especially prevalent in the United States. Fleas were, however, considered a household pest, which was partially due to the increased amounts of pets kept by families in England and the U.S. Before the plague vector discovery occurred, however, there were others who were working with fleas, for various reasons, who made discoveries pertaining to their jumping abilities, strength, and supposed learning capabilities. Some of the most accurate information about fleas, their life cycles, and their other natural abilities came from those who were not professionals and who were, at best, accidental amateur naturalists, Louis Bertolotto and William Heckler. Bertolotto and Heckler, who worked closely and

extensively with fleas, via their flea shows and circuses, made essential contributions to the discourse about fleas and their supposed intellectual capabilities.

Fabled Facades

During the early Victorian period, Louis Bertolotto, the prominent flea circus master, rose to fame. Bertolotto referred to himself as the “original inventor” of the flea circus and performed in Europe and New York, beginning around 1833. During the Progressive period, another flea circus master, “Professor” William Heckler, became well-known in the flea circus business. William Heckler began his flea circus in the early 1900s and his son continued it into the 1960s. Bertolotto and William Heckler were at the top of the flea circus echelons. Bertolotto and Heckler tirelessly promoted and traveled with their fleas. The two men had a deep understanding and respect for their fleas that elevated these showmen, especially Bertolotto, to the status of published naturalists. Their contributions to the study of the flea are ignored and typically dismissed. More importantly, their work with fleas is vital to understanding the ongoing debate about insect intelligence and their possible learning capabilities, which reached new heights during the Victorian period.

In Clark’s *Bugs and the Victorians*, he wrote that “in the last quarter of the nineteenth century, therefore, emergent professional scientists increasingly rejected the categories of ‘naturalist’ and ‘natural history’ as old-fashioned.”⁵² Naturalist, as it relates to Bertolotto and the Hecklers, is a more appropriate term than entomologist. Entomology, the formal study of insects, has a professional connotation. Naturalist denotes an amateur or hobbyist status of those who study insects and other living creatures, often in their natural environment. Bertolotto and, to a lesser extent, William Heckler, were showmen who were transformed into naturalists through their work with fleas. This was probably not their intention but a closer examination of their writings demonstrates their understanding of the natural habits of fleas. Bertolotto especially

worked hard to prove that he was knowledgeable about fleas whereas the Hecklers' were focused more on entertaining their audiences.

Louis Bertolotto and William Heckler both published promotional pamphlets about their shows. Analyzing their pamphlets gives insight into their thoughts and actions while providing information that other sources cannot. Newspapers from their respective eras were often filled with minute to lengthy articles detailing their shows and their alleged expertise in the world of fleas. As with most promotional material, it is wise to keep in mind the nature and motives of these publications. Bertolotto and Heckler were entertainers. Exaggeration of the feats of fleas, slight or otherwise, was not always necessary to gain an audience but it was a way of attracting people to their shows. There are other materials about the prowess of fleas which can be used to corroborate their promotional materials. Their works, especially Bertolotto's, were often noted within reference materials as well as critiques and works on flea circuses. It appears that Bertolotto and Heckler only slightly exaggerated their claims; their knowledge of fleas was gained through observation and experimentation. More importantly, they kept an open mind about the physical and mental abilities of fleas.

The jump from fleas as pests to presentable performers began in 1578. A watchmaker, Mark Scalliot, wanted to show off his trade skills. Scalliot

forged his place in history by making "for exhibition of trial and skill" a lock of iron, steel, and brass that, with its key, weighed "but one grain of gold." Scalliot connected this tiny lock to a thin gold chain of 43 links and fastened them "about the neck of a flea, which drew them all with ease. All these together, lock and key, chain and flea, weighed only one grain and a half."⁵³

This was remarkable. Although the specific species of flea Scalliot used is unknown, sanitary conditions in Europe during the 1500s were severely lacking; it is not unreasonable to assume that it could have been a human flea, or *Pulex irritans*. Over the next few centuries, tradesmen attempting to showcase their various skills worked to chain, tie, and manipulate fleas to the best of their human abilities. During the 1800s, for reasons unknown, the manipulation of fleas for entertainment purposes became widespread with the most prevalent form being the flea circus.

Louis Bertolotto, the self-proclaimed "original inventor" of the flea circus, was perhaps the first major flea circus proprietor. Not much is known about Bertolotto's personal life and earlier years except that he was from Italy and was bitten by the showmanship bug in the 1830s. During the mid-1800s, Bertolotto performed thousands of flea circus shows, primarily in England, Canada, and the United States.⁵⁴ He was a showman but through his extensive interactions with his circus performers, he became familiar with their habits and abilities. During his enduring tenure as a flea circus master, he had the chance to observe his performers in their natural state and in their capacity as "trained" performers. Whether by choice or by accident, Bertolotto became a knowledgeable expert on the human flea, perhaps on par with insect naturalists of the period. Bertolotto possibly knew more about fleas than other naturalists as fleas had not been the subject of much research during the Victorian Age.

In 1876 Bertolotto published the fifth edition of his pamphlet, "The Curious and Amusing Exhibition⁵⁵ of the Educated Fleas: with notes, observations, and interesting anecdotes."⁵⁶ This promotional brochure was more than just a program of his various shows. It was a compilation of what Bertolotto had learned about fleas. From breeding to feeding, he provided a keen insight into the trials and tribulations of being a great and prominent flea circus owner. Although

Bertolotto's pamphlet heavily referenced other flea related materials, it did provide some of the most up-to-date information on the biological habits of the flea available during the mid-1800s.

Bertolotto started with a description of the fleas' eggs and their larval stage. This information was accurate but the wording was reminiscent of the section on fleas in Oliver Goldsmith's 1849 edition of *A History of the Earth and Animated Nature*. As a caveat, it must be noted that the first edition of Bertolotto's pamphlet was published in 1835, fourteen years prior to the edition referenced by Goldsmith. Goldsmith's *History* did begin publishing editions in 1774 and while it is uncertain if the information originated with Bertolotto or Goldsmith, it is more than likely that Bertolotto borrowed from Goldsmith especially considering that Bertolotto possibly cited Robert Hooke's work as well.

Goldsmith's entry described the fleas' eggs and larval stages

The young fleas are at first a sort of nits or eggs, which are round and smooth; and from these proceed white worms, of a shining pearl colour: in a fortnight's time they come to a tolerable size, and are very lively and active; but if they are touched at this time, they roll themselves up in a ball: soon after they begin to creep like silk-worms that have no legs.⁵⁷

Compare to Bertolotto's description of the same biological processes

Fleas bring forth eggs or nits, which they deposit on animals that afford them proper food. These eggs being very round and smooth, usually slip straight down, unless detained by inequalities of the clothes, hair, &c. From these eggs are hatched white worms, with a brilliant pearl like color...in a fortnight they come to a tolerably fair size, are very lively and active, and if at any disturbed, they suddenly roll themselves into a kind of ball. They begin to creep two days after being hatched, after the manner of silk worms.⁵⁸

Bertolotto added some of his own wording yet the language is similar to the section from Goldsmith. Some of Bertolotto's added wording was quite different. It is unclear, for example, why Bertolotto mentioned the eggs dropping straight down unless they are detained by clothes or hair. Perhaps Bertolotto was trying to educate the public about how fleas infest human bodies and their dwellings, as a cautionary measure. A few pages later, Bertolotto used the most common phrase seen in flea reference materials for this period, "when examined by a microscope," and followed with a description of the flea's scales.⁵⁹ This most likely referred to Robert Hooke's work, *Micrographia*, which was also mentioned by Goldsmith. Robert Hooke was one of the first to view a flea under a microscope, during the seventeenth century. Various definitions and concepts of fleas were simply repeated with additions by those who used the information.

Bertolotto gave an in-depth physical description of the *pulex irritans*. He described the legs, armor, and feelers and noted that "its eyes are large and beautiful."⁶⁰ That statement captures the fascination and respect that Bertolotto had for the human flea. He thought of them as complex creatures with extraordinary strengths and skills. Bertolotto was deeply intrigued with these creatures and their abilities. Although small, the human flea was tough and easy to train. The *Pulex irritans* lived longer, was bigger in size, and was stronger than most other species of fleas. They were simple, yet marvelous creatures.

Illustrating the physical prowess of the flea, Bertolotto gave examples of what he had seen his fleas accomplish. Bertolotto claimed that one flea could move a tiny ship weighing fifty grains. A grain is a unit of weight equal to .065 gram. Over fifteen grains compose a gram. For humans, this is a minute amount of weight but for the *pulex irritans* it was massive. As a point of comparison, Bertolotto stated that a fully fed flea weighed about one-tenth of a grain. He was

astonished to realize that this flea could easily pull along the ship, which, per Bertolotto, was about five hundred times its size.⁶¹ This strength is what made them perfect for his minuscule circuses. Often, he rigged the fleas to pull trains, ships, and carriages, among other objects. Bertolotto was not the first to notice the amazing strength of the flea but his experiments with fleas and their strength were more in-depth than others who had worked with fleas before and during this period. Although his experimentation revolved around perfecting his show, he was one of the first to keep detailed notes on the physical strength of the human flea.

Not all species of fleas were capable of these amazing feats. Bertolotto was intent on using human fleas. He explained that other fleas, such as dog fleas, were not as hardy as human fleas. Furthermore, he did not relish the idea that dog fleas had to be fed several times a day. He claimed that his human fleas had to feed about once every four days.⁶² This was practical. Feeding your performers several times a day, on different hosts, would have been time consuming. Charles Dickens, writing for *Household Words* in 1856, described his visit to Bertolotto's shop and reported that the fleas "were luckily chained, or fastened in some way or other, so that the escape and subsequent feasting upon visitors was impossible... [although] they have their supper, and in the morning also their breakfasts, upon the hand of their owner – sometimes he has nearly all his fleas on the backs of his hands at the same moment, all biting and sucking away."⁶³ If Bertolotto used his body for his fleas' sustenance, every few days, he could conserve his time and energy for other endeavors.⁶⁴

Using *pulex irritans* was a must but Bertolotto was also insistent that his fleas come from specific locations. An article from the *Sydney Mail* of 1876 claimed that Bertolotto's fleas were "brought from Canada, the professor making the delightful announcement that fleas are extremely scarce in the United States."⁶⁵ The article did not state why Bertolotto seemed to

prefer Canadian fleas or why he was delighted about the scarcity in the United States. Curiously, his pamphlet does not mention his geographical preferences for fleas.

Just as Bertolotto was nitpicky about the species of flea used for performances, he was fussy about their gender. He stressed that "the supporters of the women's rights movement will be delighted to know, that my performing troupe all consists of females, as I have found the males utterly worthless." He observed that male fleas are typically half the size of females, while being "excessively mulish and altogether disinclined to work."⁶⁶ He claimed that males were more obstinate than the females. Using fleas that were smaller and weaker, who also exhibited an uncooperative attitude, would not bode well for his flea circus. Although Bertolotto was not the first to realize the physical differences, he discovered these differences by observation and experimentation and then documented his findings. His discoveries had practical and entertainment value while simultaneously adding to the body of knowledge known about the flea.

Over a century after Bertolotto's observations, Russian biologist Boris Krasnov also described the difference between the sexes. Species differ to varying degrees. The *Pulex irritans* is a species with visible sexual differences, as Bertolotto noticed in the 19th century. Unlike Bertolotto, Krasnov did not view the males as worthless. He stated several findings about their behavior which could explain Bertolotto's derogatory outlook toward the males. Krasnov discovered that "males have no role in reproduction besides mating. As a result, females are generally more mobile than males and have greater locomotory ability."⁶⁷ To a trained parasitologist, these are not signs of worthlessness; they are just basic biological differences between the sexes. To the flea circus proprietor Bertolotto, it was those missing qualities that made the males ill-suited for his performances.

Although Bertolotto had an interest in keeping his fleas alive, his constrictive training efforts were not always humane. Bertolotto wrote "that in order to fasten anything to the fleas, I must first tie a band of the finest silk around their waists, secured by a knot on their backs, upon which anything I wish to fasten, may easily be gummed." Previously he claimed that he was unable to use any sort of glue or other adhesives directly on the flea because the fleas had such polished scales.⁶⁸ At one point, Bertolotto had tried to use glue and adhesives on the fleas. It is unknown if he used glue on his fleas for purposes of experimentation or entertainment. For his show, he instead affixed a knot on their chain on which he attached various props. Although it was not as cruel as being directly glued to something, having to be chained to circus paraphernalia for almost the entirety of its short life could not have been optimal for the flea. To Bertolotto's credit, a news article in the *Sydney Mail* from January 22, 1876, reported that Bertolotto did remove the fleas from their "harness of threads once a day to be fed."⁶⁹ That statement was contrary to what Charles Dickens seemed to imply but it is possible Bertolotto fed them chained and unchained. He also kept boxes of back-up fleas that he did not use in his regular performances. These fleas were not confined to harnesses. Although fed on a regular basis and kept alive as long as possible, his performing fleas were dependent on the whims and fancies of Bertolotto.

Apparently Bertolotto was seen by some to be abusive toward his fleas, as he responded in his pamphlet, "some people have raised a cry, that I am cruel to my fleas, in making them do as they do; but this idea exists, only in their imagination, for few masters give so freely of their blood."⁷⁰ Yet he plainly illustrated his fascination and admiration for these creatures when he referenced an article he had read about fleas in Encyclopedia Britannica. He chided the author's inability to recognize the exemplary strength of the flea, remarking that "the extraordinary

strength of this little insect, has escaped the observation on the author, and which I found to be above all conception."⁷¹ He did not understand why the author failed to recognize the amazing talents of the flea. The author of the section on fleas was not the only one to fail to recognize the marvelous qualities of fleas. Flea circuses, and especially Bertolotto, faced criticism too.

One outspoken critic of Bertolotto was the naturalist William H. Dall. Dall's article, "Educated Fleas," was published in the *American Naturalist*, in 1877. The article's tone indicated that Dall was not an admirer of Bertolotto or his talents as a flea trainer. He wrote that "so far as my mind was occupied with the subject [flea circuses] at all, it had concluded on general principles that intelligent action, of the kind described in old works referred to, could be attributed to fleas with very little probability; and that, whatever the innate mental ability possessed by them, it was in the highest degree unlikely that it was susceptible of training."⁷² Dall was skeptical of the flea circus and of educated fleas. Given that he thought the subject worthwhile enough to write about, however, the subject clearly occupied his mind more than he admitted.

Dall recounted his visit to a flea circus in late 1876. He did not mention Bertolotto by name but he did discuss the pamphlet he received while at the show. The show was called "Exhibition of Educated Fleas," which was the name of Bertolotto's circus. Considering the date, 1876, it is apparent Dall was referring to Bertolotto. After watching the show, Dall declared that "the fleas are not educated."⁷³ Dall discussed Bertolotto's methods of "educating" fleas and he was not convinced. Dall stated that Bertolotto's fleas were placed in a box with a glass top and bottom; "after a few days of confinement herein, the flea, which in a state of nature is, as we know, excessively inclined to jump, becomes broken of the habit."⁷⁴ Dall did not accept that statement as truth and remarked that it would be difficult for them to jump with heavy objects

fastened to them. Bertolotto did not explain his training methods in his pamphlet but he did write that “by keeping fleas in a glass tube, corked up at both ends, so as to admit fresh air, their several actions may be more particularly scrutinized.”⁷⁵ Although hardly an admission of training methods, that statement does illustrate that Bertolotto was using glass tubes to experiment with and observe fleas and gives credence to Dall’s description of the training methods. It is probable that Dall learned that information from Bertolotto, either through observation or direct questioning.

Throughout the article, Dall cited examples from Bertolotto's pamphlet to prove that his fleas could not have been educated. His most compelling argument was that the fleas lived and performed whilst being chained. If Bertolotto’s fleas were educated, there would be no need to tie them to various apparatuses. His second argument claimed that the fleas' movements during their performance were attempts to escape their surroundings and whatever they were attached to.⁷⁶ Although manipulation was involved on some level, Dall did not even attempt to consider any other explanations for the mental or physical abilities of Bertolotto’s trained fleas.

Curiously, Dall’s article, while a critique of Bertolotto’s abilities to “educate” fleas, did not direct the readers to any additional material about fleas. More fascinating was the mention of Dall’s article in the 1893 edition of Encyclopedia Britannica.⁷⁷ Not only were earlier researchers of the flea borrowing from previous works but so were the flea circus proprietors who in turn influenced other encyclopedic and reference materials. As knowledge about the flea was reiterated, Bertolotto also added to it.

Bertolotto was aware of the skeptics. One of his acts featured a "wild" flea. The wild flea, as reported by Dall and *The Sydney Mail* in the late 1870s, had a ball and chain attached to one of its hind legs. The "wild" flea then jumped up and down furiously, supposedly indicating its

"unfitness to associate unrestrained with its civilized brothers."⁷⁸ Neither the *Sydney Mail* nor Dall mentioned a "tame" flea that was chained up for comparison. Referencing the latter, Dall argued that a flea fastened by one leg would look wild next to one that was completely chained to an object much bigger than a tiny ball and chain.⁷⁹ That could have supported Dall's point that the fleas were not educated, but it would have been poor showmanship if Bertolotto did not try to address the arguments against the education of his fleas.

Harold Russell, a fellow of the British Zoological Society, examined flea circuses in his 1913 work, *The Flea*. Although this work was written as a response to the recent discovery of fleas as vectors of disease, his chapter on the human flea briefly discussed flea circuses and the education of fleas. Russell commented that

this account of a despised and detested group of insects would be very imperfect if it did not mention those educated or performing fleas which have evoked so much astonishment among people who have watched them. It will be best to say, at once, that the fleas are not educated and that the performance can only be attributed to their desire to escape.⁸⁰

Like Dall, Russell described the "training" techniques and the performances which were designed to exploit the fleas' natural inclination to escape certain adverse situations. Dall and Russell dismissed the possibility that fleas could be trained to perform circus tricks. These critics maintained that the flea has natural instincts and that Bertolotto and other flea circus masters manipulated those instincts to portray them as being educated.

Missing from the severe critiques of the idea of educated fleas was a discussion or reference to Charles Darwin. Darwin, though he never specifically researched fleas, took an interest in the behavior of insects. Clark's *Bugs and the Victorians* summarized one of Darwin's

arguments: “Darwin refuted the possession of memories and language as attributes which distinguished man from animals; for ‘even ants’ recognized fellow inhabitants of the same nest after four months of separation, and communicated with each other using their antennae.”⁸¹

Darwin’s work would have been available to Dall and Russell yet it is possible that they were not familiar with his thoughts on the reasoning power of insects. Had they acknowledged Darwin’s work, it might have weakened their arguments. Darwin believed that non-human animals, including insects, possessed the capability to reason in addition to being able to respond to events instinctively. In *The Descent of Man* Darwin admiringly described the ant’s brain. He wrote:

No one, I presume, doubts that the large proportion which the size of man’s brain bears to his body, compared to the same proportion in the gorilla or orang, is closely connected with his higher mental powers. We meet with closely analogous facts with insects, for in ants the cerebral ganglia are of extraordinary dimensions, and in all the Hymenoptera these ganglia are many times larger than in the less intelligent orders, such as beetles.

Following this commentary was his brief caveat that potential for intelligence could not solely be determined by the size of brain or skull matter after which Darwin gushed, “under this point of view, the brain of an ant is one of the most marvellous atoms of matter in the world, perhaps more so than the brain of a man.”⁸² Although Darwin concentrated on the reasoning abilities of ants, similar arguments could be applied to fleas, especially in the context of the flea circus. Certainly, flea circus masters, such as Bertolotto, did manipulate fleas’ natural instincts. It took a keen eye, however, and a sense of wonder coupled with scientific experiment to recognize those instincts. Furthermore, it is quite possible, given the arguments of Darwin alone, that the fleas involved in these circuses might have had some mental capacity for reasoning. When the fleas were placed in a confined area designed to break them of their jumping habits, for example, it is

possible that the fleas associated pain with jumping and reasoned that if they did not jump, they would not continue to feel pain. For Dall, Russell, and other critics to immediately trivialize and diminish the fleas' capacity for intelligent reasoning was dismissive.

In addition to the skeptics' lack of references to Darwin, there were not any references to any other articles that were published which discussed the intelligence and reasoning abilities of fleas. One such article was published in the September 12, 1868 edition of *The Albion, A Journal of News, Politics, and Literature*. The author claimed that "the theory that animals think and reason, and their mental manifestations differ from those of mankind only in degree, has found a new advocate in Ernest Mensalt."⁸³ Finding information on Mensalt is difficult but that there were others besides Darwin who argued for insect intelligence was important. The article reported Mensalt's love for fleas stating that "he also claims for these inferior creatures the affections of parental love, and an emotional nature, capable of gratitude for kind treatment." Mensalt then cautioned that "while pleading, however, for the flea, we cannot do as much for the bug, though he is gifted with fuller developed intelligence."⁸⁴ Although Mensalt's wording suggests that he thought fleas did not possess an intellect as great as other bugs, his phrasing does not allude to a complete dismissal of flea intelligence. Darwin and Mensalt, however, were in the minority with their optimistic declarations of insect intelligence. Despite the skeptics of flea circuses, the circuses maintained their popularity throughout the rest of the 1800s and into the early 1900s. Many traveled with medicine shows or appeared at fairs and carnivals. Bertolotto's imitators and future heirs were many but none was as well-known as "Professor" William Heckler.

William Heckler came from humble beginnings in Switzerland. A journalist reported the following story, as told by Heckler

It was while traveling on the Mediterranean that I struck up an intimate acquaintance with the rapacious marauders [fleas]. Many craft on which I were shipped were waterlogged and unfit for travel, wallowing from port to port, unclean and infested by these minute demons. I remembered seeing in my childhood a strange old woman travel about our village, displaying a form of flea entertainment. To the subsequent amusement of the crew I began to capture and train a number of our pests. Having much idle time, I also made a miniature merry-go-round and other things that might be used in a show.⁸⁵

If true, the story provides an explanation of how Heckler became interested in flea circuses. If the story is nothing more than embellishment, it made good fodder for his future efforts at promoting his flea circus. Based on the vitriolic language used to describe the fleas, embellishment, whether on behalf of Heckler or the reporter, was a real possibility. William Heckler, perhaps more so than Bertolotto, was an entertainer.

Heckler's notoriety blossomed in New York City. Heckler had been perfecting pulex performances for years prior to 1925, when he was granted a permanent spot at Hubert's Flea Circus in the city. Hubert's was a "Coney Island-style dime museum with sword swallows and freaks and, of course, trained fleas."⁸⁶ Although the interest in flea circuses waned by the beginning of the 1950s, Heckler and his son, LeRoy (or Roy) Heckler, had the distinction of having the longest running flea circus in New York City.⁸⁷ Prior to his permanent residence in New York City, William Heckler was a traveling performer. After eleven years at Hubert's, William Heckler passed away. His death in 1936 was chronicled in newspapers nationwide. The show then passed on to his son Roy Heckler who performed with the fleas until the 1960s.

William Heckler, possibly inspired by Bertolotto's pamphlet, penned his own promotional brochure about fleas and his flea circus. Published in 1915 and entitled *Puli-cology*, Heckler's sixteen-page pamphlet was a slightly shorter version of Bertolotto's twenty-four page

Educated Fleas. Both Heckler and Bertolotto detailed the habits of the *Pulex irritans*. They had illustrations of fleas, but Heckler's were mostly performance based while Bertolotto's were more scientific. Heckler's pictures were of the fleas playing football or dancing instead of emphasizing their biological traits or life cycles. Heckler's writing was more accessible for the public and his choice of illustrations emphasize that accessibility. Both were mindful of the audience they were writing for and the materials reflected Bertolotto's and Heckler's desire for promotion.

There are not a lot of major differences between the writings of Bertolotto and Heckler. Heckler detailed the breeding of fleas. The information presented corroborated Bertolotto's and it appears that they were referring to the same flea, the *pulex irritans*. They used the same terminology and the breeding information was extremely similar. It would be difficult to imagine that they both misnamed the species of fleas. Heckler's language is different, however, in comparison to Bertolotto's but the information remained factual. Whereas Bertolotto referenced previous works on the flea, rarely exerting the effort to phrase the borrowed information with his own words, Heckler's writing was simplified, although it is possible that he too had consulted previous works on the flea. If he had quoted previous flea materials his language did not reflect it. Concerning breeding, Heckler wrote that "as with the rest of the insects the flea is either male or female, the later lays eggs from three to eight, varying with length of time she has been in the industry. The egg is so small that the naked eye might see it, but hardly discover it. It is after the type of a snake egg, but rounder and transparent."⁸⁸ The information is written in a way which is understandable and accessible to most of the population. Class considerations might explain why Bertolotto's writing aimed to be more knowledgeable and scientific whereas Heckler's language appears to be geared toward the middle and working classes. Bertolotto tried demonstrating that he was interested in attracting a more upscale and noble audience whereas Heckler seemed to

court anyone who would pay the admission fee for his show. The inclusion of a variety of demographical groups of audiences for these circuses demonstrated the shift from circuses, zoos, and museums, once seen as forms of educational entertainment for the wealthy only, to institutions wanting to attract members from all classes.⁸⁹

Heckler's pamphlet was more personal, whimsical, and anthropomorphic in approach. This was evidenced when Heckler described the emerging of a larval flea to an adult flea; "when it steps forth a full-fledged flea it is ready to face life with all its flea problems."⁹⁰ He compared the flea to humans when he assumed that they too had problems. Although, based on the drawings in Heckler's pamphlet, the fleas were without care. His depictions of fleas dancing as Hans and Gretel, along with a *pulex* Prince Henry the juggler, gave an impression of fancy and fun. Unfortunately, it was not always fun to be a flea, as Heckler illustrated in several sections of *Puli-cology*. Besides being unable to withstand severe climates, fleas had other problems. He stated that "many fleas shorten their lives by gluttony and over-breeding, especially in warmer climates."⁹¹ This was an important observation. Heckler, like Bertolotto, wanted his performers to live as long as possible. Gluttonous fleas could have had huge consequences. Although Heckler did not make any specific claims about the longevity of the flea, a shortened life span meant that Heckler's shows would have been more difficult to maintain. Regulating their feeding habits was necessary so that his flea circus business could flourish.

Unlike Bertolotto, Heckler devoted a substantial section in his pamphlet to the explanation of the phenomenon of itchiness that occurs when fleas are the subject of thoughts and conversations. "No doubt it has been observed by almost every individual that a conversation on mosquitos, fleas and other insects has made people scratch and actually feel a bite or sting." Having allegedly heard testimonials to this phenomenon from several people, Heckler believed

that the affliction was more imagination than reality.⁹² He claimed that this problem had nothing to do with the biology of the flea. It could be that Heckler was addressing the possible concerns of those who may not have wanted to attend his performances because they did not want to get bitten or itchy.

Heckler did not have trouble in attaining a reputation as a star flea circus proprietor. His fleas were well loved by those who visited his shows. One of his star performers was so adored by the public that its eventual passing was reported in several newspapers. The October 20, 1932, editions of the *Pittsburgh Press* and the *Milwaukee Journal* lamented the death of Paddy. The *Milwaukee Journal* reported that Paddy was an accomplished flea and mentioned the myriad of tricks he had performed. That article related that Paddy's death was caused by smoke inhalation during a fire in Pennsylvania.⁹³ Heckler was distraught at the loss of his star performer.

The *Pittsburgh Press* article did not deviate much from the article in the *Milwaukee Journal*, but offered a twist. As Heckler regaled the reporter with the tragic story of the fire that extinguished Paddy, he began to reach into a box. Heckler then pulled a flea out of the box, a flea he referred to as Paddy, the Irish flea. Seeing the reporter's confusion, he quickly explained that it was an understudy of Paddy's that he was training to perform his act.⁹⁴ Heckler was always the showman, even in the face of a supposed tragedy such as the loss of a well-known performer.

The articles on Paddy, the Irish flea, mentioned that Paddy performed 52,850 times. Heckler told the *Pittsburgh Press* that Paddy had performed for over six years and had been with Heckler for around ten years. Bertolotto, Dall, and Krasnov all wrote that human fleas typically do not live past a year. In rare circumstances, some fleas had been known to live longer than a year but as Bertolotto realized, those that did were often in bad health towards the end of their

lives.⁹⁵ It would have been impossible for Heckler to have one single flea that performed for over six years. Apparently, Paddy had had a lot of understudies.

Less than a month after Paddy died, there was an article in *The Pittsburgh Press* claiming that Heckler was looking for a new Paddy. This article claimed that the previous Paddy had died in a car wreck, not a fire. Heckler claimed that Paddy could do everything and that it was going to be difficult to find another as skilled as he was.⁹⁶ Paddy, the star flea, was integral to the promotion of Heckler's flea circus. Whenever a Paddy died, an obituary was published in newspapers along with a call for a replacement. Paddy seemed to have changed personalities. In October 1932, he was reported as being Irish while in November, his nationality was not revealed at all.

While the idea of the mistreatment of his fleas did not seem to have crossed Heckler's mind, he explained a test he performed to gauge the intelligence and reasoning abilities of the *Pulex irritans*. Before he began his discussion, he made note that there were secrets he would not divulge. His secrecy was borne from a worry about imitators in the industry.⁹⁷ Bertolotto exercised the same discretion when he wrote of his fleas. Though, as Bertolotto, Heckler did not bother to conceal some of his methods. Heckler explained one of his tests:

I place them in a glass jar with cotton. In order to determine its degree of intelligence and ambition, the bottle is held near heat; in a short while the atmosphere becomes warmer than preferred by the insects. The shrewd fleas immediately start on a trip of investigation. They circle the jar in as large a circle as the interior permits. When they return to the starting point, they stop for a moment; they then make a bee-line for the side opposite the heated one. This shows that they have reasoning power as to be able to distinguish which side is coolest.⁹⁸

As a self-proclaimed "Professor" and untrained scientist, Heckler performed these tests to observe and record their behavior. Unlike most trained scientists, Heckler used the knowledge

gained from his experiments to perfect the art of flea entertainment. As previously mentioned, it is worth considering Darwin's work with ants in respect to training and educating fleas. Unlike Bertolotto, Heckler specifically applied the term "reasoning power" about the fleas' training abilities. Heckler also wrote that "it is reasonable to suppose that all fleas came from one original pair; notwithstanding the many points of difference in appearance."⁹⁹ Although it is not for certain if Heckler wrote this as a declaration of his religious beliefs or as a further nod to Darwin, it did show that Heckler was engaged in the debate of the origins of life as well as their ability to reason.

William Heckler was a dominate force in the flea circus business at the time of his death in October 1936. Newspapers across the nation mourned the passing of the "Professor." *The New York Times*, *Milwaukee Journal*, and *The Pittsburgh Press* were a few of the papers to publish a tribute to Heckler, who had been a staple of New York City and traveling fairs for over thirty years. After his passing, his son Roy continued his father's work in flea entertainment. During the 1950s, Roy Heckler moved his flea circus to Sarasota, Florida. In 1957, the *Milwaukee Journal* told of Roy Heckler and "the country's last flea circus."¹⁰⁰ The newspapers claimed that by that time the human fleas necessary for flea circuses were difficult to locate. Pleas for fleas by Heckler were to no avail; the flea circus was on its way to becoming a novelty of the past.

In the 1800s and early 1900s, fleas were easier to procure. In an article from the August 24, 1931, issue of the *Gettysburg Times*, Roy Heckler, who was interviewed although his father was still alive, claimed he imported his fleas from the south of Europe.¹⁰¹ This could have been where his father, bored and on a boat with no escape, first created flea shows for his shipmates. As previously mentioned, Bertolotto supposedly received his fleas from Canada due to a dearth

of the insects in the United States. There was not a reason given for the scarcity of fleas in the United States, but it was clear that foreign fleas could be obtained with relative ease.

According to Roy Heckler, European fleas were better than the fleas from the United States, even if they were not scarce. "They've got energy and tenacity but their European cousins have the jump on them in more ways than one, it seems." Supposedly, "the species from Spain and Italy is the best performer of all-it's hardier and lives longer, and thus has time to get its act polished up for top billing."¹⁰² Roy Heckler compared human intelligence to fleas' intelligence in a different interview when he remarked that "some fleas, like human beings, just can't learn."¹⁰³ He did not directly refer to European fleas in the second interview. Unfortunately, Roy Heckler never specified how he arrived at that conclusion about European fleas. Whereas William Heckler was more of a showman than Bertolotto, the younger Heckler was even more focused on the entertainment aspects of the flea circus. Having learned about the flea entertainment industry from his successful father, Roy Heckler carried on his father's legacy and reputation for fun and fanciful flea performances.

The Hecklers, like Bertolotto, received recognition for their flea circus. Their circuses and their claims of trained fleas also received criticisms, like Bertolotto. Heckler's son, Roy, was the subject of Bill Ballantine's chapter on flea circuses in his work, *Wild Tigers and Tame Fleas* of 1958. Ballantine was a former circus clown and his chapter focused primarily on the Hecklers' flea circus and his writing gives the impression that he interviewed the younger Heckler.¹⁰⁴ His work was published when Roy was still performing. It must be noted that Ballantine did not cite any sources and offered no bibliography. He did not include any footnotes or endnotes. Even so, some of what he claimed can be substantiated through newspaper reports and other sources.

Ballantine started his chapter with a discussion of William Heckler and stated that “William Heckler was a Swiss who had shipped out as a merchant seaman on German sailing schooners. He made many trips across the Atlantic to America, finally remaining on these shores to become a circus strong man.”¹⁰⁵ This statement is compatible with Heckler’s recollection about how he became interested in flea circuses. Heckler mentioned that he was on a ship when he started experimenting with flea acts. He also recalled seeing a woman with performing fleas come through his village as a child; it is possible that he lived in a small European village. Although Ballantine could have been told the same story that was possibly crafted for publicity’s sake, this does lend some credence to William Heckler’s previous interview.

Ballantine described the elder Heckler’s journey from being a circus strongman to owning his own flea circus operation at Hubert’s Museum in New York City in 1925. Interestingly, he mentioned in passing that “flea historians are not numerous but George Jean Nathan, essayist and theatrical critic, has stated that the Flea Circus originated with a Professor Hupf in 1885 at Coblenz, Germany.”¹⁰⁶ It is difficult to believe that Ballantine could have written a whole chapter on flea circuses without mentioning any earlier flea circus masters, especially Bertolotto. Bertolotto was still performing around 1885 and it is unimaginable that Ballantine had not come across any information referring to Bertolotto. Perhaps Ballantine limited his information to what was told to him by Roy Heckler which could cast doubt on his assessments.

Ballantine mentioned the infamous Paddy the flea. He related the figure given by Heckler about the number of Paddy’s performances, almost 51,000, given over the course of his life. Understandably so, Ballantine was skeptical of Heckler’s claims about Paddy, “since the life of a trained flea is of about six months’ duration, the great Paddy at that age would have given during

his lifetime 8,479 ½ performances daily, which would have been a lot even at Coney Island in the old days.”¹⁰⁷ Ballantine, like other flea circus critics, remained unconvinced that fleas could be educated or trained. It is not known for certain if performing fleas were ever truly trained or educated. That fleas’ cognitive capabilities were being discussed openly, by entomologists, naturalists, and showmen alike shows a progression in how humans were starting to question non-human animals’ abilities to reason as well as their abilities to be educated. What is more remarkable is that these discussions benefitted from the work of flea circus proprietors.

As recently as 2011, the question of educated fleas was still being addressed. In "A Speck of Showmanship: Is that a "Pulex irritans" pulling that carriage, or is someone just pulling our leg?," Ernest B. Furgurson evaluated the claims of flea circus masters, including Bertolotto. The idea of trained and educated fleas was curious to Furgurson. After mentioning various flea circus acts, he discussed how the fleas were trained not to jump by being locked in a glass jar or tube. After hitting their heads enough times, the fleas were supposedly broken of their jumping habits.¹⁰⁸ He did not believe that that was an indication that fleas had any sort of education or training, coming to the same conclusion as Dall and others. He attributed the performance of the fleas to manipulation and confinement. Dall and Furgurson, however, did give credit to Bertolotto for having a grand and entertaining show. Both authors marveled at the complexity and opulence of Bertolotto's presentation.

Flea circuses were fascinating novelties. From the 1830s throughout the 1960s, they were fun forms of family entertainment. Louis Bertolotto and William Heckler were among the most recognizable flea circus proprietors. Louis Bertolotto dominated Europe and the Eastern United States as a grand flea circus entertainer during the second half of the 1800s. Around the beginning of the 20th century, a new star was rising as Bertolotto's was fading and his name was

"Professor" William Heckler. When William Heckler passed away, the legacy that he created was carried on through his son Roy. For almost two decades, William and his son were performing daily shows on 42nd Street in New York City.

Bertolotto and William Heckler were more than just flea circus masters. Bertolotto and Heckler examined flea behavior, often with uncomfortable experimentation, using what they learned to create, at least, the appearance of trained and educated fleas. In turn, the fleas were "taught" through various tests how to walk and pull heavy items such as chariots. The most important skill the fleas "learned" was not to jump. Seemingly harsh tactics employed by Bertolotto, the Hecklers, and other flea circus operators broke the fleas of their instinct to jump. Fleas that could not jump were better suited for the life of a circus performer. That realization was most likely instinctual but, arguably, it could be evidence of reasoning. Without repeated scientific experimentation and observation of the *Pulex irritans*, it is highly unlikely that Bertolotto and William Heckler would have been as successful as they were. Flea circuses and their proprietors hold an exciting place in history. The minute performers, however, were the real stars of the show and proved that fleas could be more than just pests and nuisances.

Louis Bertolotto worked with fleas before their discovery as disease vectors while Heckler operated during the Progressive Era and beyond, post disease discovery. Despite the overall lack of attention given to fleas in the Victorian period, there were others, besides Bertolotto, who found themselves fascinated with fleas. As the study of insects evolved from a naturalist pursuit into a full-fledged legitimate profession, there were insect researchers who bridged the gap between amateur and professional. Concerning the study of fleas, Charles Rothschild is an example of one who was interested in fleas before their disease discovery and who researched fleas while the profession was developing. Charles Rothschild was a wealthy

naturalist who, by the time of his death, researched and contributed much information to the body of knowledge about fleas. Although Charles often worked extensively with colleague Karl Jordan, his interest began as a young child and his enthusiasm for the flea compelled others to take on the task of researching the fantastic flea.

Flea Fiefdom

“The flea found on the Arctic Fox is the rarest variety known, living the longest. Rothschild, who has a collection of fleas and other insects, offered several thousand dollars for a flea of that species.”¹⁰⁹ This report was taken from “Professor” Heckler’s pamphlet, *Puli-cology*. Louis Bertolotto also referenced the Rothschilds in his promotional work when he claimed that “the late Baroness Rothschild sent me an invitation to attend a large and fashionable party at her villa, near London, at which there was a number of the nobility, and other distinguished personages.” He then went on to state that he spent time convincing the Baroness that the fleas in his circus were real and not mechanical trickery.¹¹⁰ As discussed in Chapter 2, Bertolotto and Heckler were well known flea circus masters who, through their show business antics, became well acquainted with the biological processes of fleas. It was no accident that they both mentioned the Rothschilds in their pamphlets. The Rothschilds had a reputation of wealth and prestige.

The Rothschilds were known for their obsessive collecting tendencies and their interests in animals. More importantly, their family wealth enabled them to partake in scientific and scholarly pursuits, which represented their interests in collecting and animals, without much concern for the costs associated with those activities. The brothers Walter and Charles Rothschild, along with colleague, taxonomist, and entomologist Karl Jordan, did much to advance the study of zoology, including entomology, during the later years of the Victorian period. Walter was an avid and indiscriminate collector of specimens. Walter’s main interest, however, seemed to be ornithological. Charles was interested in collecting and furthering knowledge about fleas and through his research, he demonstrated to Jordan the value of studying these minute insects. Miriam Rothschild, Charles’s daughter, although removed from the

Victorian period, carried on her father's penchant for fleas. Her work further enhanced and added to what is now known about fleas. The Rothschilds' wealth, family background, and education, combined with Victorian ideologies regarding scientific study, propelled them to the forefront of flea discoveries.

How Charles began his fascination with fleas is undetermined, but his love of these hardy little insects began as a boy much as Walter's and Jordan's fascinations with insects and animals. Charles bridged the gap between amateur and professional entomological researchers. Although he was well known for his flea collection, he was employed in the Rothschild family business until his untimely death. As a gentleman from a family considered to be "new wealth," and whose primary career was in banking, he managed to increase public and scholarly interest in fleas through his research.

Walter too was employed in the Rothschild business for several years, only being released from his responsibilities when it was proven that he could not handle them. Walter was notoriously poor with finances, a problem exacerbated by his choice in women.¹¹¹ Walter and Charles were not career zoologists or entomologists. Furthermore, Charles's fascination with fleas was removed from the typical entomological studies of the day which tended to focus on insects that had a greater relation to or effect on humans. Although the Rothschilds' contributions to science have been documented, missing from the secondary literature is a detailed study of how Charles, with Jordan, brought fleas out of the penumbra of entomology and into the public eye.

As explained in previous chapters, fleas were not usually the focus of entomological work during the Victorian age. That does not mean, however, that there was a complete lack of research focusing on these minute creatures. The impetus for flea research was the discovery of

fleas as plague vectors, which occurred in 1898. Charles and Jordan, however, had their attention focused on fleas before that discovery. Charles had been interested in fleas since he was eight years old, in 1885, and once he met Jordan, in the later 1880s, he convinced Jordan of the value of studying fleas. Given the lack of viable and reliable research about fleas at that point, perhaps Charles and Jordan saw a promising niche which they could fill. It is possible that Charles was highly influenced by his older brother's work with and collection of birds. The reputation that the Rothschilds received for their zoological and entomological collections was worldwide. Additionally, the reputation of the Rothschilds' work was popular and scholarly. Due to their wealth and notoriety, their collecting exploits were often reported in newspapers across the globe, often during the same time when flea circuses were popular. The attention, public, popular, and professional, showered upon the Rothschilds, was typical of the period. This recognition also proved that the Rothschilds progressed beyond their humble beginnings.

Niall Ferguson asserted that “it had been the original French Revolution that, in 1796, had literally demolished the walls of the Frankfurt ghetto and enabled the Rothschilds to begin their phenomenal, unprecedented and since unmatched economic ascent.” Ferguson reasoned that their economic fortune occurred because of the tumultuous nature of the banking and trade business at that time. This created opportunities for those who were not averse to engaging in risky investments.¹¹² This was a perfect setting for the Rothschilds' ascendancy. Thus began the rise of the Rothschilds and “with riches came status. In the eyes of contemporaries, the Rothschilds personified new money: they were Jews, they were ill educated, they were coarse – yet within a few years they had accumulated net paper wealth worth far more than most aristocratic estates.”¹¹³ The Rothschild family utilized that wealth to pursue their own interests

and hobbies. These interests and hobbies eventually led to serious zoological and entomological research, which was disseminated academically and popularly.

Lionel “Walter” Rothschild, 2nd Baron Rothschild, was born in 1868. He was internationally recognized for his menagerie and private collection of animal species, most of which was eventually donated to the British Natural History Museum. According to Miriam Rothschild, Walter’s niece, the Rothschilds had certain characteristics including a penchant for obsessively collecting items of fascination. Additionally, they were known for their interest in and respect for non-human animal life.¹¹⁴ Miriam observed that “one and all possessed zest and persistence and a tendency to become deeply, almost obsessively involved in everything that interested them.”¹¹⁵ Walter was no exception. Miriam’s biographical study of Walter described his descent into animal mania. Emma Rothschild, Walter’s mother, had recorded Walter’s joy when, as a young child, he observed camels and zebras riding along in a circus. She also mentioned how, at the age of ten, Walter aspired to collect all the non-English insects and moths he could find while he was vacationing.¹¹⁶ Ferguson corroborated Miriam’s recollections when he described that

Walter had begun collecting animals, stuffed and live, at the age of six and was already a knowledgeable zoologist when he went to study natural science at the University of Bonn and then at Cambridge. In this, he had the more or less unqualified encouragement of his parents; as a twenty-first birthday present his father built him a museum at Tring to house his collection.¹¹⁷

Miriam elaborated on Walter’s ambitions and claimed that since the age of seven, Walter had wanted his own museum.¹¹⁸ From a young age, Walter was quite the collector of animals, live or not, and through his family’s wealth and support, he could realize those ambitions relatively

early in life. Additionally, Walter would eventually prove himself unable to handle the demands of the family business. This enabled him to fully dedicate himself to his natural history museum.

Miriam concluded that Walter's interest in a variety of animals stemmed from his parents. Both Nathan and Emma were interested in animals. As a young child, Walter observed his parents engage with the animals that they kept. This most likely cultivated and encouraged any inherent love for animals that he had. In addition to owning dogs, Nathan bred fancy birds such as albino peacocks and ornamental pheasants. Nathan also had an aviary at their home.¹¹⁹ Additionally, Nathan's grandfather, Nathan Mayer, had kept carrier pigeons. An appreciation of birds was a prominent trait within the Rothschild family, Walter likely acquiring his interest through his father's bird collection. Although his father's birds were more a display of class rather than a serious endeavor to scientifically study and research those birds, through this collection and other habits of his father, Walter learned at a young age what having wealth meant and how it could be used.¹²⁰ In time, Walter too would become especially known for his love of birds and his ornithological research, despite the fact that he hunted wild duck for sport.¹²¹ Walter was rumored to have been extremely shy and prone to anxiousness. This purported fear of human contact and being surrounded by birds throughout his childhood could have combined to form his greater interests in aviary research. Moreover, Walter had a speech impediment.¹²² It is possible, that in his attempt at avoiding having to speak to people, he found solace in the animal life which surrounded him at Tring Park. The bonds and curiosity which stemmed from these relationships likely served as part of the impetus for his future scholarly work within the zoological discipline.

Walter did not receive any formal zoological instruction until the age of 19. He was homeschooled until he was 18 years old after which he attended the University of Bonn.¹²³ He

would eventually study for two years at Cambridge University where he met a professor of zoology, Alfred Newton, who further inspired his interests in birds, other animals, and natural history. Newton, an ornithologist, showed Walter some specimens from the South Seas, which “fired his imagination.”¹²⁴ Newton is also credited with helping Walter evolve from a wealthy, private, amateur collector of specimens to a naturalist whose efforts contributed to natural history.¹²⁵ Walter did not finish his education at Cambridge before returning to Tring Park. Eventually, at the young age of 21, he received a section of Tring to function as a museum, a birthday present from his father.

After his return from Cambridge, Walter went to work at the family business, N.M. Rothschild & Sons. In 1908, at the age of 30, Walter “retired” from the business. Walter possessed neither the motivation nor the financial acuity to successfully contribute to the Rothschild banking industry. Furthermore, by this time Walter had acquired several mistresses, one of whom bore him a child. A few of these mistresses would blackmail him for decades.¹²⁶ Miriam also noted his financial troubles and insisted, perhaps with a slight bias, that one of his blackmailers ruined his life and forced him to sell off part of his prized bird collection to the American Natural History Museum.¹²⁷ Moreover, Walter’s financial ineptitude affected the museum at Tring. It was discovered that Walter was losing money in the stock market due to poor speculation. It then became Charles’s responsibility, along with Jordan and other Tring employees, to clean up Walter’s monetary mess at the museum.¹²⁸ Clearly, Walter had to be reined in and removed from all financial responsibilities, which he was all too pleased and eager to do. Walter was interested in collecting specimens from around the globe for scientific study and display and was not concerned with pesky pecuniary problems. Because of this, the museum at Tring occupied an even greater space in Walter’s heart and it was clearly where he preferred to

spend his time. The world of business and banking was not for him but the world of natural history was. This was the realm in which Walter excelled. For the rest of his life, with the help of Walter's curator and taxonomist Karl Jordan, Walter would focus his energies and enthusiasm towards the discovery, collection, classification, and display of new and exotic animal specimens from all around the world.

By the end of the 19th century, it was becoming common for wealthier families to eschew their business ties and to delve into other interests and professions, including fields of scientific study. This newfound and increased tendency to engage with scientific and scholarly pursuits most likely stemmed from a broadening of educational opportunities at that time, partially due to wealth and societal conditions.¹²⁹ As previously mentioned, the Rothschilds represented new wealth and were not a long established noble family of any part of Europe. It would be short-sighted, however, to say that the Rothschilds, especially Walter and Charles, were involved with zoological and entomological studies solely because of the opportunity to do so. In addition to having inherited a family tradition regarding a love of animals and collecting, the Rothschilds were representations of scientific study during the Victorian period.

In her essay on the culture of Victorian science, Barbara Gates argued that change was the driving force behind the increased and renewed interests in scientific discovery present during this period. She remarked that although Darwin's work on evolution and natural selection was influential, it was not the only impetus guiding the urge for scientific investigation. Advances in other scientific disciplines, such as mathematics and the physical sciences, guided people's thoughts about life and its origins.¹³⁰ Although medicine, mathematics, and physics may have been construed by some as "harder" sciences or those that involve more rigorous scholarly attention, the basic argument can be applied to zoology and entomology. The discovery and

classification of new species of flora and fauna caused many scientists, amateur naturalists, theologians, and others to think about their place in the world. The sheer variety of animal life with all their innate abilities and wide array of colors was cause for question. Additionally, the intellectual capabilities of insects, such as the ant, were being questioned, most notably by Darwin. Flea circuses too eventually became part of the discourse on insect intelligence. These were not questions specifically addressed by Walter or Charles, but their interests in animals and insects did lead to discoveries in other fields, especially that of medicine. Zoological and entomological studies were necessary for advancements in other scientific disciplines. Moreover, Walter's collection, especially of his birds, showcased the awe-inspiring variety of creatures that were found in all corners of the globe. Often, these specimens were readily collected by those with access to the wealth and spoils which resulted from the period's colonial exploration and the domination of the British empire.

Harriet Ritvo examined the zoological discipline during the Victorian period with a critical lens as she discussed taxonomy and classification. She maintained that glory and vanity combined with the benefit of a growing British empire were other reasons for collecting and classifying new plant and animal life. It was, however, forbidden for discoverers of new species to name them after themselves and, instead, they often named them after whomever sponsored the collecting expeditions. The Rothschilds sponsored countless missions into all corners of the world. Ritvo noted this too when she used Walter as an example. She referred to him as “an aggressive collector who sent his proxies to gather the zoological spoils of the British Empire in the late nineteenth and twentieth centuries.”¹³¹ Over 200 different species of animal life were named in honor of Walter, including birds and insects. In addition to the personal and social reasons behind Walter's passion for natural history, he was involved with these pursuits because

he could afford to be. His family loved animals, it was a period of discovery and expansion, and because Walter originated from wealth, he could afford to abstain from working in the family business. He took advantage of his privileges, inherent mental capabilities, and the period in which he lived. Tring Park was a vital advantage in Walter's work in addition to a fortunate meeting with one of his future curators, Karl Jordan.

Tring Park is a country estate located in a hilly and scenic area of England. Miriam related that Nathan Mayer Rothschild, the founder of the English branch of the Rothschild banking business, began renting Tring as a summer residence in the 1830s.¹³² It was not until May 1872 that Lionel Rothschild, Walter's grandfather, had officially purchased Tring Park.¹³³ Although Tring was bequeathed to the British Museum upon Walter's death in 1937, for almost 50 years it served as an estate that was instrumental in the development of Walter's and eventually Charles's, zoological and entomological interests. It was a beautiful location for Walter's long desired museum which housed the Rothschilds' vast collections of birds, butterflies, fleas, and other numerous specimens.

In 1893, four years after Walter's museum at Tring was established, a new curator and taxonomist, Karl Jordan, arrived. Jordan was highly educated and proved to be an invaluable asset and an inspiration to Walter, Charles, and Miriam. Miriam alluded to the fortuitousness of Walter's meeting with Karl Jordan as well as Walter's ability to convince Jordan that he was needed more at Tring than as an educator of natural history, mathematics, and physics.¹³⁴ Jordan had been interested in zoology, and especially classification, prior to becoming acquainted with Walter and Tring. Jordan believed that naming and classifying animals was a vital and necessary component in the study of nature and its inhabitants.¹³⁵ Jordan was responsible for curating

Walter's beetles, butterflies, and other insects; however, he was to eventually develop an interest in fleas.

Ordering Life, a recent biography of Karl Jordan, provides a starting-point for analyzing his interest in insects. Kristin Johnson noted that Jordan became interested in insects as a child in the 1870s. This was a period when animal collecting was still mostly a wealthy, upper-class hobby. Moreover, most of these wealthy collectors were novice enthusiasts rather than formally educated zoologists.¹³⁶ The irony is not lost here as Jordan would eventually work for Walter at Tring and would be vital in assisting Charles with his private flea collection. Walter, and later Charles, also became fascinated with animal life when they were younger. When Jordan was still a young boy, an older brother took him beetle collecting in his native home of Germany. Jordan, perhaps similarly to Charles, credited his older brother for stoking his interest in beetles. Jordan's brother had a pocket-sized card for identifying different species of beetles which provided the impetus for Jordan's lifelong interest in beetles.¹³⁷ Throughout his long life he would become known for his work with butterflies and most importantly, fleas.

Jordan attended the University of Göttingen where he earned a doctorate in zoology and botany. Afterwards, he served a brief stint in the military. His immediate post-military career was as an educator of mathematics and science at the School of Agriculture on Hildesheim.¹³⁸ After those brief occupations, Jordan came to Tring to work with Walter as a curator. Later, he would work with Charles and his flea collection. Jordan was an accomplished taxonomist and was to eventually become internationally recognized as an entomologist. Jordan was often wry about public and academic perceptions pertaining to the classification of species, even occasionally referring to himself as a "species-maker."¹³⁹ Regardless of the reasons for and implications of his taxonomical work, Jordan became highly influential in the entomological

field and would later come to argue for the study of entomology as necessary for the well-being and longevity of the human species. Despite his original interests in beetles and butterflies, his research with fleas would endure as a major part of his legacy.

Many who have studied Karl Jordan and the Rothschilds credit a young Charles Rothschild for creating, or at least encouraging, Jordan's interests in fleas. Robert Traub noted that Jordan's interest in fleas began in 1898 when he encouraged Charles's interest in the flea.¹⁴⁰ N. D. Riley also gave 1898 as the date in which Jordan became interested in fleas, due to Charles's inspiration.¹⁴¹ Additionally, Johnson discussed Charles's interest in insects, especially fleas. She noted that his interest in fleas was an anomaly as most entomologists and naturalists of that period were focusing their attention on the study of beetles, butterflies, and moths.¹⁴² Miriam Rothschild credited Charles's friendship with Jordan as the reason why Jordan became interested in fleas. Charles was 21 years of age in 1898 when it was discovered that fleas served as transmitters of the plague. At that time, however, the idea that they were vectors of disease was neither readily accepted nor fully understood. Also, Charles's love of fleas originated during his childhood, many years before fleas were reviled for their role in the transmission of the plague.

Miriam explained the origin of Charles's fascination with fleas. She claimed that "although Charles first became interested in fleas at the age of 12 when he acquired a slide of the Helmet Flea from W. Farren, the taxidermist, we find him four years earlier thanking his mother for the mouse trap she sent him to Bentley Primary and announcing his first capture."¹⁴³ When Charles was eight it was 1885, almost a decade before the recognition that fleas brought disease. As Johnson noted, Charles's interest in fleas was unusual because the focus was usually on other insects, especially insects that were more relatable to humans. The study of insects for agricultural benefit had been argued since decades before the start of the Victorian period but

fleas were not a huge agricultural pest at that time and so they escaped the notice of entomologists. It is difficult to determine what Charles's reasoning and logic behind his interest in fleas was but it may have been an attempt to impress Walter. Miriam recalled that, at a young age, Charles had looked up to Walter with much admiration.¹⁴⁴ By that time, Walter was already determined to have his museum and it was apparent that he was knowledgeable in the realms of zoology and ornithology. One can hardly blame young Charles for looking up to his older brother and wanting to emulate him while maintaining his own identity and naturalist pursuits. The study of fleas would have provided Charles with an outlet for those wishes.

Charles took over for Walter at N.M. Rothschild and Sons in 1908, where he worked until his death. His heart, however, was with entomological and natural history studies. Ferguson mentioned Charles's prowess with fleas. He discussed Charles's role in the Rothschild banking empire but also stated that "Charles too was a scientist at heart. A dedicated amateur botanist and entomologist who published 150 papers and described 500 species of flea, he was also one of the country's first modern conservationists."¹⁴⁵ Although Charles might have been considered by many to be an amateur entomologist, he was influential in the development of knowledge about the flea. By the time he was in his late 20s, at the close of the Victorian period, Charles was taking part in collecting expeditions and was regularly being consulted when other specimen hunters had questions about newfound species of fleas.

One of Charles's first publications came from his time at Harrow, when he was working with butterflies. Published in 1895, *Harrow Butterflies and Moths* provided the students with an opportunity for studying the flora and fauna around the Harrow school while contributing to knowledge of natural history. His first publication concerning fleas, however, came in 1899 and was a call for fleas which was published in *The Irish Nationalist* journal. The short notice read

Dr. Scharff very kindly forwarded me last year some fleas. It may possibly be of interest to the readers of the *Irish Nationalist* to record the species. I received a large series of *Clenopsylla musculi* from Dublin taken off the House Mouse, and a pair of *ceralopsylla jubata* taken off the Hairy-armed bat (*scotophilis Leisleri*) from Bray River, September 7, 1898. In addition to these there were some others which I hope to record later.

So very little is known of even our British fleas that many new species must be forthcoming. I should much like to receive any Irish fleas collectors may be disposed to part with, and can give British birds and lepidoptera in exchange.¹⁴⁶

There are a lot of remarkable points in this call for fleas. One of the notable items is the date. This was from 1899, about a year after the formal discovery of fleas as disease vectors. This passage, however, does not mention anything about needing fleas for further investigation of disease or anything about the plague. It is possible that Charles was not aware of the discovery as some of the early discoverers of the plague transmission were French and Japanese. Additionally, the reception of this discovery was initially poor and riddled with skepticism. His wording also hinted at his previous work and attempts at collecting fleas. It appears that he was looking for and discussing fleas found on nonhuman animals. Perhaps the most important information gleaned from this short passage is the lack of monetary compensation offered for these fleas. He offered to trade British birds and butterfly specimens. These possibly came from Tring or his own personal collection, as Charles was also known for earlier work with butterflies. The lack of compensation offered is interesting as newspapers would soon explode with reports of Charles's flea collection and rumors of great monetary rewards being offered for various flea specimens.

Charles quickly became known, in England and internationally, for his collection of fleas. The October 18, 1902, edition of the *Pittsburgh Press*¹⁴⁷ reported that Charles was looking for

fleas in the North Sea which included those of the “blue fox, the polar bear, the Eskimo dog and other Arctic animals.” The article mentioned that any fleas which were obtained through these expeditions would be added to a collection that had already contained thousands of specimens.¹⁴⁸ Less than a year later, newspapers were reporting that Charles’s North Seas’ expedition was still looking for the flea of an arctic fox and supposedly Charles was offering \$5,000 in exchange for that particular flea.¹⁴⁹ According to the April 1910 issue of a monthly entitled *The Architect and Engineer of California*, regarding the expedition to the North Seas around 1902, “the captain evidently returned flealess, for in August last Mr. Rothschild offered a reward of 1,000 pounds for an Arctic fox flea – a reward which the writer believes has yet to be earned.”¹⁵⁰ It was not solely the newspapers, monthlies, and interested entomologists who were caught up in the excitement of a potential reward for such a rare flea. As previously mentioned, flea circus master William Heckler noted in his pamphlet, *Puli-cology*, that Rothschild was offering rewards for certain fleas. Charles had gained quite the reputation for his flea collection and additionally his desire to collect as many species of fleas as there were in existence. In addition to becoming a respectable name in entomological circles, it appears that the Rothschild name carried weight in the hearts and minds of the public, through the endless stream of newspaper reports pertaining to Charles and his fleas. Charles Rothschild was well-known on two accounts, academically and popularly.

Popular science in the Victorian age evidently arose from a need for “nonprofessionals, who could convey the broader significance of many new discoveries to a rapidly growing Victorian reading public. Some periodical editors even preferred to recruit journalists, rather than professional scientists, to write on scientific subjects.”¹⁵¹ Journalists were quick to report on the Rothschilds’ continued hunt for new specimens, yet the reasons behind their doing so seem to

have revolved less around a need for the popular dissemination of knowledge stemming from their works and more from a quick way to gain a reputation as a “respectable” reporter simply by mentioning the Rothschild name. This is not too dissimilar to Bertolotto’s previously mentioned pamphlet where he also referred to the late Baroness Rothschild. Although this reference came in 1876, well before Walter’s and Charles’s zoological and entomological work, especially concerning fleas, Bertolotto likely referenced their name to gain respect and credibility for his show. He used their name as a symbol of their wealth and opulence to improve his own reputation. Although newspaper articles would often have some scientific information about fleas, the press had mostly taken to dissemination of hyperbolic reports of the Rothschilds’ collecting mania and wealth, which was an unintended side effect of their scholarly pursuits. Regardless of his lack of affiliation with the scholarly study of fleas, Bertolotto was but one of the many who accepted, without question, the Rothschilds’ ascendancy into the upper socioeconomic echelons of Victorian British society.

William Heckler’s New York City flea circus operated during the same period in which Charles was actively collecting fleas. The mention of Charles’s search for fleas by Heckler in his pamphlet demonstrated Heckler’s commitment to maintaining his image as a “Professor” of fleas. Thus, Heckler used the Rothschild name, too, since the name drew recognition. Whereas Bertolotto entertained the Rothschilds with his flea circus years before Charles’s interests developed, and referenced them in his pamphlet, using the name as a paragon of wealth and nobility, Heckler used their name to promote an image of being scientifically knowledgeable. Perhaps Bertolotto’s flea circus performance originally piqued the Rothschilds’ curiosity about fleas in the 1870s but it was Charles’s contributions to flea research in the 1900s, the collection aspects being heavily reported in easily accessible newspapers across the world, which may have

further inspired Heckler's "research" with fleas. This difference between the flea circus masters' usage of the Rothschild names highlights the change in public perception of the Rothschilds. Not only were they wealthy, but they became known as eccentric collectors of fleas and other natural specimens who would pay exorbitant sums of money for those specimens. Eventually, they would carry a reputation for scholarly pursuits in the natural sciences. Due to their wealth, eccentric collecting manias, love of naturalist pursuits, and their research, it is not surprising that they repeatedly caught the attention of budding newspaper reporters who needed a quick and easy story.

Some of these newspaper reports, however, were questionable. For example, a 1914 edition of the *New York Times* claimed that "Alfred Charles de Rothschild of London is said, on authority of Edmond Perrier of the French Institute, to have paid \$5,000 for a specimen of a rare variety of flea-one of the kind found in the skin of the sea otter."¹⁵² The newspaper reporter must have been mistaken as Nathaniel Charles Rothschild had the flea collection. Alfred, his uncle, was more of an art collector while Edmond Perrier was a French zoologist. It is highly unlikely that a collector of art works would suddenly turn to fleas, not to mention do it at the same time as his nephew while simultaneously having a flea collection like Charles had. The reporter most likely confused the two Rothschilds. Unfortunately, it probably did not matter to the reporters that they had incorrectly reported on the Rothschilds. Newspapermen were likely aware of the potential benefits to reporting on the Rothschilds, regardless of which one it was. Even Walter was reported to have paid handsomely for specimens. Although some specimens surely came at a cost, it was never more than a few dollars, and not the hundreds of pounds it was reported to be. "But both the public and the fellow naturalists found the stories of the museum's purchasing power easy to believe, given the Rothschilds' standing as the wealthiest family in the world."¹⁵³

Walter and Charles received a lot of attention for their collections and the role their wealth played in those ventures.

The sheer volume of newspaper articles detailing the exploits of Charles in the search for fleas were often inaccurate or exaggerated. It brought Charles and his flea finding missions into the homes of everyone who had access to newspapers and other popular periodicals. In this sense, although the Rothschild name may have been mentioned by those hungry to improve their own reputation, these articles demonstrate an inclusion in the world of popular science. Charles was not focused on being a scientist for the masses nor does it seem that he disseminated flea knowledge solely for the benefit of the public. The constant reporting of his funding for fleas piqued curiosity in the minds of many, however, and perhaps inspired others, including Heckler, to collect fleas and other oddities for themselves, for wealth, and for science. Charles was influential in the entomological world due to his work with flea specimens. He was popular with the general masses because of the fascination with his extreme wealth and propensity for collecting “odd” insects. His flea collection was the product of wealth and eccentricities and captured the hearts and minds of many who were removed from the entomological profession.

Funding for operations at Tring was not always guaranteed. During the first decade of the 20th century, the museum saw financial troubles. Walter’s previously mentioned inability to handle his financial and romantic affairs resulted in strict budget tightening at Tring. Additionally, taxes on inheritance, which Walter and other Rothschilds depended on, were often cited as a problem. Despite a brief two- to three- year period of financial restrictions, the museum’s budget was stable once the 1910s began.¹⁵⁴ For the most part, their wealth did enable them to fund expeditions and to buy specimens. A *Washington Post* article from 1912 corroborated their wealth and Charles’s ability to specialize in one insect. Their access to

finances was the envy of other entomologists.¹⁵⁵ Without access to the Rothschild family fortune, Walter, Charles, and Jordan would not have been able to collect specimens. The subsequent research and academic work were important too. Furthermore, there were other entomologists of the time but not many seemed to have the reputation and wealth of the Rothschilds and, thus, received less attention.

Although the great, and occasionally exaggerated, monetary rewards offered by the Rothschilds did not always result in the collection of new specimens, Charles has been credited with the discovery of a flea known as one of history's most notorious public enemies. In 1901, he and an associate, Alexander "Sandy" Wollaston, undertook an expedition through Egypt and Sudan. It was there that Rothschild discovered six new species of the flea, including the Oriental rat flea, *Xenopsylla cheopis*. He reported his findings in the April 1903 edition of *The Entomologist's Monthly Magazine*. He described the *pulex cheopis*, as he then referred to it, in great scientific detail observing that "this species is larger than *P. nubicus*, the palpus being shorter than the rostrum and not reaching to the end of the coxa. In the male, sternites three to seven inclusive bear four bristles, while those of the female have five."¹⁵⁶ The rest of the paragraph is worded in a similar fashion. His detailed, esoteric, and scientific language proved that his expertise in fleas was not limited and demonstrated his eye for detail in addition to a knowledge of flea anatomy that eclipsed his status as an amateur naturalist or popular scientist. Charles did not mention in this report that this flea is one of the fleas primarily responsible for the transmission of the plague.

Miriam discussed Charles's African expedition and claimed that "there is no doubt that this was the most notable as well as the most enjoyable of Charles's expeditions, for at Shendi he discovered the plague-carrying flea – at that time a new species, which he later named

Xenophylla cheopis. He intuitively knew this was a great find.” According to Miriam, he wrote to an acquaintance saying that he might have found fleas that belonged to a group of plague-carrying fleas originating from India.¹⁵⁷ Miriam might be correct but it did not appear as though Charles was sure about his discovery at that time. Had he been more certain of his finding, he probably would have mentioned it in his report on the expedition published in the *Entomologist’s Monthly Magazine*. Being the capable and exceptional researcher that he was, he would not have wanted to concretely state that he had found the plague flea if he was not sure.

Charles, however, cannot take sole credit for the work with the Oriental rat flea. Some sources credit Jordan with that discovery and subsequent research. The author of Jordan’s obituary that was published in the *Washington Post* and the *Times Herald* claimed that Karl Jordan was the entomologist who provided the impetus for the discovery, research, and discussion of the flea responsible for transmitting the plague to humans.¹⁵⁸ In *The Flea*, Harold Russell completely omitted Jordan from the equation when he discussed “the oriental rat-flea first described by Mr. Charles Rothschild from specimens in Egypt.”¹⁵⁹ Jordan’s biography tells a slightly different story

Following a plague outbreak at the turn of the century, a British inquiry, the Commission for the Investigation of Plague, which had been sent to India from 1904 to 1905, had enlisted Charles to sort out the distinctions between the various kinds of fleas studied by those seeking the key to plague transmission. Together, Charles Rothschild and Jordan made sure plague workers got their identifications right. Rothschild and Jordan showed that in fact those places without plague were home to a different species of flea.¹⁶⁰

Riley offered a similar observation when he stated that “Dr. Jordan played a leading part in that concerning plague and the systematics of the genus *Xenopsylla*.”¹⁶¹ Jordan and Charles both

were integral to the discovery and subsequent classification of this new and important species of flea. Without Charles's discovery of this flea on the expedition and without Jordan's taxonomical expertise, it is possible that work on this notable insect would have languished for some years. Charles and Jordan both deserve the credit for their continuous research regarding this flea. There is a variety of reasons why credit for this discovery is often contradictory. Charles seems to receive more credit for this discovery as he carried a bigger name than Jordan. Furthermore, he was on the expedition when the flea was found. In later years, especially after Charles's death, Jordan kept writing and researching fleas, eventually earning the title the "Dean of Siphonaptera." He received credit for his research later in life, decades after Charles's death and after the memories of the excitement of that discovery faded. This possibly explains why Jordan's obituary in the newspapers credited him without mentioning Charles. It is heavily documented and noted that they worked on researching the Oriental rat flea together and deserve shared credit for this vital contribution to the entomological field in addition to the fields concerning health, hygiene, pathology, and epidemiology.

Charles continued to prove his worth as an entomological expert on fleas throughout the first two decades of the 20th century. In addition to publishing his findings on fleas, he was regularly consulted by those who undertook various expeditions in different areas of the world and who found fleas for Charles to identify. These expeditions came at a price. As Miriam explained, the financial costs of these expeditions were huge. One way to alleviate some of the monetary burden was to sell unneeded or duplicate specimens to others. She then mentioned, as an example, that Charles was occasionally offered fleas from expeditions undertaken by the British Museum, especially if Charles had funded those trips.¹⁶² Due to career, familial, and other obligations, it was unlikely that Charles could accompany every expedition that set out.

Furthermore, even considering the wealth held by the Rothschilds, neither he nor Walter could afford to solely fund every expedition. Flea collecting was typically not a major part of most collecting expeditions. By contributing a limited amount of funding, however, Charles received and identified several new species of fleas over the course of his short lifetime.

One of the expeditions in which he did not take part was the 1908-1909 Clark Expedition through northern China. Charles was called upon for his expertise in identifying specimens from the journey. The expedition was undertaken by Robert Sterling Clark and Arthur de C. Sowerby. Both men came from wealth; Clark was heir to the Singer Sewing fortune and Sowerby stemmed from a Christian missionary family stationed in China. In their introduction to their published findings from the expedition they stated that their “best thanks are also due to the Hon. N. Charles Rothschild, M.A., F.L.S., for the paper on *Siphonaptera*.” The M.A. behind Charles refers to his degree obtained at Cambridge while the F.L.S. alludes to his membership within the Linnaean Society. Over the years, he also acquired F.Z.S. and F.E.S. which are indicative of his membership in the Zoological and Entomological Societies of Britain. The introductory section also thanked the British Museum staff for examining and classifying different specimens collected from the expedition.¹⁶³ Although it is unclear if Charles provided any sort of financial aid to this expedition, or if the British Museum was involved because of Charles, the collaborative efforts between the British Museum, Charles, and others in the field is notable. That these expeditions usually occurred within geographic areas of British interest is another representation of how far the English stretched across the world. British colonialism was good for wealthy English collectors, especially those interested in collecting and identifying non-human species not found in the British Isles.

Charles's work embodied a symbiotic relationship between his vast collection and knowledge of fleas. His work was a manifestation of the increased amount of attention paid to fleas after the discovery of their capacity to transfer diseases. As previously mentioned in Chapter 1, the discovery of fleas as disease vectors for the plague was documented in 1898. During the first decade of the 20th century, a greater volume of work scientifically analyzing different species of fleas was published. Charles, along with Jordan, contributed to this growing base of knowledge. His work also contributed to the history of scientific discovery relating to the flea.

Given the revelation that fleas were responsible for the transfer of disease, it is not wholly remarkable that some of Charles's work was published in non-entomological and zoological publications. The September 1906 edition of the *Journal of Hygiene* carried a short article by Charles entitled "Note on the species of fleas found upon rats, *Mus rattus* and *Mus decumanus*, in different parts of the world, and on some variations in the proportion of each species in different localities."¹⁶⁴ This article was concerned with the rat flea which, by this time, had the unsavory reputation as the flea mainly at fault for the various scores of plagues that infected different areas of the world throughout history. Like Harold Russell's *The Flea*, this article was primarily concerned with the flea as a disease carrier. Within the article, Charles cited five different sources other than himself. As previously mentioned in Chapter 1, Russell had observed that despite the new interest in fleas, there were still a handful or less of people doing work with fleas. At this point, such work was usually disease related. Although Charles's article was brief, which could explain why he only needed five references, Russell's point about the lack of attention paid to fleas becomes clearer. Furthermore, the disease aspect is more apparent as two of Charles's sources were from hygienic publications while a couple of others were concerned

with the fleas' parasitism. Unlike earlier predecessors like Robert Hooke, Charles was less awestruck and concerned about the beauty of the flea. Charles's publications, at least, veered towards a more objective and rational approach in his scientific endeavors with the flea. He was interested in productively contributing to the growing body of knowledge about the flea which his work demonstrated.

He continued to publish regularly into the 1910s. He made several other contributions to *The Entomologist Monthly* magazine as well as following in Walter's footsteps and having his work published in *Novitates Zoologicae, A Journal of Zoology*. Walter was the editor of *Novitates* and it was published from Tring. This should not discredit Charles or his work, however, since he had other findings published in journals with which neither he nor his brother was associated. It is more of an indication of how influential Walter and Charles were in the disciplines of zoology and entomology as well as how being wealthy enabled those with scientific interests and hobbies to disseminate the information gleaned from their work via their own publications. This also demonstrated the busyness of the Rothschilds. Miriam discussed this phenomenon and asked

how could anyone find the time and energy to deal with this army of collectors, becoming personally involved – as Walter often did – with a tremendous load of detail, examining and sorting the material which poured in, and yet relentlessly churning out paper after paper, publishing *Novitates Zoologicae* regularly every quarter, and directing the Museum and the Library?¹⁶⁵

Although Miriam asked this in regards to Walter, Charles was involved with Tring and identifying fleas and was likely just as busy as Walter if not more so because he was employed at N.M. Rothschild and Sons. Jordan kept busy with his own publications and jointly authored a

variety of works on fleas with Charles. Unlike the Victorian period, the decades directly after were practically a heyday for the flea, with heavy contributions from Charles, Jordan, and others like Russell and Doane.

Had Charles not passed from an untimely death at his own hands in 1923, he likely would have kept contributing original and thoughtful works concerning the flea. Charles had an “agonizing depressive illness” and spent most of World War I in Switzerland recuperating. Jordan joined him and they did not return home until 1919.¹⁶⁶ Miriam claimed, in addition to Charles’s depressive disease, that he was hit hard by influenza around 1918. This was also around the same time when Charles was promoted to his late father’s position at N.M. Rothschild & Sons, where he would work until his death five years later.¹⁶⁷ Eventually illness and depression appeared to be too much for Charles and he committed suicide. Walter and Jordan were despondent over his death.

In 1937, fourteen years after Charles’s death, Walter died. He bequeathed Tring to the British Museum. It is difficult to surmise what would have happened to Tring had Charles not died before Walter. Charles was originally supposed to inherit Tring but his premature death prevented that occurrence. Between Charles’s and Walter’s deaths, it was unclear what would happen to Tring and, with Karl Jordan’s insistence, it was decided that Walter would leave Tring to the British Museum of Natural History, making Walter one of their largest donors.¹⁶⁸ Jordan took the deaths of his friends and esteemed colleagues with much difficulty. Jordan was affected and influenced through his friendships with Walter and Charles but he was also a present force in their lives. After their deaths, his work with Tring and the museum continued, and eventually he came to make a professional acquaintance, to a lesser extent, with another Rothschild, Charles’s daughter Miriam.

Miriam Rothschild's work with fleas spanned most of the 20th century. Although her work with fleas was remarkable, and occasionally groundbreaking, it was different, in some respects, from her father's work with fleas. She had moved past the urge to collect and classify, although she certainly continued with her father's and Jordan's work in that respect. She voiced a more romantic appreciation for the flea and was also curious about how fleas biochemically functioned. That curiosity eventually led to her work, with others, detailing the jumping mechanism of the flea. Although Miriam extends beyond the Victorian and Progressive periods, she is worth briefly discussing because she embodied some of the Victorian period's ideals which shaped her uncle's and father's work.

Miriam decided to follow her uncle's and father's lead into the world of zoology and entomology.¹⁶⁹ Miriam had other interests besides fleas but it was her continued work with fleas that earned her the title "Queen of Fleas." Although Miriam did not have much formal education, throughout her lifetime she received many honorary degrees. Without the influence of Charles, Walter, and Karl Jordan, Miriam may have been content with a different lot in life and her discoveries would have been in the hands of someone else. As a Rothschild, she embraced the family tradition of being avid collectors and obsessed with nature and animals. She also enjoyed the benefit of the Rothschilds' wealth. She not only inherited some of her family's notable qualities but she brought the Victorian period's renewed interests in entomology and natural history into the 20th century.

Miriam recalled being "obsessed" with nature and collecting from a young age, in a similar manner to Walter, Charles, and Jordan.¹⁷⁰ She eventually went on to study marine biology for a time but only after World War II and having children, "she wrote her first book, *Fleas, Flukes, and Cuckoos*, about parasites, and then concentrated on the family fetish: fleas."¹⁷¹

The work was co-authored with Teresa Clay. When she finally decided to turn her attention to fleas, Miriam first focused her attention on cataloguing her father's extensive flea collection. While undertaking the tedious and time consuming task of sorting Charles's collection, roughly the span of two decades, she supposedly found, by accident, that to know the flea is to know other insects.¹⁷² What is different from her father's published work is that she has some of that awe and wonder that is reminiscent of Robert Hooke, Louis Bertolotto, and the others who were astounded by the capabilities and prowess of the flea.

Miriam possessed a combination of traits and personality which stemmed from Charles, Walter, and her mentor, Karl Jordan. She was an embodiment of all three of those accomplished, distinguished men. Miriam learned from Karl Jordan. Jordan, who found inspiration in Charles and Walter, and who most likely inspired them, was instrumental in developing a different kind of classification system for fleas, which was less chaotic and more orderly.¹⁷³ Later, Miriam would go on to develop another classification system with colleague, G. H. E. Hopkins, which borrowed heavily from Jordan's system.¹⁷⁴

Miriam's awareness of those who came before her is demonstrated in her usage of a quote by Robert Hooke at the beginning of her chapter on fleas in *Fleas, Flukes, and Cuckoos*. Here she chose his words that mention the "Structure, Strength, Beauty of its limbs and Parts."¹⁷⁵ Moreover, she dedicated the book to Charles. Her chapter on fleas, as well as the rest of the chapters in her book, was written in extremely accessible language. Clay and Rothschild appeared to have written a popular science work with a general audience in mind. For example, Miriam described the external part of a flea as such

It is, of course, well known that the hard part of an insect is external. In other words the skeleton consists

of a chitinous outer covering to the body similar to that of a crab or a lobster instead of an internal scaffolding like the bones of mammals and birds. This hardening and toughening of the cuticle is most pronounced, on the whole, in parasitic insects.¹⁷⁶

Her information is accurate, yet it is noticeably devoid of esoteric, scientific jargon that can weigh down the information and make it difficult for readers to interpret. It appears that this book was written for those outside the scientific community as well as those within it. This contrasts with most of Charles's writings, which were for a more academic audience. Later in her life she would comment that various parts of the flea were beautiful; however, this commentary was limited in her book and most of her other writings.

Another marked difference between the language used by her and Charles is how she referred to the various parts of the fleas. Whereas Charles examined fleas with a businesslike intensity, Miriam's views on the physical nature of the flea were more romanticized. In an interview for *Scientific American* she stated: "look at their lovely mouthparts. They have got such beautiful mouthparts, fleas. Really, they have."¹⁷⁷ It is possible that Charles or Jordan could have made similar remarks about fleas but, if so, they have yet to be found. Miriam was enamored with the small but powerful flea and this love and respect for the flea guided her research. Coupled with a curiosity that only a strong microscope could cure, she was an unstoppable force in the realm of flea research.

Miriam, in the same vein as her predecessor Hooke, was enthusiastic about the microscope. In her essay, published in *Whole Earth*, a popular magazine, she proclaimed "it's a new world! Once you are hooked on the microscope, life can never be long enough. There is a curious inescapable attention, for instance, in the graceful movement of the unicellular organisms

found in a cow's rumen, or a stained section of the intestinal lining of a mouse or man under a strong lens."¹⁷⁸ One has to wonder if it is a coincidence that she used the term "hooked" when describing her great interest in the microscope. The short essay discusses the vagina of the mole flea for which she supplied a drawing. The drawing is remarkable because during the Victorian period entomologists often commissioned others to do their illustrations. In this context, Miriam transcended Walter and Charles as eccentric collectors. She illustrated her own discoveries. She also mentioned the systematic classification method and admitted that "today this study is rather out of fashion, dated perhaps, a Victorian hobby?"¹⁷⁹ Although she probably adhered to the systematic way of studying fleas because she found it useful, she was not shy about admitting that it might be a relic from the Victorian period. It is apparent that her experiences with Jordan and Charles greatly influenced her and her work.

Miriam's most important flea discovery, although later revised, was the biological mechanism which enabled fleas to propel themselves to great heights. In 1975, she and four others published an article entitled "Execution of the Jump and Activity." This article reiterated that fleas have an amazing jumping ability. Miriam discovered that "in species which execute large jumps, take-off is accelerated by elastic energy released from a resilin pad (homologous with the wing hinge ligaments of flying insects) situated in the pleural arch."¹⁸⁰ This was a tremendous breakthrough as the flea's remarkable leaping abilities had been noticed with wonder and awe for hundreds of years yet no one prior had determined the biological conditions present in the flea which contributed to that ability. Charles's and Miriam's groundbreaking findings were a testament to their dedication to unlocking the secrets of the flea. Their success could not have been possible without their great financial holdings. Moreover, as Charles's daughter, Miriam had a head start on other enthusiastic flea researchers. Although known as the "Queen of

Fleas,” she also researched birds and their pests. She achieved much and should not be kept within the shadows of her famous family. Her inspiration probably stemmed from the work and influences of Charles, Walter, and Jordan, yet she was an entomologist and naturalist in her own right. Most importantly, her work with fleas transcended that of Charles and Jordan.

The Rothschilds, as wealthy members of the upper class who collected specimens, such as birds and fleas, in their leisure time, became known as scholars and discoverers of information. Charles and Miriam, with the assistance of Karl Jordan, amassed, classified, and catalogued a flea collection which numbered into the thousands. They would be hailed in their lifetimes for their unique and groundbreaking contributions to the knowledge of the flea. Walter, although an indiscriminate collector who was incapable of managing anything financial, provided the impetus, through Tring and endless collecting, for Jordan’s and Charles’s foray into the world of fleas. With Walter’s fortuitousness in hiring Jordan, Charles and Jordan made their mark in the world of entomology. Through Charles and Jordan, Miriam developed an interest in the flea and contributed to knowledge of the flea by assisting in the discovery of the biochemical functions of their leaping legs. The flea became a family fetish and through their work, Charles and Miriam established a flea fiefdom into which others were drawn.

The Rothschilds, particularly Charles, while pursuing their scientific endeavors, bridged the gap between amateur and professional entomologists. Charles’s flea collection and Jordan’s taxonomical expertise led them to discover the Oriental rat flea, which is a major carrier of the plague. This discovery was vital to furthering flea research. Not all species of fleas carry the plague and most of the plague carriers reside in areas outside of England and the U.S. There were advocates in the U.S., such as Emanuel Lyon and L. O. Howard, who saw the need to eradicate fleas due to their role as annoying household pests. During the Victorian and

Progressive periods in the U.S., social, political, and economical circumstances combined to further promote the flea's reputation as a pest. As agricultural production reached exponential heights and the U.S. expanded westward, insect pests and the need for control thereof increased.

Festering Fleas

“FLEA PLAGUE IN BROOKLYN” yelled the headline in the July 28, 1889, edition of *The New York Times*. The article detailed a heavy flea infestation in Brooklyn, New York, during that summer. It told of a similar problem in New Jersey, reporting that “they have in more than one spot swooped down like Attila’s Huns.” There were no definite conclusions as to the causes nor were any solutions reported. There was a brief discussion of certain home remedies along with the “observation that the flea had not been the subject of much scientific study and consideration.” Moreover, it was recorded that druggists who attempted to concoct flea powders did so incorrectly. This often meant that flea removal chemicals were worse than the problem.¹⁸¹ By the end of the century, fleas were discovered as vectors of disease. In the U.S. the plague was not a major concern for entomologists but fleas were viewed as annoying household pests. Due to the increase in this viewpoint, more research on fleas and proper eradication efforts began in earnest and fleas increasingly become the subject of entomological study. Emanuel Lyon advertised some of the earliest flea control powders and L. O. Howard worked diligently to eradicate fleas. Howard, as head entomologist with the U.S. Bureau of Entomology, was especially vital in the promotion of the view that fleas were household pests.

While the wealthier members of society enjoyed leisurely pursuits of fleas, others were searching for ways to exterminate fleas. During the later Victorian period, there was an increased public concern for the control and eradication of diseases and for improved sanitary and health conditions. It was around this time that more people, especially of the middle and upper classes, began keeping pets indoors. During this period, there were entrepreneurs who saw pest problems as opportunities, such as Emanuel Lyon. In the 19th century, industrial man-made chemicals were produced with the need for insect control propelling some of this research. Eventually, after it

was shown that some of the chemicals used as pesticides and insecticides were harmful to human and non-human lives, their use was regulated and monitored by the U.S. federal government. Federal entomological experts such as L. O. Howard led the way in devising appropriate remedies for eradicating fleas and other insects, while attempting to reduce the toxicity of the solutions. Victorian period ideals combined with agricultural growth in the U.S. to form a need for insect control. The U.S., unlike England, saw rapid westward expansion along with an exponential growth in agricultural production, which increased the amount of insect pests. Fleas, although not agricultural pests, were uninvited household guests. Household pests were a focus of entomological research in the Progressive period in the U.S., especially within the United States Department of Agriculture. The efforts to control fleas would have been useless, however, if research into their life cycles and habits was not undertaken. The need for flea control propelled researchers, such as L. O. Howard, to discover more information about the flea.

Insect eradication was not an invention borne of the Victorian period. For centuries, flea and insect control concoctions were derived from natural components like flowers, herbs, and other plants found to be harmful to the insect pests. The ancient Egyptians used date flour and water for flea control.¹⁸² Other ancient peoples used a coriander water concoction to kill fleas. Albertus noted a thirteenth-century remedy which was a spray comprised of colocynthor rubus, a type of bitter apple.¹⁸³ Although these forms of control are typically thought of as home remedies, they were examples of how humans controlled insects using insecticides. Oberemok and his collaborators discussed the history of insecticide use in their article, “A Short History of Insecticides.” They surmised that insecticide use was derived from nature and occurred centuries ago. Insecticides were likely first used by early farmers. They also observed that it was not until the 19th century that chemicals were specifically developed for use against insect pests.¹⁸⁴ These

chemical insecticides were more potent and were produced on a commercial scale never seen before. Paris green was one of the insecticides popular during the Victorian period. Paris green was used on a massive level to destroy insects ranging from Colorado beetles in England to gypsy moths in the United States. Flea control, during this period, depended on older methods as well as powders and potions created by druggists and chemists.

In the early 1800s, entomologists began to realize the importance of studying insects because of their proximity to and effects on humans. Learning insects' life cycles and how they affected humans was of growing importance. Insects affected crops, especially in the U.S. Due to the increase of crop destruction caused by insects, by the beginning of the twentieth century the U.S. would lead the world in applied entomology. Fleas were common and perpetual nuisances who invaded households like Attila's Huns. Furthermore, Victorian ideals of cleanliness would clash with the realities of indoor pet keeping to promote a healthy dislike for insects like the flea. These amplified dislikes were nurtured by consumerism and the increased advertising of soaps to produce a blossoming industry for flea control products.

Flea control had been addressed before the Victorian and Progressive periods. In the July 21, 1826, issue of *The New England Farmer and Horticultural Register*, there was an indexed reference for a "flea garden remedy."¹⁸⁵ Eleven years later the same publication featured an article about how to control ground fleas. The solution was to spread tanner's waster around the perimeter of plants. It was also recommended that tan be put on hills as an eradication measure for a yellow bug, presumably the one that ate the vines of concern in this article. The short article did not mention why ground fleas needed to be eradicated. Fleas are parasitic and would not eat vines or any other plant. It is likely that the fleas saw the garden as an optimal breeding area. This remedy was a way to destroy them along with other insects that were detrimental to plant

life. As seen in Chapter 1, the study of insects which affected agricultural production was one of the first pushes in modernity leading to the development of the entomological field. *The New England Farmer* specialized in horticulture and offered information and advice for eradicating fleas from gardens and other outdoor areas. This was before the advent of grocery stores and convenient food options. Keeping crops healthy and insect free was often a life or death situation. In an 1844 issue of *The Annals and Magazine of Natural History*, there was a report of another remedy that was discovered while the author, Professor Francois-Joseph Cantraine, was in Eastern Europe. He discovered that the Bosnians and Dalmations had been using the chrysanthemum plant, kept at the foot of the beds of dogs and cats, to ward off fleas. Cantraine claimed it was effective.¹⁸⁶ A common link between these articles, and others addressing the same topic, is that they described home remedies. In the 1840s, flea control products were not being produced, advertised, marketed, or sold as much as they would be by the start of the 20th century. Soap, an item that was being marketed heavily beginning in the Victorian period, would become another important impetus for the eventual demand for flea control products.

The advertising of soap was integral to the promotion of ideals of cleanliness. Soap existed before the Victorian period, but it was not as heavily advertised or categorized into many different varieties. Kelley Anne Graham and Victoria Kelley examined the phenomenon of cleanliness and soap advertising in the Victorian period. Their work is important; it adds to historical context surrounding hygienic practices in the Victorian period as well as the context of the rise of a robust advertising industry. This advertising industry was often instrumental in the promotion of flea powders and other insect removal methods.

The Victorian period saw an increase in touting the benefits of cleanliness and the importance of good hygiene. Victoria Kelley argued that cleanliness during the Victorian period

was closely related to socioeconomic status and gender roles typical of that period. It was the woman's duty to keep a house free from filth.¹⁸⁷ Additionally, this discussion involved the concept of civilization and education for the lower classes and masses. Proper "civilized" Victorian women would never allow their homes to become bastions of filth and disease. Cleanliness was a middle-class ideal that was pushed onto lower class women. Although the lower classes often resisted these measures to regulate their hygienic habits, especially in England,¹⁸⁸ the ideal of a sparkling clean home was prevalent.

According to commonly held Victorian notions of what constituted "proper" behavior for women, women were responsible for maintaining the domestic sphere. Household manuals often were published with women in mind, during this period and continuing into the 20th century. The original preface of the *Manual of Household Work and Management* of 1913 stated that the publication was for "all classes of women."¹⁸⁹ This manual included information on how to control insect pests. For fleas, it was recommended that Persian powder be sprinkled on bedding to prevent an infestation.¹⁹⁰ Persian powder was nothing more than chrysanthemum powder. The chrysanthemum plant, as discussed previously, was a long held remedy for flea infestations. Moreover, "bedding" is not overly specific but it could have referred to either human bedding or the bedding of animals. The Victorian period, and the immediate years after, saw a marked rise in the number of pets acquired and kept indoors. Whether pets were indoors or outdoors, the increase in cats and dogs meant an increase in fleas.

Katherine Grier discussed pet keeping in the United States between 1840 and 1940. She discovered that the first general reference book for pet keeping, *The Book of Household Pets*, was published in 1866.¹⁹¹ By this time, the keeping of pets had technically existed for centuries. It was during this period, however, that there was a notable increase in the keeping of indoor

pets. This resulted in an increase in publications and products for pet keeping. The pets kept then were not too different than the pets kept in modernity. Pets included fish, birds, cats, and most importantly, dogs. Fish and birds were commonly kept indoors while most households kept cats outdoors as workers and mousers, at least until the 1950s.¹⁹² Dog were coming indoors more often and were the not-so-occasional cause of flea infestations.

As the 1800s passed, farmers, housewives, tenement dwellers, and others who were bothered by the flighty flea did not have to rely solely on home remedies. Given the sanitary conditions of the 1800s, or lack thereof, entrepreneurs recognized the need for the control and eradication of household pests. One such entrepreneur was Emanuel Lyon. He was the creator and promotor of Lyon's Magnetic Powder. Ads for his product were published in newspapers from the 1850s until the 1870s. Lyon's Magnetic Powder, and others like it, were advertised and produced in the U.S. during a period of lax governmental regulatory practices. It was often claimed that these earlier and unregulated powders and potions were worse than the problem they were created to cure.¹⁹³

The advertising and marketing of various patent medicines during the second half of the 19th century were akin to how flea control products were being promoted. Ann Anderson examined the role that advertising played in the patent medicine industry. She found that "readers were hammered with outlandish claims for cure-alls and insidious suggestions that lethal disease lurked in their unmedicated bodies."¹⁹⁴ This sentiment is closely related to the propagation of cleanliness via soap advertising. In addition to being told that filthy homes were immoral and uncivilized, people were told that they fostered disease. The only cure for some of these ailments was, of course, the cure offered by the oft travelling patent medicine makers.

Lyon's Magnetic Powder was designed to kill fleas and other insect pests. The powder was heavily advertised in newspapers. Being one of the earliest known insect powder proprietors, Emanuel Lyon warrants a closer examination. Moreover, some of his ads specifically mentioned fleas in the product name.¹⁹⁵ Lyon's advertisements ran in a variety of newspapers, which provides a decent amount of material for analysis. Unfortunately, Lyon's background is unclear. It is unlikely that he was involved in naturalist pursuits or the nascent entomological profession. Furthermore, it can be assumed that he was not a veterinarian. Small animal veterinarians were not common during the American Victorian period. Although those who fancied themselves doctors and small pet veterinarians likely had some knowledge about companion animals, such as dogs and cats, they were not licensed professionals. Licensing at the turn of the century was not common. Susan Jones stated that only a handful of colleges and universities in North America at the turn of the 20th century offered veterinary courses or certificates and that most veterinarians at the time trained through experience or work under a practicing veterinarian.¹⁹⁶ Moreover, she noted that it was uncommon for veterinarians to practice on pets. Most veterinarians viewed animals in economical or practical terms. They looked upon the sentimentality associated with pet keeping with disdain and linked it to femininity.¹⁹⁷ Cleanliness of the home was also viewed as part of a woman's duty. The idea of cleanliness, almost non-existent veterinary care for 19th-century pet animals, and the lack of regulation for consumer goods created an atmosphere in which Lyon could attempt to build a successful flea powder business.

Lyon knew how to promote his product. His ads often featured testimonials such as the one included in the February 12, 1852, issue of *The Independent*. In this ad, chemist James R. Chilton touted the efficacy of the powder in killing fleas and other insects while explaining that

there was no danger to humans.¹⁹⁸ An ad from the November 14, 1866, issue of *The British Columbian* started with a promise of “death to fleas.”¹⁹⁹ An 1869 ad for an insect removal powder produced by E. Lyon urged consumers not to accept imitations and claimed that only his powder would kill fleas, moths, and other bugs.²⁰⁰ In addition to the claims of the efficacy of his powders, Lyon and Chilton tried to demonstrate that Lyon’s products were not harmful to humans. This concern for human safety would increase from this period on and would prove to be influential in shifting the responsibility for flea removal from amateurs to federally funded professional entomologists who found new ways for insect eradication.

It is possible that Lyon was not a chemist but he did use recognized chemists to provide assurance to consumers that his products were not harmful to humans. In the 1835-1836 edition of *Longworth’s American Almanac, New-York Register, and City Directory*, James R. Chilton was listed as an M.D. who worked at 263 Broadway. His father, George Chilton, was listed at the same address as a chemist and apothecary.²⁰¹ George’s obituary, published in the *American Journal of Science and Arts* of 1837, told of George’s contributions to 19th-century chemistry, including the creation of chrome yellow. The obituary also mentioned James R. Chilton and claimed that he was an experienced chemist, trained by his operative chemist father.²⁰² James Chilton was used by Lyon to promote his products. Chilton was a household name in chemistry during the 19th century. James and his father were called upon by various health boards and companies for analysis and testimony. For example, *Philadelphia and Its Manufactures* listed an analysis of lager beer which was performed by James Chilton.²⁰³ An 1842 edition of the *Journal and Documents of the Board of Assistants of the City of New York* listed a testimonial regarding the safety of lead and tin alloy pipes submitted by chemist, Jas. R. Chilton.²⁰⁴ The Chiltons were widely used for chemical analyses and the names carried weight with consumers.

Lyon's promotion of his flea powder was not exceptional. Although his ads described some of the earliest proprietary powders produced, there were other companies who made the same claims. A Keating's Insect Powder ad from an 1879 edition of the *Sydney Morning Herald* urged consumers to "ask for, and take no other than."²⁰⁵ An 1896 ad for an unnamed insect powder claimed that it might cost more but it worked better and was pure.²⁰⁶ An 1899 ad for SureDeath Insect Powder touted its supposed purity and advised against accepting any substitutes.²⁰⁷ The claims continued into the early 20th century. In 1906, the same year the Pure Food and Drug Act was passed, an ad for insect powder from Wardin's Drug Store was placed in *The Nevada Daily Mail*. There were no claims for the purity of that insect powder but Lyon's ads rarely mentioned purity either. His ads, however, spanned between the 1850s and the 1870s, before the public and political mood shifted towards acceptance of government regulation. Lyon's ads for insect powder were some of the earliest for these products. Although it would be unwise to assume that Lyon invented flea and insect powders and the advertising thereof, he took advantage of a clear void in the market during the early Victorian period.

Because cleanliness and pet keeping were associated with women and femininity, Lyon saw another opportunity for promotion and marketed his products towards female members of the household. In an ad from June 28, 1874, he briefly stated that his powder could be dusted on ladies' furs to control moths, worms, and insects.²⁰⁸ This connection between women and cleanliness continued into the Progressive period. Marion Harland, a columnist for the *Los Angeles Times*, who wrote on matters of housekeeping, frequently tackled the problems of fleas and pests. In a column of March 20, 1902, she promoted sulpho naphthol to exterminate fleas, as well as other household pests. She insisted that it was for sale by most druggists and that "for dogs with fleas it is a marvel, as it will kill every one of them."²⁰⁹ Although no brand was

mentioned, chemical remedies offered by drugstore chemists were acceptable solutions to the problem of fleas. The use of sulphur compounds in insect control efforts dates to the 1830s.²¹⁰ This could explain why early druggists promoted this as a remedy, even beyond the Victorian period. That the article was directed at women is indicative of the view of that women were in control of their domestic surroundings. Their domestic duties included the removal of dirt and insects, indicators of a filthy household. The urge for clean and pest free homes meant that more preventative and eradication efforts were needed against these pests. These efforts were to come from professional entomologists employed by the USDA who were on a mission to eradicate household pests as well as agricultural insect pests.

Insect control became a greater concern for the public as the 19th century flowed into the 20th. The concern became so great that the federal government decided to intervene. In 1854, before the USDA was officially established as a department, it existed as a smaller subset of the federal government. In 1862, the USDA was established with a provision for the first federal appointment of a professional entomologist.²¹¹ Thirty-two years later, the Bureau of Entomology was established within the USDA. At this time, there was special concern amongst farmers, horticulturists, and the American public about the damages caused by insects.²¹² Additionally, the second half of the 19th century saw a peak in the number of invasive species which found their way to the U.S.²¹³ Economical, agricultural, empirical, and political considerations and involvements all coalesced to provide the impetus for the U.S. government, on behalf of public and business interests, to develop methods to control harmful insects.

Fleas, although neither an invasive species nor one that typically damages crops, did not escape the attention of the USDA entomologists. Leland Ossian Howard worked diligently to overcome and eradicate insect pests that were creating problems. He mostly focused on

household insect pests, such as the mosquito and the fly. He did, however, publish a variety of bulletins relating to flea control. Howard held a Ph.D. from Cornell University in natural history.²¹⁴ He was a professional entomologist who was qualified to give advice on the eradication of insects. From 1894 until 1927, Howard worked at the United States Department of Agriculture. Part of his tenure was as chief of the Bureau of Entomology, whose goal was to investigate agricultural and household insect pests and to disseminate the information to farmers, horticulturalists, and the rural U.S. Howard published on fleas and was recognized as an expert entomologist.²¹⁵ He researched and reported on many species of insects and demonstrated this knowledge through his bulletins and articles. These bulletins and articles were written for the audience which would benefit most from the information, mostly those outside of the entomological profession.²¹⁶ Howard had an interest in insect control for the benefit of humans, their health, and their food production. Moreover, he tirelessly and continuously encouraged the public to study insects and their life cycles.²¹⁷ Since fleas were an undeniable part of the experience of living and from 1898 known disease vectors, the USDA, with Howard leading the way, started increasing its publications on flea control. Howard wrote bulletins on the boll weevil, gypsy moth, tobacco pests, and fleas. Additionally, newspapers published interviews with Howard and excerpts from his work. Through these newspaper reports Howard, much as Charles Rothschild, became known and respected in professional entomological circles as well as with the public.

One of the earliest newspaper references to L. O. Howard comes from an article entitled “Farm and Garden,” from the October 29, 1896, edition of *The Daily Reporter*. Howard was cited as an advocate for the use of multiple resources when attempting to eradicate insects as the cost of spraying machinery was prohibitive for many.²¹⁸ This demonstrates his concern for the

average member of the American public. His writings were typically geared toward farmers, housewives, and gardeners, the average American citizen. In 1897, he published a bulletin for the USDA on mosquitoes and fleas. He noted that flea infestations in the U.S. were typically caused by dog and cat fleas, because human fleas were not very common in the Americas.²¹⁹ Again, he was writing practically for an audience of lay people who needed the information. An August 23, 1899, article in the *New York Times* referred to Howard as “one of the most expert of all Government entomologists.”²²⁰ This article cited Howard as declaring that spider bites were not known to be fatal. He was dedicated to the field and wanted to dispel as many myths as possible about insects. Additionally, he worked tirelessly to find productive and practical solutions to insect problems.

The December 20, 1906, edition of *The Independent* included Howard’s article entitled “Household Insects.” Regarding fleas, he reiterated his previous assertions that the most common household fleas were dog and cat fleas.²²¹ Many U.S. citizens owned cats and dogs, if not both. As previously mentioned, more pets were being kept indoors. Howard also blamed “dog-houses in the garden.” He noted that pyrethrum, derived from chrysanthemums, was not as effective as some claimed it to be.²²² In 1910, Howard would publish his *Insect Book*. The solutions offered in this work ranged from soap and water to benzene spray. He also recommended “free use” of pyrethrum powder, despite his earlier claim that it is not always effective.²²³ Much of this information on fleas ceased to be new. His information on fleas had rarely changed since his first publications of the 1890s. Regardless, fleas and the plague were not a concern for most U.S. citizens. It is understandable that he stated and restated the information about dog and cat fleas and solutions for their eradication as these were the fleas most likely to affect his intended audiences. Additionally, he did not recommend patent or proprietary powders as potential

panaceas. Neither Lyon's Magnetic Powder nor any other such product was mentioned in his reports or bulletins.

In a 1907-1908 edition of *Science*, Howard discussed two flea remedies which he had yet to test. Howard insisted that flea control had never been so important. Both remedies appeared to have been older and time tested but they were also both proposed by those connected to the entomological field. One remedy, submitted by entomologist E. M. Ehrhorn, involved a bowl of soap suds with a contraption in the middle for kerosene to be lit. The fleas were said to be attracted to the fire which would cause them to fall into the suds and drown. The other remedy was culled from a writer on ants who swore that alum was the solution to fleas.²²⁴ Flea control was being taken seriously by entomologists, agriculturalists, and other professionals. In addition to the eradication of fleas and other insects, Howard was dedicated to encouraging people to learn about insects and their life-cycles. More importantly, Howard represented the new era of government involvement in finding solutions for the problems of insect pests, which, at one point, were estimated to have cost U.S. farmers and horticulturalists millions, if not billions, of dollars in losses.²²⁵

In 1908, Howard published another bulletin on fleas for the USDA, entitled *House Fleas*. Although some information included had been unchanged since his earlier publications on fleas, there were some new remedies noted. He did not favor carpet or straw bedding, which was not new. He mentioned a different remedy, however, involving raw meat and fly paper but he assured his readers that it was mostly ineffective.²²⁶ Moreover, one of the remedies included was the one Howard discussed a few years earlier, Ehrhorn's soap suds and kerosene contraption. Additionally, he continued to tout the effectiveness of benzene spray and pyrethrum powder as remedies. Howard's inclusion of different and various remedies demonstrated his persistent

dedication to finding practical solutions for the American public's pest problems. It also demonstrated a willingness and eagerness to experiment with different remedies which was indicative of his formal education. It took a dedicated individual to repeatedly try various solutions to insect problems. The Progressive period was notable for its insistence for quick solutions to problems²²⁷ and Howard's work exemplified those ideals. Outside of the occasional home remedy, the cures for flea infestations continued to be powders and sprays, insecticides.

Insecticides during the Victorian and early Progressive years were unregulated in the U.S. This was to change with the Pure Food and Drug Act of 1906 and the Insecticide Act of 1910. Following decades of industrial growth, these acts were passed amidst a growing concern on behalf of the American public for safety in consumption. As Ilyse D. Barkan argued in her article on the Pure Food and Drug Act of 1906, part of the push for regulation of food and medicines came from journals, newspapers, and other publications. Journals reported on adulterated foods, patent medicines, and alcohol. These reports did nothing but exacerbate the public's mistrust of industrial and business titans.²²⁸ During the early 1900s, there was a noticeable anti-business mood in the U.S. This was not solely the result of the media but connections were being made between poor health and poor living standards, which included the consumption of adulterated food and medicine. As the federal government began more research into various industries, their products, and their claims, it was discovered that many of these products were more harmful than beneficial. These harmful products were not limited to food and medicine but also involved insecticides.

Roughly four years after the passage of the Pure Food and Drug Act, the Insecticide Act of 1910 was passed. The concern for safety centered around humans. The Federal Insecticide, Fungicide, and Rodenticide Act, the formal title of the Insecticide Act of 1910, was also

designed to decrease the sale and manufacture of adulterated insecticides. This Act, much like the Food and Drug Act of 1906, was supposed to protect consumers, the industry, and the environment. Another likely prompt for this legislation was the attention paid to the harmful properties of arsenic. Arsenic was a main ingredient in insecticides like Paris green. With regulation, the flea control industry became more professionalized and regulated and, ultimately, more successful in creating goods which would safely and adequately control these pests. This regulation of chemical products also coincided with vigorous efforts undertaken by Howard and other USDA entomologists to understand insect pests so that they could be removed or eradicated successfully.

The intervention of the U.S. government in the production and sale of consumer goods and insecticides reflected a change in the national tone regarding business practices.²²⁹ As previously stated, the widespread dissemination of information via newspapers and periodicals partially contributed to this change. Also contributing was an increase in the importance of chemistry and other sciences, along with scientific discoveries and research in foods, drugs, medicines, insecticides, and pesticides. The U.S. government realized not only that adulterated products negatively affected humans and potentially the environment but also that those poor products meant a loss of profits and business opportunities as company reputations were ruined in the U.S. and overseas.²³⁰ The previously mentioned acts and moods of the public now came to affect the flea control industry. Moreover, the growing connections made between insects and diseases further propelled efforts to control pests and ultimately led to more federal involvement in pest control.

F.C. Bishopp was another entomologist within the USDA. As the Entomological Assistant in the Bureau of Entomology, he too wrote bulletins for the Bureau. In 1915, his thirty-

one-page bulletin on fleas was published. Bishopp, according to his obituary, did heavy research into insects which affected livestock and other agricultural pests, such as cattle fever ticks, cattle grubs, and poultry insects.²³¹ This concern for the agricultural industry mirrored Howard's interests in losses suffered by the agricultural industry due to insects. This also reflected their employment within the USDA. Throughout the bulletin, Bishopp cited other entomologists, presumably those with more experience with fleas. Howard's and Bishopp's work proved that knowledge of the flea had become more scientifically developed since the earlier years of the Victorian period. This work also cemented knowledge gained and disseminated over earlier centuries and even confirmed claims made by Bertolotto and Heckler. Citing work done in California which found that the human flea could jump up to thirteen inches, Bishopp noted that "the human flea is probably the strongest jumper."²³²

Howard, along with Bishopp and other USDA entomologists, represented a shift away from the amateur and leisurely pursuit of knowledge about the flea. In the article that addressed the "flea plague" in Brooklyn, from 1889, it was reported that fleas were not the subject of much study.²³³ Less than a decade after that article was written, Howard was publishing bulletins concerning fleas, their life cycles, and proposed solutions for ridding areas of them, on behalf of the USDA. Government involvement in the control and eradication of insect pests was the result of various social, political, and economic conditions. The need to control household pests, in addition to agricultural pests, created the conditions necessary for the mainstream study of the flea.

The perceived need for flea eradication jumped dramatically during the Victorian period and continued immediately thereafter. Victorian age ideals of cleanliness, consumerism, companion animal ownership, and crafted concoctions camouflaged as cures combined to

prompt concerned citizens to make clarion calls for flea eradication. The Progressive period in the U.S. saw changes in attitudes towards business and adulterated products. Health concerns ran rampant among the public and housewives wanted to eliminate insect life from inside their homes. Fleas were connected to disease and dirt, which civilized and educated people should never have allowed into their homes. The products to remove these creatures were often more harmful than helpful until federal legislation and regulations were created to stem the flow of these toxic products. Although the USDA concentrated on agricultural pests, some federal entomologists focused more on household pests. Even though plague concerns were not relevant in the U.S., fleas were household pests. Because of this, there was a greater need for information about the flea. Lyon may have been one of the first to create insect powders that specifically targeted fleas but it took federal intervention and entomologists like L. O. Howard to bring flea research to the mainstream public. Without the work of newly professionalized entomologists working under a federal organization, control and eradication efforts for the flea may not have progressed as quickly as they did and dogs and housewives would have suffered a while longer.

Conclusion

“To distinguish between eccentricity and genius may be difficult, but it is surely better to bear with singularity than to crush originality.”²³⁴ Although the stereotype that bug enthusiasts were eccentrics lessened by the end of the nineteenth century, this anonymously authored maxim could easily be applied to the pioneering pulex investigators Louis Bertolotto, William Heckler, Charles Rothschild, Karl Jordan, and L. O. Howard. These “eccentrics,” who formed three different kinds of relationships with fleas, contributed new and important information to the non-medical study of the flea during the Victorian and Progressive periods. Although studies of insects proliferated during the Victorian and Progressive periods and entomology professionalized, the flea remained a neglected insect. This thesis showcased the varying relationships that these figures had with their fleas, as entertainers, collectible commodities, and household pests, and how the nature of these relationships contributed to the development and professionalization of the entomological study of the flea.

To say that Bertolotto, Heckler, Rothschild, Jordan, and Howard were eccentrics or geniuses would be unfair. Their understudied contributions to entomological studies of the flea fall somewhere in the middle. The study of the flea, its life cycles, and its origins dates to antiquity, with Aristotle’s paving the way for future research. His work was expanded upon and amended by the likes of Albertus Magnus, Robert Hooke, Antoni van Leeuwenhoek, and Harold Russell. The invention of the microscope, the Scientific Revolution, and the fleas’ eventual identification as a disease vector increased the amount of flea research undertaken. This research has been known and discussed for decades. What has been typically omitted from historical studies of the flea are the contributions made by the flea circus masters, Bertolotto and Heckler, the wealthy collectors and their taxonomist colleague, the Rothschilds and Jordan, and those who

worked diligently to eradicate fleas, Lyon and Howard. Each of these groups had a distinct relationship with fleas. These relationships provided impetus for distinct and fruitful exploration of fleas.

Bertolotto and Heckler created miniature circuses with their fleas in the Victorian and Progressive periods, respectively. They published pamphlets comprised of knowledge gained through their careful observations, some experimentation, and close relationships with fleas as trained performers. Although their assertion that their fleas were trained or educated was usually dismissed, the discourse that centered on the training of fleas could have been important to the development of the idea that insects were intelligent or capable of learning. The debate of insects as automatons increased during the Victorian period. Bertolotto's and Heckler's work has been overlooked for what it added to the debate about the potential intelligence of insects during the nineteenth and early twentieth centuries.

Charles Rothschild's and Karl Jordan's research with fleas has been understudied and undervalued. Rothschild was wealthy and viewed fleas as objects for collections. His financial well-being enabled him to amass a collection of thousands of fleas. As a recognized taxonomist, Jordan assisted Charles in the classification and cataloguing of his extensive collection. Charles's collection and Jordan's taxonomical skills led them to discover the Oriental rat flea. This species of flea is a main carrier of the bubonic plague. Charles and Jordan were hailed for identification of the Oriental rat flea and other entomological work but modern studies of the flea and general histories of entomology either ignore the pair or include but passing references to them.

Lyon and Howard were active in earlier efforts to eradicate fleas. They viewed fleas as unwelcome household pests. They worked tirelessly to promote their methods for flea removal. Lyon advertised one of the first proprietary powders specifically marketed towards the

destruction of fleas. Although Lyon did not contribute new information to the study of the flea, his insect powders were representative of the view that fleas were household pests and of Victorian period ideals about cleanliness. Howard was one of the first entomologists within the USDA and paid close attention to fleas as household pests. His work for the USDA led him to publish several bulletins on fleas and how to remove them from the home. Through his publications and interest in fleas as household pests, Howard succeeded in bringing the non-medical study of fleas from obscurity into the mainstream of entomology. Like Charles Rothschild, Howard's work on fleas is often overlooked in favor of his other research.

The U.S. and England experienced a vast variety of changes throughout the Victorian and Progressive periods. How fleas were studied evolved in tandem with the greater developments made to the study of insects and the professionalization of entomology. Flea research during this time of growth in the study of naturalist pursuits, however, was largely ignored in favor of research on other insects. The butterfly, moth, beetle, ant, and bee all saw renewed interest and an explosion of information learned about them and disseminated in popular and academic studies. Information learned about fleas during those periods, made by the flea circus masters, collectors and taxonomists, and the flea eradicators, has been undervalued and understudied in historical examinations of the study of the flea and entomology. This thesis corrects this omission. Additionally, the thesis contributes to historical studies of scientific research and advancements as well as the development of entomology as a field of study and as a profession. Moreover, this thesis shows how an expanded historical study of the flea deepens understanding of humans, their history, and their interaction with other living beings.

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CONCLUSION

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