A Social Network and Text Analysis of Charles Darwin's Correspondence, 1835-1842.

by

Caroline Floyd

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ABSTRACT

A SOCIAL NETWORK AND TEXT ANALYSIS OF CHARLES DARWIN’S CORRESPONDENCE, 1835-1842.

Caroline Floyd
University of Guelph, 2019.

Popular and historical conceptions of Charles Darwin portray him as a lone scientific genius. My thesis challenges this picture by using digital tools from the digital humanities to analyze the collaborative process and extensive production timeline of his theory of evolution. My work characterizes him as a project manager figure identified through trends in his professional and personal communities. While traditional historical analysis has offered insight into Darwin’s collaborative networks, my work adds to this by digitally re-creating the academic network surrounding Darwin’s theory. I examined Darwin’s correspondences from 1835 to 1842, a period identified by historian Martin Rudwick (1982) as significant in the formulation of his theory. I generated social network visualizations separately for “hidden figure’s”, academic colleagues, and family members for each year, and I used text-based analysis to identify and compare key terms allowing identification of content within given letters representative of an individual’s original idea.
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Chapter 1: Introduction

In 1836, British Naval Captain Robert FitzRoy was approached by the magistrate of London, William John Broderip, about a three-volume joint publication that included his research journal along with those of Charles Darwin and Captain Phillip King\(^1\) from the *H.M.S. Beagle* voyage.\(^2\) Experiencing a delayed departure, the *Beagle* left from Davenport in December 1831. The entire voyage encompassed five-years, originally intended to last only two. Beginning in the Azores, the *Beagle* travelled to South America, the Galápagos Islands, New Zealand, Australia, the Keeling Islands, the tip of Africa, with a quick return to Bahia in Brazil before docking in Falmouth, England on October 2\(^{nd}\), 1836.\(^3\)

Each contributor was given their own volume, Darwin authored his *Journal of Researches* (1839) (later named *The Voyage of the Beagle*) along with a Preface to FitzRoy’s volume. Between his time on the *Beagle* and the volumes’ publication, Darwin’s scientific status had improved. However, Darwin tended to fail to acknowledge those who assisted him along his path.\(^4\) FitzRoy did not let this go unnoticed in his return of criticism to Darwin’s preliminary Preface to FitzRoy’s *Journal* volume:

“…Most people (who know anything of the subject) are aware that you’re going in the *Beagle* was a consequence of my original idea and suggestion—and of my offer to give up part of my own accommodations—small as they were—to a scientific gentleman who would do justice to the opportunities so afforded.— Those persons also know how much the Officers furthered your views—and gave you the preference upon all occasions—(especially Sullivan—Usborne—Bynoe and Stokes)—and think—with me—that a plain acknowledgment—without a word of flattery—or

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\(^1\) Efram Sera-Shrijar, “Tales from Patagonia: Phillip Parker King and early Ethnographic Observation in British Ethnology, 1826-1830,” *Studies in Travel Writing* Vol 19, No 3 (2015): 205. Phillip Parker King was a commanding officer of the *Beagle* but his work did not achieve great recognition due to the prominence of Darwin’s work on his second *Beagle* voyage (1831 to 1836). During King’s first *Beagle* voyage (1826 to 1830) he was responsible for the geological survey of the Strait of Magellan.


fulsome praise—is a slight return due from you to those who held the ladder by which you mounted to a position where your industry—enterprise—and talent could be thoroughly demonstrated—and become useful to our countrymen—and—I may truly say—to the world…"

In what function as a back-handed compliment and criticism of Darwin’s character, FitzRoy drew attention to the lack of representation of very crucial individuals within Darwin’s process of specimen collection and geological observation onboard the Beagle, and in his subsequent publications, Zoology of the Beagle Voyage (1838-43) and Journal of Researches (1839). FitzRoy’s words encouraged Darwin to write a more inclusive Preface.6

While aboard the Beagle, Darwin’s fame had grown in London due to the extensive research notes, fossils, and specimens he sent to his mentor, the botanist John Stevens Henslow in Cambridge.7 Henslow amassed Darwin’s collection and avidly presented select pieces to the largest names of the scientific world in London.8 The immediate fame Darwin received upon his return was substantial, and as FitzRoy argued, achieved in part by the work of other men. From the very start, Darwin’s inclusion in the Beagle voyage was specifically as a gentlemen companion for FitzRoy.9 He was expected to dine, converse, and spend leisure time with FitzRoy throughout the voyage, to maintain ‘a normal life’ in the words of FitzRoy.10 What FitzRoy means here is ‘normal’ social stratification, clear in his requirement of ‘gentlemen’ company seeking an individual of good family and financial support, with appropriate social status and scientific knowledge.11 Social stratification was intentional and useful on the ship to stimulate respect for commanding officers in the enforcement of a naval command structure. The social

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7 Ibid., 335.
8 Ibid., 334.
9 Ibid., 149.
10 Ibid., 148.
11 Ibid., 149.
status of the Darwin family allowed Darwin to fit neatly into the upper class of the ships social order. At first, the naval officers were not fond of Darwin but came to appreciate his knowledge and respected him, bestowing him the nickname *philos*, the ship’s philosopher.¹²

Darwin returned from the *Beagle* voyage with a changed character and professional image.¹³ Before the voyage Darwin was an unknown entity, changing drastically to a figure in social and scientific demand upon his return.¹⁴ Darwin’s ‘awakening’ involved the realization of key evidences (e.g. rhea and Ostridge split range distribution in South America, Galápagos island-specific variation of finches and mockingbirds) forming prominent pieces of his evolutionary theory.

By viewing Darwin through a lens that focuses on these influences, he emerges as a leading man of science but one that drew from an extensive background network of people to support himself throughout his career. This picture of Darwin has been demonstrated by historians such as Janet Browne, Adrian Desmond, and James Moore.¹⁵ This thesis adds to this picture through a close examination of Darwin’s correspondence during his period of evidence collection between 1835 and 1842, analyzing the collaborative process and extensive production timeline of Darwin’s theory of evolution. I analyze his correspondence using tools created by the digital humanities community. Broadly speaking, my thesis asks what we can learn about Darwin’s period of evidence collection and process using digital humanities tools, and what a focus on his correspondence can tell us about the role that various groups played within Darwin’s work between 1835 and 1842.

¹⁴ Ibid., 21.
The intent of my investigation is to increase understanding of the context and dynamism of Darwin’s collaborative process between 1835 to 1842, and how this impacted the development of his evolutionary theory. In a broader context, my research was directed by the following questions: What can a focus on his correspondence via digital tools tell us about the role each of these groups played in Darwin’s work between 1835 and 1842? What can we learn about Darwin’s period of evidence collection and process between 1835 and 1842 using digital humanities tools? More specifically, I examined the way in which social network analysis reveals new information about Darwin and his exchange of scientific information with correspondents during this period by addressing the following questions: How did Darwin’s network evolve during this period? Was it about developing understanding or just gathering evidence or both? Who were the “hidden figures” and how much were they under-represented? How were the “contribution dynamics” of his colleagues, “hidden figures”, and family different from each other? Were they sounding boards or active contributors? To what extent were discussions public or private? Finally, my text analysis aimed to provide insight into changes in Darwin’s terminology in correspondence between 1835 and 1842, by addressing these questions: What was the nature of contributions using key term lists? Can we capture Darwin’s transition from geologist to naturalist?

The collection of primary documents for this project comes from the Darwin Correspondence Project (DCP) archive of 15,000 of Darwin’s letters, forming the most comprehensive collection of his correspondence to date. Established by Frederick Burkhardt in 1974, the DCP has published 25 volumes of the collection to date, up to 1877, and plans to publish the entire collection by 2025. Letters were digitized and placed in their online searchable database, provided for this project in TEI format. Social network visualizations and analyses
were generated using Gephi, a visualization software. Network visualizations identified “hidden figures”, previously unconsidered familial contributions, and patterns in overall network expansion with Darwin’s transition from Cambridge to London after his return from the Beagle voyage in late 1836. Text analysis captured a transition from geological to biological terminology within the content of Darwin’s scientific correspondence, supporting his transition from geologist to naturalist between the years 1835 and 1842.

Digital social network and text analysis revealed that during this crucial period Darwin is best characterized as a self-sufficient master collaborator and project manager working towards his 1842 “first sketch” of the theory. This sketch formed the base of the theory that ultimately appear in On the Origin of Species by Means of Natural Selection (1859). As of his time on the Beagle, Darwin strategically collected evidence and observations of transmutation by natural regulation until publication of his theory. Darwin secured specialized assistance in accurate classification of his Beagle specimen’s in the late 1830s and early 1840s leading him to isolate the natural mechanism at the center of his theory of evolution. He built on the work of his predecessors, pulling together theories from his colleagues, and culling observations from amateur scientists into the first comprehensive theory of evolution by natural means. Darwin had a self-centered motivation, regularly concerned with the productivity of those he employed

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16 Gephi is a network graph and analysis tool designed to assist researchers in their organization of large data sets into network visualizations, supported as an ideal tool for social network analysis; Ken Chervan, Mastering Gephi Network Visualization, (Birmingham: Packt Publishing, 2015): 7-8.

17 Desmond and Moore argue Darwin’s growing status as a naturalist facilitated a greater degree of freedom in use of funding by the Chancellor of Exchequer for his Zoology of the Voyage of H.M.S. Beagle (1838-1843); Desmond and Moore, Darwin: The Life of a Tormented Evolutionist, 226.

due to an unyielding focus on his own work. Darwin organized and paid a premium for assistance to achieve speed and accuracy in these classifications to facilitate progress of his transmutation work. When Darwin identified his own shortcomings in natural history, he immediately co-opted the best anatomists, physiologists, and specialists he could afford. Darwin achieved success through his strategic use of institutional and societal networks, often facilitated through correspondence. The period between 1835 and 1842 was a crucial period for Darwin and his transmutation work. Historian Martin Rudwick argues this period as one of great transition for Darwin, returning from the Beagle voyage in 1836 and moving to London in early 1837.19

While traditional historical analysis has offered insight into Darwin’s collaborative networks,20 my investigation provides a digital re-creation of the academic environment surrounding the development of Darwin’s theory. Rudwick attributes significance of this period, in part, to Darwin’s improved notetaking skills, and his active interaction and collaboration with experts.21 This period saw Darwin experience a transition from scientific isolation upon his return from the Beagle, to a busy social and academic environment in London before his move to Kent in 1842.22 The process of theory development and publication was long and tumultuous for Darwin23 due to the inherent social ramifications of discrediting divine intervention in the processes of nature, and inclusion of humans as part of the animal kingdom.24 Darwin’s theory

22 Ibid., 188-89.
was the result of a process of interlinked scientific communication developing his knowledge base in anatomy, zoology, geology, and natural history, with a complex set of correspondents.

Rudwick draws attention to the immediate contrast in Darwin’s environment, from reclusiveness on the *Beagle* to throwing himself into the highest social circles of Victorian London.\(^{25}\) He emphasizes Darwin’s exposure to these social circles as expanding his correspondence network and extending his reach into a rapidly growing pool of academic activity and scientific knowledge. Browne similarly argues that Darwin reaped value from his London network even before his return on the *Beagle*.\(^{26}\) London scholars were familiar with Darwin’s growing collection due to his correspondence with Henslow. Through their classification efforts they were inadvertently collecting evidence of a natural mechanism for transmutation, for Darwin.\(^{27}\) A majority of activity centered around his *Beagle* specimens, with various specialists and local societies involved in their classification and preservation to divide labor. Rudwick argues this expanding network, along with new techniques in Darwin’s theoretical notetaking skills, facilitated an unmatched intensive work period in Darwin’s career.\(^{28}\) My network analysis analyzes this activity. How did Darwin’s network evolve during this period? Did he use his network to actively develop understanding, to gather evidence, or both?

Darwin communicated with three categories of correspondents during this period; gentlemanly specialists and naturalists, “hidden figures”, often from a lower social class, and members of his family. He accessed gentlemanly specialist and naturalists networks in London and Cambridge through colleague introductions and engagement in varying societies, such as the Geological and Zoology Societies of London, and academic institutions, such as the Hunterian

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\(^{26}\) Browne, *Charles Darwin: Voyaging (Volume I of a Biography)*, 156.


\(^{28}\) Ibid., 188.
and British Museum. Through these avenues, Darwin attained the specialized assistance required to classify, preserve, and analyze specimens collected while accompanying Captain FitzRoy on the Beagle’s second geological survey (1831-36). Infiltration of multiple levels of society by Darwin gained him the mass quantity and diversity of natural information required to support such a socially and scientifically controversial theory. His social maneuverability was evident in his engagement with a range of social classes, especially elite scientific circles through dinner parties, soirées, and private meetings.29 Darwin sought assistance in locating, collecting, storing, and transporting specimens throughout his life, not just in his time on the Beagle.30

Darwin also probed “hidden figures” during this period. Working- and lower-class farmers were targeted to attain observation of random variation in nature,31 as breeders of livestock, farmers had first-hand experience with causes of variation in their stock. Amateur scientists were utilized as ongoing sources of global geological observations, Darwin was a master collaborator and maintained communication with these individuals to secure large amounts of data overtime to solidify his own geological conclusions on regions visited by the Beagle.32 Merchants had a more variable role, straying from provision of scientific books and well-read debate, to sales of rare and important specimens and fossils while on his Beagle voyage. It was not uncommon for Darwin to purchase specimens and fossils, rather than collect them.33 Similar to farmers, animal breeders were sent dense lists of specific questions on the

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29 Desmond and Moore, Darwin: The Life of a Tormented Evolutionist, 212.
31 Desmond and Moore, Darwin: The Life of a Tormented Evolutionist, 282.
33 Browne, Charles Darwin: Voyaging (Volume I of a Biography), 264.
intricacies of domestic breeding. Together, Darwin used these “hidden figures” to seek scientific publications, geological observations, local natural histories, and observations to support his work. I question, to what extent did Darwin under-represent their contributions?

Finally, familial networks and correspondence for Darwin played a different role in his career and personal life than gentlemanly specialists, amateur scientists, or working-class correspondence. The familial role of contribution varied from social indicator with Heinsleigh Wedgwood, sounding board with his sisters, Catherine, Caroline, and Susan, to active contributor with William Darwin Fox. Fox is largely seen as a contributor and sounding board, while his sisters’ roles could be described as research assistants but their use would not stray past sounding boards for Darwin, regardless of relevance, seen through his lack of recognition of their contributions. In the instance of his sister’s contributions, Darwin was perpetuating a socially embedded perception of the inferiority of women, especially in science. His belief was rooted in biological and anatomical differences between sexes that were misconstrued to assert that women did not have the cognitive capacity to make progressive contributions to science.

In analyzing these three categories, my thesis illuminates the contribution dynamics of each group of Darwin correspondents between 1835 and 1842. By constructing network visualizations of the contributing individuals and scientific content exchanged in Darwin’s correspondence of this period using Gephi, I characterize the roles they played in Darwin’s scientific life as varying from sounding boards to active contributors to his research. Darwin’s use of his correspondence network can be packaged as years of external contribution, outreach,

reclusiveness, or intermediary. The years 1835 and 1836 are characterized by outreach from Darwin to his correspondents while on the *Beagle* voyage, and the year 1837 presented the beginning of Darwin’s collaborative phase. Peak diversity in external contribution was reached in the year 1839, when Darwin’s scientific correspondence network was the largest and most dynamic of the eight-year period. Declining in diversity as a result of Darwin’s illness, the year 1840 was intermediary emphasizing a balance between contribution and outreach. The year 1841 maintained this intermediary structure, with a slight increase in external contribution over internal outreach by Darwin due to illness. The year 1842 depicted a similar singular outreach dynamic as the year 1835, but was rather the result of reclusiveness and limited correspondence.

Text-based analysis using the text-analysis software Voyant was used to identify and compare key term frequencies, and create graphical representations based on returned terminology with the highest frequency of use. This method captured the transition of Darwin as a geologist to a naturalist upon his return from the *Beagle* in London, before moving to Down House in Kent in late-September 1842. The terminology returned was predominantly geological and geographical in nature for the years 1835 and 1836, with transition to more biological terminology by the year 1837. The results solidify his early years as a geologist with a clear detectable transition to a view of himself as a naturalist starting in the year 1837 and complete by the year 1841. This coincides with the first appearance of notes on transmutation in Darwin’s personal notebook in the year 1837.37

The London landscape included a growing public versus private separation of Darwin’s character. The most public platforms included published works, circulating manuscripts, society lectures, and pamphlets. A scale of increasing concern for privacy existed starting with dinner

party conversation, correspondence with colleagues, journal and notebook entries, to more private correspondence with family members, and finally use of his personal diary created the private end of Darwin’s character spectrum.\textsuperscript{38} Browne contextualizes details of Darwin’s private theory formulation explaining what proportion of these thoughts he would have repeated in person versus correspondence.\textsuperscript{39} A great strength of her argument is re-creation of the juxtaposition of Darwin’s two images in a way that accurately replicates the mechanistic process, associated discomfort, anxiety, and risk of exposing his true agenda. Interestingly, she argues that his diary entries were not completely representative of his private thoughts, and were intended to be sent back home and read aloud to his family in Shrewsbury.\textsuperscript{40} Browne emphasizes the requirement of critical analysis when studying Darwin on this base exactly, erring on the side of caution when drawing research conclusions from related resources. My analysis of Darwin’s correspondence expands on this public versus private tension in his work and character during this period, by determining which sorts of communications were public and which could be deemed private.

\textsuperscript{40} Browne, \textit{Charles Darwin: Voyaging (Volume I of a Biography)}, 307.
1.1 Digital Methods in History: Google Ngrams

An example of the potential of digital methods for the conduction of historical research is the Google Ngram viewer. This tool can represent historical trends through literature, is freely accessible, and built in an easy-to-use framework. Google Ngram viewer is a text mining software powered by Google Books that graphically visualizes term frequencies through comparison over time. These tools have been effectively incorporated by historians to display changes or trends in terminology eluding to deeper historical transitions.41

The following analysis compared terms ‘natural selection’, ‘transmutation’, and ‘evolution’ displaying two different social trends in the acceptance of evolutionary concepts in the nineteenth-century (Figures 1.1 - 1.3). The first comparison of ‘natural selection’ and ‘evolution’ outlined in Figure 1.1 shows strong social contention over Darwin’s mechanism for evolution, natural selection. The use of the term ‘evolution’ was less religiously contentious than ‘natural selection’ resulting in a higher frequency of use after 1860.42 The term ‘natural selection’ was controversial in Christian Victorian society, because it removed God’s involvement in species modification and formation in the Christian creation story.43

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43 Thagard and Findlay, “Getting to Darwin: Obstacles to Accepting Evolution by Natural Selection,” 629-630.
Figure 1.1 – A comparison of the term frequencies of natural selection and evolution during the nineteenth-century, generated using Google Ngram viewer (supported by the Google Books Archive).

Figure 1.2 – A comparison of the term frequencies of natural selection and transmutation during the nineteenth-century, generated using Google Ngram viewer (supported by the Google Books Archive).

Figure 1.2 shows comparison of terms ‘transmutation’ and ‘natural selection’ in the nineteenth century. Between 1800 and 1858, ‘transmutation’ occurred at a higher frequency than ‘natural selection’, showing natural selection did not emerge in any text in the Google Books collection before the mid-1850s. Darwin’s research during the late 1850s and his *Origin* introduced the term, surpassing the use of transmutation in only few years. This type of visualization is simplistic but effective, relating to any viewer the immediate impact of Darwin’s work in relation to previous work in the field.
Figure 1.3 – A comparison of the term frequencies of evolution and transmutation during the nineteenth-century, generated using Google Ngram viewer (supported by the Google Books Archive).

Extending from this, comparison of ‘transmutation’ and ‘evolution’ term frequencies in Figure 1.3 indicate literary discussion of transmutation never occurred at a higher frequency than evolution, even before Darwin’s publication of *Origin*. The analysis demonstrates that literary use of evolution had always surpassed the use of transmutation during the nineteenth century, discrediting assumptions of a transition from the use of one to the other with the release of *Origin*. 
1.2 Literature Review

1.2.1 Darwin, History, and the Digital Humanities

Historical literature on Darwin has tackled his changing historiographical image, with Bernard Lightman emphasizing a transition in depictions of Darwin after his death in 1882 until 1900 as first a scientist, a great man, and then later evolutionist.\textsuperscript{44} Addressing a later historiographical period, Janet Browne has shown that Darwin’s changing representation is insightful to how society thought of science.\textsuperscript{45} She argues for four waves of historiographical interpretation, each with distinct societally-dependent characteristics.\textsuperscript{46} The first, from 1882 to the 1910s, focused on the hard-working, virtuous, and industrious Darwin as a hero or ideal man of science.\textsuperscript{47} The second wave, from the 1920s to 1940s, took an increasingly social perspective on Darwin as respectable and rational.\textsuperscript{48} The third wave represented Darwin as a biologist with growing support for evolutionary biology in the sciences of the 1950s to 1970s.\textsuperscript{49} The Beagle expedition is boasted as a crucially transformative period in Darwin’s progress towards evolutionary theory, exemplified by Alan Moorehead.\textsuperscript{50} Unfortunately, during this wave association of Darwin with a sudden moment of realization within the Galápagos Archipelago by David Lack\textsuperscript{51} propelled a lone genius over-night success image. This historiographical artefact

\textsuperscript{47} Ibid., 11-15.
\textsuperscript{48} Ibid., 16-17.
\textsuperscript{49} Ibid., 20-24.
has been combated through the elevation of collaborative elements within Darwin’s formative years in the work of Martin Rudwick (1982), Adrian Desmond and James Moore (1991), James Secord (1991), Browne (1996) and throughout the present project. Publication of Darwin’s notebooks and correspondence in the 1970s provided greater insight into his process of theoretical formulation, evidence collection, and external contribution. The final modern wave of historiography, considered the 1980s to present, focusing on the circulation of information and network dynamics of Darwin’s scientific community.

1.2.2 Natural History and Naturalists

Katie Whitaker traces the origin of motivations and practices of collecting natural rarities in England to the elite ‘curiosi’ and ‘virtuosi’ culture of seventeenth century Europe. Their values facilitated the cultural context of natural history and its role in forming the ideal naturalist image of the nineteenth century. My project required comparison of Darwin against this traditional naturalist image to better understand its social context. Lifestyles of seventeenth century English gentry changed through development of an obsession with curiosity fueled by an increasing return of exotic animals, plants, natural rarities, and wonders. Whitaker’s context aligns with my analysis as she links natural history’s educated culture of science with gentlemen of status. The financial and social mobility of the upper classes allowed such activities to be conducted. Part of the tradition entailed a tour of the continent, or New World, to study and collect items of a curious nature. Whitaker contributes to my characterization of Darwin as a

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53 Ibid., 25-27.
55 Whitaker, “The Culture of Curiosity,” In Cultures of Natural History, 82-88.
56 Ibid., 75.
57 Ibid., 75.
58 Ibid., 75.
scientific manager by establishing upper class status, social mobility, and financial stability as pinnacle requirements to engage in naturalism. These factors influenced Darwin’s respected status as the *Beagle* philosopher, unofficial naturalist status while onboard, and ease of conference with social equivalents and scientific specialists. Engagement by men of growing influence in natural history voyages, like Sir Joseph Banks, Carl Linnaeus, John Hershel, and Alexander von Humboldt, affirmed a pattern of collection and exotic exploration Darwin intended to follow as standard procedure in his study of nature. Setting the stage, Whitaker identifies the cementing of religious connotations in natural study during the seventeenth century as reason for the heavy resistance to secular science in the nineteenth century. Darwin’s social mobility, scientific familial environment, and secrecy in conducting secular science within a religiously charged society were factors unconsciously shaping his identity, career goals, and aims in publication.

Dorinda Outram presents the double edge of English naturalism, promoting positive internal public perception of British imperial expansion on one side, and targeting utility in nature through collection of medicinal plants, and divinely crafted rarities on the other. Her work provides a contrast to Darwin in his naturalist image, as he placed himself in a quest for natural knowledge, not one challenging his resilience against dangerous foreign environments to appreciate God’s creations. Contrasting Outram’s suggested natural history motivations, Darwin did not navigate his actions with a perception of championing nature, the wilderness, and primitivity.

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61 Outram, “New Spaces in Natural History,” In *Cultures of Natural History*, 259.
Darwin chose to consciously engage in the emerging concept of a ‘field’ naturalist developing through continual expeditions abroad by leading naturalists. Outram identifies the ‘field’ as a new space for natural history, presenting the turnover over of the eighteenth century as a period of great transition and change.62 Outram argues that the period between 1780 and 1830, saw specialization of paleontology, physiology, anatomy, and taxonomy from a more general form of all-encompassing natural philosophy.63 The organizational goals of collections shifted from purposeful contrast and diversity to similarity in form, function, and physical appearance.64 State and institutional funding began to support scientific endeavors and exploration linked with a growing nationalist agenda towards the end of the eighteenth century.65 Publications and troves of new natural discoveries were the intended national product from expedition creating an externally perceived civility, technological advancement, and dominance of Britain over the natural and economic world.

Separation in the practices and social representation of traditional collection-based and field-based naturalists intensified, as the field naturalist garnered a heroic image through foreign adventures and exploits.66 In practice, this created two separate pools of naturalists with two separate methods of examining organisms. One, purely based on observation of a specimen devoid of its environment within a private collection or museum, the second observed the organism within its environment.67 Darwin found a middle ground in the extensive use of his field journals recording observations on behavior, landscape, ecosystem, and varying other

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62 Outram, “New Spaces in Natural History,” In Cultures of Natural History, 249.
63 Ibid., 249.
64 Johns, “Natural History As Print Culture,” In Cultures of Natural History, 87.
65 Outram, “New Spaces in Natural History,” In Cultures of Natural History, 249.
66 Ibid., 259.
67 Ibid., 259.
minute details as points of later consideration when studying his specimen’s he sent to London. Darwin engaged in traditional methods of observation without environmental consideration through study and exchange of specimens and fossils, and in zoo visits studying behavior and emotion in primates.\(^{68}\) This methodological duality in observing natural phenomenon influenced the development of distinction between organisms ‘in the wild’ and ‘in domesticity’.\(^{69}\) Differences in reproductive selection in the wilderness and with human intervention in domesticity translated to two distinct selection systems of evolutionary control for Darwin, one natural and the other artificial.

In the action of engaging in the *Beagle’s* circumnavigation of the globe, Darwin, as an upper-class member of English scientific society stepped into the image of an iconic naturalist. His social class, familial scientific affiliation, education, *Beagle* experiences, career aims, and funding should not be attributed fully to his own prowess. Some perceive Darwin as a pinnacle figure actively combining essential naturalist characteristics to achieve success, rather than the more accurate interpretation as a privileged individual in the right place, at the right time. Regardless, Darwin stands as the last truly definable Victorian naturalist.\(^{70}\)

### 1.2.3 Women and Victorian Natural History

Darwin fit the image of a traditional Victorian naturalist but the very essence of his acceptance into these influential and productive circles was based, in the most reductive sense, on his male gender. Evelleen Richards has shown that the separate spheres of gender ideology within Victorian society translated directly into the practice of science.\(^{71}\) Proven biological

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\(^{68}\) Desmond and Moore, *Darwin: The Life of a Tormented Evolutionist*, 243.

\(^{69}\) Outram, “New Spaces in Natural History,” In *Cultures of Natural History*, 253.

\(^{70}\) Ibid., 259.

\(^{71}\) Richards, “Redrawing the Boundaries: Darwinian Science and Victorian Women Intellectuals,” 127.
differences between males and females throughout the animal kingdom promoted conceptions of female inferiority and fragility, resulting in a male-dominated perspective of their unsuitability for the complexities of science. Richards presents the experiences of different women in science as no standardized route of inclusion existed, Victorian women of science had to be creative, tenacious, and steadfast in their beliefs to circumvent this misogyny. Difficulty in defining the social space Victorian women of science inhabited stems from their required circumnavigation, complicated further by variation in female perspectives of their place in society, and science. The antivivisection movement, started by female naturalist Francis Power Cobbe in the late nineteenth century and perpetuated by a large proportion of women, generated resistance to women in science rather than promotion. Richards argues that from the male perspective these efforts were interpreted as a subversive use of femininity to hinder scientific progress. Further, Victorian women in general were linked to domestic animals in their expected social behaviors, characteristics, and resultant treatment by men.

To define and understand the significance of their contributions, a better understanding of how women of stature navigated themselves throughout male-dominated circles of Victorian science is required. The absence of formal scientific education for women in the mid-nineteenth century did not always inhibit study of the natural sciences. The most common avenue for women with interests in natural history were private journals, diary entries, travel narratives, and published essays under male pen names. Recorded observations expanded into critical

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73 Ibid., 130.
74 Ibid., 131.
75 Ibid., 132.
discussion of coastal marine biology, topography, zoology, and natural history. Women with natural history interests were involved in institutional cataloguing and specimen illustration. Unfortunately, the realm of female scientific publication did not stray far beyond textbooks and popular science.

Mary Ellen Bellanca identifies a common strategy of access to scholarly natural history by women in the work of travel author Mary Ann Evans, who operated under the pen name of George Eliot. She assisted her husband, Lewes, with collection and experimentation associated with his marine biology work. Her husband included excerpts of her “Ilfracombe Journal” in his publication “Sea-side Studies”. With assistance from Evan’s journal, Bellanca deciphered her scientific background and experience, using Evan’s comfort in use of scientific terminology and methodological conduction of research to strengthen the accuracy of her own observations as evidence. The requirement of Evans to present herself, and her work, under a false male identity is result of the same restrictive paradigm of male superiority in science that functioned to dissuade recognition of Caroline and Catherine Darwin’s assistance to Darwin in his published works. An element of Caroline’s’ writing to Darwin is identified by Ballenca as a social requirement, or expectation, of women in science. The tendency of female scientific authors of the late nineteenth century to include disclaimers of ignorance, inadequate qualification, and

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78 Ibid., 21.
81 Ibid., 23.
82 Ibid., 25.
incompetence functioned to immediately devalue their presented research. From Caroline, a similar admission statement emerges in the preface of her questions about coral reef geology and estimations of the Earth’s age to Darwin.\(^{84}\) The extent of Victorian gender roles infiltrated so deeply the internal female perspective that women felt the need for apologetic self-deprecating modesty to encroach on a scientific world they perceived as not theirs.

1.2.4 Charles Darwin’s Life and Work

Janet Browne’s *Charles Darwin: Voyaging (Volume I of a Biography)* (1996), *Charles Darwin: The Power of Place (Volume II of a Biography)* (2002), and Adrian Desmond’s and James Moore’s *Darwin: The Life of a Tormented Evolutionist* (1991) are classic Darwin biographies that lay the foundations for exceptional interpretations of his life, work, and work-life struggle. Browne provides extensive biographical analysis covered by two volumes, compared to Desmond and Moore’s single volume, cross-examining her analysis against Darwin’s correspondence, notebooks, journals, and personal diary.\(^{85}\) The depth, detail, and clarity of Browne’s step-wise examination of Darwin’s daily life in *Voyaging* and *The Power of Place* is unparalleled as the most critical and complete biography to date. Desmond and Moore treat Darwin in the same fashion but allocate a smaller section to the formative period in question, inherently limiting their analysis in comparison. Desmond and Moore provide greater discussion of Darwin’s social life and personal social activities creating a more complete image of Darwin’s life, as Browne conducts her work from a heavy scientific perspective.

Desmond’s and Moore’s argument focuses on Darwin as an individual balancing the internal and external torment of conducting secretive controversial science with extensive social

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ramifications in the midst of maintaining a socially and scientifically acceptable identity.\textsuperscript{86} Achieved through contrast, they present developments in Darwin’s transmutation theory alongside contextualization of his present social environment drawing direct attention to the personal struggle and duality of identity he faced. Desmond and Moore provide a deeper explanation of the social and cultural landscape of London during his formative period.

Browne’s argument is more restorative. Through a detailed chronology she pushes to create the most correct picture of Darwin’s daily life, work ethic, and collaboration.

This thesis expands on the collaborative focus incorporated by Browne’s inclusion of non-main stream individuals and their assistance to Darwin on the \textit{Beagle} and in London. Browne provided a helpful starting point in understanding the role of lesser known individuals picked up in the network analysis of Darwin’s scientific correspondence. However, a significant proportion of these lesser known contributors, or “hidden figures”, are not mentioned by Browne, Desmond or Moore. My analysis adds another dimension to our understanding of Darwin’s collaboration process.

Sandra Herbert provides a brief analysis of Darwin’s formative periods (voyage of the \textit{Beagle}, theory formulation period in London, publication of \textit{On the Origin of Species}) along with excerpts from influential literature Darwin and his contemporaries were familiar with.\textsuperscript{87} Her biographical analysis hinges on periods throughout Darwin’s life directly related to the formulation of his evolutionary theory, including his time in London. The support of her argument with primary sources is impressive and informs my work as it has a close connection between contemporary analysis and historical primary sources. This connection forms the basic


\textsuperscript{87} Sandra Herbert, \textit{Charles Darwin and the Question of Evolution: A Brief History with Documents}, (Boston: Bedford/St. Martin’s, 2011), 1-38.
core and goal of my project, linking macroscopic perspective to minute historical detail. Like Desmond and Moore, Herbert set the intellectual stage for Darwin’s theory including a more extensive analysis of prominent scientific literature of the age than Desmond, Moore, or Browne. A section was dedicated to discussion of pinnacle moments in Darwin’s researches reinforced by passages in his notebooks and private correspondences.\textsuperscript{88}

A Scottish-geological perspective towards Darwin’s earlier work is presented by Walter Stephen, who argues that the root of Darwin’s geological focus is in the work of John Playfair, James Hutton, and Sir James Hall on the accurate establishment of the age of the Earth. Stephen emphasizes Charles Lyell’s role as his theory of uniformitarianism emerged from Hutton’s *Theory of the Earth* (1795) and its suggestion of long slow timelines of natural geological change responsible for the Earth’s present state. On the *Beagle*, Darwin developed an appreciation for Lyell’s, and indirectly Hutton’s, theory. Academic debate surrounds Darwin as predominantly a geologist or a naturalist. Some historians settle on phases of focus for Darwin throughout his career depending on the type of work, others present a straight forward transition from geologist to naturalist commencing with his work on barnacles. James Secord argues that Darwin’s beginnings in geology started with a fieldtrip to North Wales with his geology professor Adam Sedgwick in 1831, continuing with his acceptance of Lyellian geological theory at the start of the *Beagle* voyage through his observation of the cliffs of St. Jago in 1832.\textsuperscript{89} Secord asserts at this point, Darwin perceived himself as a geologist. Aligning with Secord, my text analysis suggests that the dominant terminology in Darwin’s scientific correspondence was of a geological nature until the year 1837. Secord does not indicate transition away from geology, a

\textsuperscript{88} Herbert, *Charles Darwin and the Question of Evolution: A Brief History with Documents*, 70/124.
point of difference from my text analyses indication of a transition to naturalism by 1838 with brief pockets of geologically dominant content moving into the end of the project period in 1842. The first three years of my results agree with Secord, but his omission of a definite end to this vocation implies consideration of Darwin as a geologist throughout the period of 1835 to 1842 which is not supported by my text analysis results.

In contrast, Browne, Desmond, and Moore do not distinctively differentiate between Darwin as purely a geologist or naturalist but rather present his life’s interdisciplinary focus. Browne considers Darwin’s life in two career phases, travelling geologist and then naturalist, supported by the division of her book between Part 2: Traveler and Part 3: Naturalist.90 Elsewhere, Browne does refer to the Beagle voyage as the turning point igniting Darwin’s naturalist career.91 She argues that Darwin had a heavy naturalist identity before leaving on the Beagle (a time when he has been considered solely a geologist) placing Darwin in a path of English naturalism following Alexander von Humboldt in Brazil and William Herschel in the Canary Islands.92 Darwin’s love for the expedition literature of Sir Joseph Banks and Captain James Cook supported Browne’s assertion of an extreme desire for foreign naturalist adventure before leaving on the Beagle voyage.93

Browne successfully builds a framework of nineteenth century scientific naturalist society and fits Darwin into it, accomplished through explanation of trends in society and literature incrementally rationalizing Darwin’s professional transition and increasing naturalist

93 Ibid., 133-37.
interests. She establishes Darwin’s career as part of a long lineage of expedition from the eighteenth century, overlapped with more pervasive contemporary trends in the English Victorian naturalist image of the nineteenth century. Her image of Darwin is one of maintaining academic credibility and association in London, while privately untangling naturalist’s questions and observations from a geological perspective.

Paul D. Brinkman highlights issues with historical study of, what I have termed, “hidden figures” in his examination of Syms Covington (Darwin’s assistant on the Beagle and until 1839 in London), Bartholomew J. Siluvan, and Caroline Darwin. Brinkman stresses the necessity of Darwin’s advantageous social position in facilitating ease of inland travel due to the network of English gentlemen living in South America. Darwin would not have been privy to the existence, location, or means of accessing fossils key to his understanding of transmutation. In Bahia Blanca in 1833, Covington would routinely be left to collect fossils, up to days at a time, while Darwin rode ahead. Only a single letter in Darwin’s correspondence from 1835 to 1842 mentions Covington, a letter of reference for his new position in Australia. With a similar purpose, my network analysis investigates the role of lesser known individuals in Darwin’s life and career. My analysis identifies similar treatment of individuals like Charles D. Douglas, Charles San Lambert, and Robert Edward Alison. Rectification of the true contributions of these “hidden figures” is the focus of both mine and Brinkman’s work.

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96 Ibid., 59.
97 Megatherium skeleton found by Beagle crew member in Monte Hermoso, Brinkman, “Looking Back with ‘Great Satisfaction’ on Charles Darwin’s Vertebrate Paleontology,” 57.
99 Ibid., 57.
100 A geological surveyor and resident of Chiloé, an island archipelago off the coast of Chile.
1.2.5 Scientific Correspondence

Conversion of historical documents to digital formats is a pioneering interdisciplinary overlap between the humanities and digital scholarship. Sean Townsend, Cressida Chappell, and Oscar Struijve produced guidelines for constructing historical digital collections and databases. Transferring a written work to a digital format has points of consideration circulating specific characteristics of the document itself, or writing style. Townsend, Chappell, and Struijve stress importance of the preplanning phase of these projects to lay out exact components to be maintained in the digital format. It is impossible to transfer every single characteristic of a document but depending on the collections proposed use, these choices can be narrowed down. Intended use and target audience is also a factor indicating what components to save. An outline of intended use and application of the collection in the planning phase can aid in further indication of which elements to keep. Professional quality digitization software and equipment is costly to buy or rent, requiring concrete digitization standards and expectations to allow smooth progression and completion in a timely and cost-effective manner.

To preserve historical correspondence, the Private Correspondences of Early Modern Saxon Dukes and Duchesses (1503-1554) project at the LAUDATIO-Repository digitized and encoded 600 historical letters with annotations and analysis of language. Taking this methodology further, the PROPYLÄEN project digitized and annotated the diary entries, meeting transcriptions, and letters of politician Johann Wolfgang Goethe. A project of close similarity to mine is the Julius Pflug – Die Korrespondenz (1510-1564) network visualization,

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102 Ibid., 76.
103 Ibid., 76.
using two central nodes organizing the correspondents of the last bishop of Naumburg as either senders or receivers. Collections like the DCP, John Tyndall Correspondence Project,¹⁰⁴ Joseph Hooker Collection at Kew Gardens,¹⁰⁵ and Electronic Enlightenment Project¹⁰⁶ provide large corpuses of digital historical scientific correspondence. From this perspective, the choices to maintain paragraph structure, sentence structure, and emphasis of specific content in the digital collections is based on their intended use by history of science scholars. Motivation behind such projects is exposure and scholastic use, increasing accessibility to the personal and public lives of important scientific figures.

The DCP is not alone in their effort to push scientific correspondence collections to the forefront of historical study. The DCP has digitized over 15,000 letters from Darwin over the entirety of his life bringing new context to his social, academic, familial, and private theoretical activities. Professor James A. Secord has been the project director as of 2006; Dr. Alison Pearn is the associate director and has been affiliated with the project since 1996.¹⁰⁷ Funding is provided by a multitude of foundations and councils, including the Andrew W. Mellon Foundation, Alfred P. Sloan Foundation, Arts and Humanities Research Council, British Academy, British Ecological Society, Evolution Education Trust, Golden Family Foundation, Isaac Newton Trust, John Templeton Foundation, National Science Foundation, National Endowment for the Humanities, Natural Environment Research Council, The Parasol

¹⁰⁷ “Who we are,” About, Darwin Correspondence Project, last modified 2018, https://www.darwinproject.ac.uk/about/who-we-are.
Foundation, Pilgrim Trust, Royal Society, Stifterverband für die Deutsche Wissenschaft, and Wellcome Trust.108

The DCP archive of Darwin’s correspondence forms the main primary research base for investigations of his life and work, exemplified in the work of Jim Endersby.109 His use of Darwin’s correspondence shaped his investigation of sympathy as a necessity in Victorian natural history, specifically in the relationship between Darwin and botanist Joseph Dalton Hooker. He examines correspondence between the two for traces of sympathetic tendencies, claiming the trait was restricted to private male communication as it had attained a feminine association in society.110 Endersby argues for the requirement of sympathy in trusted spaces, like friendships, even within a Victorian society of distinctly separate gender spheres.111 He contextualizes a different side of Darwin, only achievable through use of his correspondence. Similarly, my project is supported by Darwin’s correspondence through use of its textual content and metadata terminology tags allowing a reconstruction and analysis of his social network between the years 1835 and 1842.

In the historical humanities, ‘computational thinking’ is moving to the forefront of the field.112 Manfred Laubichler, Jane Mainschein, and Jrügen Renn target the necessity of computational analysis and visualization in the history of science. They approach the discussion through concrete computational methodologies in their study of terminology surrounding the discovery of pathogen-based spread of malaria between 1880 and the 1910s in sources provided

108 “Funding,” About, Darwin Correspondence Project, last modified 2018, https://www.darwinproject.ac.uk/about/funding.
110 Ibid., 300-302.
111 Ibid., 300.
The team supports these methods as a means to bring transparency through recursive hypothesis testing. They argue increased use and exposure of graduate students to these methods would create future leaders in the methodology. Laubichler, Mainschein, and Renn rightly argue that the overall strength of computational approaches is their potential to display deeper patterns, not revealed through traditional historical scholarship, and their function in addressing larger research questions. My work supports this claim in the network analyses detection of a pattern of overall growth through cyclical expansion and contraction facilitated by Darwin’s broadening collaborative approach. More generally, the authors support construction and access to newly forming collaborative networks of interdisciplinary research through compatible data as another strong contribution of computer methodologies within history.

My project methodology aligns very closely with that of Laubichler, Mainschein, and Renn, as they created a network visualization of terms associated with the progression of tropical medicine, and variation of terms surrounding moments of discovery in the study of malaria. Purely a test of computational methods, the project looked to derive reliability in identification of trends previously isolated by historians of science to solidify the methodology as a useful tool in the examination of large historical datasets. Their work lent support to the accuracy and reliability of results returned from the network component of this project, similarly identifying patterns in his correspondence network and analyzing historically misrepresented groups in Darwin’s work and theoretical process. The gap in history of science described by Laubichler,

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113 Laubichler, Mainschein, Renn, “Computational Perspective in the History of Science: To the Memory Peter Damerow.” 123.
114 Ibid., 120.
115 Ibid., 130.
117 Ibid., 126.
118 Ibid., 123-26.
Mainschein, and Renn calls for a project like my own, addressed almost completely by my interdisciplinary focus, goals, methods, and results.

The importance of standardization in scholarly digitized content is stressed by Laubichler, Mainschein, and Renn. Layout and text structure standardization of digital content is provided by the Text Encoding Initiative (TEI).\textsuperscript{119} Predominantly applied to historical and literary documents when creating digital versions, the methodology involves application of mark-up tags to specific aspects of the text, drawing attention to critical components of the documents.\textsuperscript{120} In this investigation, scientific terminology in Darwin’s correspondence was marked-up in TEI format by Nicholas W. Gill assisting Mario A. Di Gregorio’s project, \textit{Charles Darwin’s Marginalia} (1990).\textsuperscript{121}

Application of social network visualization to the history of technological innovation by Francis C. Moon produced a network visualization of James Watts process of innovation leading to development of the steam engine.\textsuperscript{122} Moon’s intent is corrective, questioning if innovation can truly be associated to a single individual suggesting instead that innovation in history be examined through networks of influence involving multiple individuals and institutions. This captures the building process of appropriation and improvement on previous technologies throughout history. Along with my project, Moon presents another example of the use of social network analysis in corrective investigation within the history of science. Moon’s question resonates with my project focus. Innovation of theoretical concepts, like the theory of evolution,
can be viewed in the same light as technological innovation. Moon’s project investigates innovative pathways farther into the past than my own project. With his inspiration, an interesting extension of my project would be to trace the origin of secular natural history to seventeenth century France.

Gauging the changes and general structure of scientific communities is an overarching goal of studying scientific correspondence networks, tracing the diffusion of knowledge throughout highly connected groups. Scholars have looked at network relations in scientific communities through correspondence in periods as early as late medieval Europe. From a sociological perspective, Diana Crane characterizes this process in three different models of scientific growth. She refers to the random selection model supporting unstructured growth, identifying continuous cumulative growth with discontinuity as the Darwinian model. Involving periods of structured, or ‘normal’, science with periods of crisis or revolution, in the specific case of Darwin she argues for a process of continual change through ‘micro-revolutions’. These revolutions are facilitated by a variety of means, often a cognitive event or invention of a new tool. This model involves large scale implications across entire scientific fields, stating changes in the field are caused by the current regime’s inability to explain present phenomenon. In a natural history context, this current regime circulated divine intervention in the natural sciences, loosely grouped under the field of natural theology. Increasingly, unexplained natural phenomena presented puzzling observations for early nineteenth century

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125 Crane, Invisible Colleges: Diffusion of Knowledge in Scientific Communities, 28.
127 Ibid., 30.
128 Ibid., 27.
naturalists resulting in reliance on the hand of God in nature, through divine intervention, and spontaneous miracles to maintain nature.

1.2.6 Digital Humanities

Defining the digital humanities field is difficult due to its expansiveness and interdisciplinary nature, including scholars of literature and history applying digital methods to their work. The most comprehensive definition comes from Lorna Hughes, Panos Constantopoulos, and Costis Dallas, stating the digital humanities create an academic space where scholarly creation, analysis, and dissemination of research is computer-based. The team argues for discrete qualities in digital humanities projects involving computational methodology based on, or dependent on, database technologies in the creation, analysis, and dissemination of research. My project fits well into a digital humanities classification given these definitions.

The term ‘digital humanities’ emerged from ‘humanities computing’, or computational thinking, first applied to research analyzing and visualizing large humanities datasets in 2004. Willard McMarty interprets the early stage of the digital humanities field as vulnerable and heavily interdisciplinary. During World War II, interdisciplinary research was promoted coinciding with the planning stages of Dr. Robert Busa’s Index Thomisticus between 1946-49. Busa’s Index Thomisticus is a 56-volume comprehensive concordance study conducted by

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classification of every item of writing produced by Saint Thomas Aquinas using a punch card system, created over 34 years. Government promotion of interdisciplinary science and IMB’s early computer technologies collided in his work, establishing the origin of the digital humanities as interdisciplinary. In the words of McCarty, the birth of the digital humanities was based on ‘techno-sciences’.

A vast overarching perspective in history is not a recent concept. In 1958, historian Fernand Braudel identified the *longue durée* as a critical periodization of historical examination through its formation of critical and global narratives capturing the attention of the public and government policy makers. His emphasis on narrative and public attention strikes a chord with my project as my network visualizations convey the structure, content, and context of Darwin’s scientific correspondence to a diverse audience over a few quick images. Terminology tags included in the network analysis contextualize the type and extent of family, amateur scientist, and gentleman specialist contributions over the eight-year project period. The narrative built is one of Darwin as a project manager, collaborating, funding, and organizing research conducted on his *Beagle* specimens. Darwin’s active involvement ensured classification for his own expanding research agenda, intentionally hastening the return of accurate biological evidence for consideration in his *Beagle* publications and private transmutation work.

Best practice for working with large historical data sets, such as Darwin’s correspondence collection, are addressed by Shawn Graham, Ian Milligan, and Scott Weingart. Their work introduced me to the text analysis software Voyant created by Stéfan

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Sinclair and Geoffrey Rockwell. General instructions give traditional researchers a taste of digital methods with insight into applications within their own work. Graham, Milligan, and Weingart also introduce the network analysis software Gephi but the authors focused on the common misapplication of the methodology, rather than suggestions for successful use. The larger resonating meaning behind the book is promotion of a combination of macroscopic and microscopic methodologies in historical scholarship using digital humanities methods. My methodology incorporates elements of both, represented by the macroscopic overarching network and text analysis indicating areas of significance within the correspondence collection, and accompanying microscopic investigation of the individual letter content using traditional close-reading methods and analysis. Digital humanities scholars often make use of a combination of both methods when studying historical texts, which functions to achieve microscopic (local) and macroscopic (global) perspectives in their research.

Looking at intellectual history in science or literature studies, Dan Edelstein argues the largest issue is compatibility between traditional and digital methodologies, as the former predates the latter. Application of new digital methodologies (ie. topic modelling, word collocation analysis) over a historical traditional framework creates unforeseen issues in data format and structure. Edelstein pulls support from Jo Guldi and David Armitage’s *The History Manifesto* (2014) combining Braudel’s *longue durée* perspective in the digital age with big historical data sets covering lengthy timelines.

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142 Ibid., 238.
143 Ibid., 243.
development by historians themselves would increase compatibility.\textsuperscript{144} Apprehensions surround the inference of proximity and distance within network graphs due to force directed relationships.\textsuperscript{145} Association of such vectors within the analysis misrepresents network structure providing a misleading interpretation of historical research. On this basis, my use of Gephi-produced networks consider only the general network structure (ie. number of nodes and edges), edge weight, and node authority. Proximity and distance were not variables considered in my analysis, strengthening the application of network analysis in contextualizing historical correspondence networks.

Through a Darwinian lens, James T. Costa follows Darwin’s lifelong theoretical process through a traditional close-reading of Darwin’s correspondence, notebooks, journals, and private diaries.\textsuperscript{146} His argument hinges on study of Darwin’s fossils by Richard Owen and his Galápagos Islands bird specimens by John Gould.\textsuperscript{147} Their relation of temporal patterns in species form throughout the fossil record and identification of recent new species in the Galápagos bird specimens as proof of spatial biographic patterns of speciation, respectively, resulted in his acceptance of transmutation.\textsuperscript{148} His analysis comes from a similar perspective as my own, but from a microscopic angle. My project pairs nicely with this work illuminating the larger macroscopic perspective of the process. Costa discusses Darwin’s propensity for having exposure (in previous education) and evidence (\textit{Beagle} specimens and observations) to the building blocks of his theory before retrospectively understanding how these observations related to the nature of species and geographical distribution. Darwin’s lack of recognition supports the

\textsuperscript{144} Jo Guldi and David Armitage, \textit{The History Manifesto}, (Cambridge: Cambridge University Press, 2014).
\textsuperscript{145} Edelstein, “Intellectual History and Digital Humanities,” 245.
\textsuperscript{147} Ibid., 889.
\textsuperscript{148} Ibid., 888-89.
need for critical investigation of the successive London period (October 1836 to September 1842) to isolate his theoretical process.

For this project, the microscopic aspect is formed by content of the individual letters written between Darwin and his correspondents, giving insight into the specific concepts and ideas discussed. A macroscopic perspective is gained through distant reading using social network analysis, comparative text analysis, and the generation of key term lists. Each element of the present project required a different digital tool; Voyant conducted comparative text analysis, Google Ngram viewer generated general term frequency graphs, and Gephi constructed network visualization and conducted analysis.

1.2.7 Network Analysis

Digital projects in the humanities incorporating similar social network visualization platforms to convey the interrelation of ideas include Christina Pattuelli’s LinkedJazz, and Micki Kaufman’s Quantifying Kissinger. In a historical context, Mapping the Republic of Letters project created at Stanford University is built in a similar format of social network analysis, using correspondence data sets to track the movement of information and ideas between, and within, each case study. Their network is composed of 12 case studies forming separate networks they connected to form one large interactive visualization, created in a project specific software platform (Figure 1.6). Their overall collaborative project goals are identical to my Darwin investigation, centered on achievement of a better understanding of the structure and

change within historical correspondence networks and identifying previously undetected significant relationships.\textsuperscript{152}

Three standard applications of social network analysis converge in this project through its representation of social, cognitive, and organizational relationships to analyze social roles, knowledge and information use, and the exchange of information and resources, respectively.\textsuperscript{153} The roots of social network analysis lay in the work of theoretical psychologists of the 1930s attempting to understand the impact of group relations on an individual’s psychological development through sociograms, a rudimentary form of social network analysis based on the analysis of dyad and triad groups.\textsuperscript{154} Later mathematicians and psychologists of the 1950s built upon the concept through application of formulas and algorithms to create graphical representations of social structure similar to current social network analysis standards.\textsuperscript{155} They argue the real propulsion for social network analysis as a methodology was the emergence of the computer age in the 1970s.\textsuperscript{156} Previously time-consuming algorithms were made machine-readable allowing network calculations to be conducted in a fraction of the time.\textsuperscript{157} Application of computer technology has allowed expansion of the analytical capabilities and over-all scope of social network analysis as a research methodology for humanities scholars.

\begin{itemize}
\item \textsuperscript{152}“About the Project,” Mapping the Republic of Letters, Stanford University, last modified 2013, http://republicofletters.stanford.edu/.
\item \textsuperscript{155} Fredericks and Durland, “The Historical Evolution and Basic Concepts of Social Network Analysis,” 16.
\item \textsuperscript{156} Ibid., 16.
\item \textsuperscript{157} Ibid., 17.
\end{itemize}
A word of caution from Scott Weingart; social network analysis is not a methodology to be taken lightly or last minute.\(^{158}\) He draws attention to the amount of organization and early consideration required in social network analysis project. Data design can be frustrating with realization that project data may not create the intended network visualization, based on its structure.\(^{159}\) A strength of my methodology is approaching historical social network analysis with a distinct question and rough project parameters (ie. time period, group of individuals, geographical region) to determine if my data was best visualized as a network, or in another format. The misapplication of social network analysis on too broad a range of projects, Weingart adds, is a common criticism as tools and algorithms may seem appropriate for project data but were rather designed in an incompatible project-specific framework.\(^{160}\) Expanding, Weingart highlights the lack of transmissibility of project methodologies to other projects as another frustrating element. In more discrete and simple forms of analysis the methodological appropriation of previously tested processes to new projects is common.\(^{161}\) This is not a sound decision in network analysis as most projects require specific customized algorithms that will not match other data.\(^{162}\) Weingart’s warning is crucial as errors in network results are difficult to catch and may not be identified until final project phases. His points of consideration provided key methodological errors to avoid in my analysis. Social network analysis is a valid methodology for the type of tag data pulled from the DCP letters, but it must be conducted in a


\(^{159}\) Ibid.

\(^{160}\) Ibid.

\(^{161}\) Ibid.

\(^{162}\) Ibid.
non-redundant fashion to ensure the relevance of results through correct methodological process and considerations.

Weingart’s argument is supported by Manuela Cainai’s critique of social network analysis as being too methodological, and not theoretical enough, especially in its inability to test hypotheses. She argues network analysis is not representative of “real world” ties and dynamics, but rather those of the selected data set. Researchers remedy this by selecting data sets representative of a trend, giving results in the context of a project question rather than real life. Escaping this methodological pitfall is difficult, and I argue almost impossible to negate, resulting in reference of my own network analysis as a digital recreation of Darwin scientific environment, not a ‘real world’ representation. Following Cainai’s suggestion I limited my time range to a period of previously established significance in related literature to represent key trends in Darwin’s use of his correspondence network. In agreement with social network analysis’s inability to reflect ‘real-world’ ties, the project perspective was not intended to be a real-world representation but rather a means for visualizing the context surrounding Darwin’s scientific discussions across different categories of correspondents.

Social network analysis can be used to reinforce academic statements surrounding individual influence within a network, towards a group, or throughout an entire network, and vice versa. When dealing with a thesis-based project discussing the complex interconnection, influence, and dynamic of an important group of scientists, social network analysis provides an essential accompanying project element. It is one thing to imply a person’s importance, but it is another to visualize and statistically support that claim. Social network analysis is a fickle and

164 Ibid., 390.
fruitful methodology, useful to my project by closing the separation between qualitative and quantitative historical research.\textsuperscript{165} Value was found in indication of unexpected contexts and relationships between individuals, Darwin, and the information they shared. Social network analysis conveyed the structure and content of Darwin’s scientific correspondences quickly, as opposed to traditional historical methodology of close reading to derive context and significance. It indicated areas of further microscopic research without reading an entire corpus of letters and isolated key contributors within the correspondence network for further investigation.

1.2.8 Text Analysis using Voyant

The project included a term-based analysis comparing frequencies of use between each year of letters, and between letters within each year, to identify distinctly geological and naturalist periods in Darwin’s career between 1835 and 1842. The analysis was conducted by Voyant using the stable server platform. The project analysis aligns with Ben Heuwing’s, Thomas Mandl’s, and Christa Womser-Hacker’s outline for text analysis in the digital humanities as requiring comparison across multiple contexts,\textsuperscript{166} facilitated by our comparison within and between yearly sets of documents. Validation of results through other digital methods is suggested to strengthen project conclusions,\textsuperscript{167} addressed in our methodology through inclusion of network analysis identifying similar trends.

At the Beck Center of Emory University, the team of Sara Palmer, Sarita Alami, Moya Bailey, and Katie Rawson used Voyant to investigate the context and frequency of the term’s ‘slavery’ and ‘peace’ in a collection of 57 sermons delivered on the day of President Abraham

Lincoln’s assassination on April 14th, 1865. Similarity in methodology is presented in their specific selection of indicative terminology to represent a specific trend in the dataset, the propensity of different reverends to tie President Lincoln’s assassination to peace or slavery. A comparison of two terms suits their use of term frequency graphs well, differing from my project analysis using bubbleline visualizations depicting five different geological and biological terms over each document within a correspondence year.

Alyssa Anderson created a project analyzing 2,500 runaway slave advertisements from Texas, Arkansas, and Mississippi to identify differences and trends in terminology. Advertisements were organized chronologically, by decade, to identify changes in the use of specific terminology such as “Negro” over time and regionally. Anderson’s results included trends in the complexion descriptions and racial status of slaves, the persistence of the term “African” in Texas over other regions, and the realization that slave advertisements were in use in Texas 50 years after the criminalization of international slavery. This suggests a slow diffusion or ignorance of legislation allowing the persistence of slavery in Texas beyond other states. Anderson reported frustration with the web-based Voyant interface as stop word lists could not be saved for future use, along with results having to be saved through screenshots or requiring re-application of data modifications each time Voyant was opened. She states, decision making surrounding the periodization of her text data was a conscious and important part of her methodological process. She recognized the issues presented by incorrect or

169 “Text Mining with Voyant,” https://disc.library.emory.edu/lincoln/about.
171 Anderson, “Using Voyant for Text Analysis.”
172 Anderson, “Using Voyant for Text Analysis.”
173 Ibid.
unregulated separations of text within Voyant and suggested careful planning as variation causes representational differences in data, skewing results.\textsuperscript{174}

In relation to Anderson’s experience, the stable server-based version of Voyant was used to ensure permanency of conducted analyses, rather than re-creating each data trial on the web-based version. Text periodization was considered and proficiently maintained through the multiple document platform on the server-based software. The multiple document platform surpasses the analytical accuracy of the alternative method of uploading the entire corpus as a single document with letters separated by paragraph. Text analysis methodology is not discrete and can be conducted through a variety of ways using a diversity of digital tools.

\textsuperscript{174} Anderson, “Using Voyant for Text Analysis.”
Chapter 2: Darwin’s Background

2.1 Early Years

On February 12th, 1809 Charles Robert was born into the wealthy upper-class Darwin family of Shrewsbury. The Darwin’s were a family of scientific thinkers, as his grandfather published a poetic zoological work, *Zoonomia* (1794), and his father, Robert Darwin, was an esteemed doctor. Darwin was destined for a career in medicine, and started at the University of Edinburgh in 1825. Two years later he decided to attempt a career in the Church at Christ’s College, a part of the University of Cambridge, in 1827, changing degrees in 1828. At Edinburgh, he discovered his disdain for the medical communities dynamic along with his propensity for developing empathy towards his patients.175 Aside from a disconnect from medicine, Edinburgh provided Darwin with an introduction to the cutting-edge geological and natural history controversies of Thomas Charles Hope, Robert Jameson, and Robert Grant.176 Darwin’s first year chemistry professor, Hope, instilled an early understanding of the relationship between chemistry and mineralogy with an emphasis on understanding geology from a chemical perspective.177 Robert Jameson’s strength for Darwin lay not in his teaching but in his institutional natural history museum, and its curator William Macgillivray.178 As a class requirement, Macgillivray instructed students to visit and work with museum specimens three times a week, which pressed Darwin to conduct study in natural history.179 Interestingly, aside from Darwin’s insistence on the uselessness of Jameson’s teachings, he extensively annotated his

177 Secord, “The Discovery of a Vocation: Darwin’s Early Geology,” 139.
179 Ibid., 72.
work in mineralogy. Jameson introduced Darwin to the process of fossilization, the existence of giant mammals in geological history (e.g. the *megatherium*, mammoth, and mastodon), the order of rock strata, and imparted the importance of order and classification in natural history.

At meetings of the Plinian Society at Edinburgh, Darwin first brushed shoulders with comparative anatomist and marine biologist Robert Grant. Grant had several critical influences on Darwin, first as an early supporter of transmutation. He promoted an extension of Jean-Baptiste Lamarck’s theory of transmutation in his own theoretical ‘metamorphose’ process evident in fossil species involving serial succession, spontaneous generation, and nebular development. Grant also imparted on Darwin a complex understanding of invertebrate development through their combined work on zoophyte and seaweed fertilization, critical to Darwin’s later understanding of coral polyp development and reef formation. Under Grants supervision, Darwin conducted research establishing reproduction by ciliated locomotion of the *Flustra* egg in fertilization. Unfortunately, Grant did not conduct himself honestly while working with Darwin, and took advantage of the young scientist’s work, presenting Darwin’s findings as his own. Grants mistreatment gave Darwin the final push out of Edinburgh, moving to Christ’s College, a part of the University of Cambridge, for just under a year before

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186 A species of Bryozoan.
188 Ibid., 86.
changing degrees. Grant was the closest Darwin had to a mentor in Edinburgh. At Christ’s College he looked to his cousin William Darwin Fox as mentor, and later to his botany professor, Reverend John Stevens Henslow, with Darwin’s transfer to an ordinary degree within the University of Cambridge in 1828.\textsuperscript{189}

Known as the man who secured passage for Darwin on the infamous \textit{Beagle} voyage, Henslow advanced Darwin’s scientific reputation like no other. He taught Darwin botany, but would also form the core of Darwin’s research approach throughout his career. From Henslow’s botany lectures, Darwin gained experience in classification theory based on anatomy and physiology, discussed genetic hybrid species, and the production of ‘monstrosities’ in nature.\textsuperscript{190} Henslow encouraged Darwin to dissect plant specimens, a general skill of crucial importance for any scientist looking to conduct a proper examination of nature.\textsuperscript{191} Henslow took Darwin under his wing, inviting him on natural history collecting fieldtrips and to close-knit soirées with Cambridge’s elite.\textsuperscript{192} Henslow’s methodological routine set an example for Darwin of scientific practice and field collection, methods of investigation through empirical observation, and dissection revealing anatomical and physiological similarity or difference.\textsuperscript{193} Essentially, he created Darwin’s scientific toolkit. According to Janet Browne, Darwin’s success stemmed more from this ability to identify individuals who inspired him to learn, rather than a driving interest in nature.\textsuperscript{194} Henslow was Darwin’s entrance into the highest intellectual circles of Cambridge, and

\textsuperscript{189} Browne, \textit{Charles Darwin: Voyaging (Volume I of a Biography)}, 124.
\textsuperscript{190} Ibid., 121-22.
\textsuperscript{191} Ibid., 122.
\textsuperscript{192} Ibid., 123.
\textsuperscript{193} Ibid., 120-22.
\textsuperscript{194} Ibid., 124.
facilitated his introduction to geologist Adam Sedgwick. Henslow insisted that Darwin participate in Sedgwick’s upcoming geological field trip to Tenerife in Wales in 1831.

Sedgwick was the first of Darwin’s professors to actively engage him in geological fieldwork, and intended to propel him towards a career long focus. He supported catastrophist interpretations of geological activity, which held that historical geological activity was more intensive than that of the present, and that geological change was achieved through large-scale, catastrophic geological events. Darwin would grow to oppose this ideology from a Lyellian uniformitarian perspective by 1832 onboard the Beagle. Darwin hoped to impress Sedgwick with his geological deduction, but mistakenly referenced a single tropical shell found in the gravel pits near Shrewsbury as evidence for a previous tropical climate in the region.

Sedgwick’s response taught Darwin a handful of lessons, but first and foremost he outlined that the proposition of scientific theories, such as a disputation of superficial deposition in the Shrewsbury gravel pits, required mutually supportive evidence to prove. From a theoretical standpoint, Sedgwick taught Darwin to support his hypotheses with a collection of facts providing evidence, establishing the requirement of holding one’s conclusions close until sufficient evidence can be provided, a lesson closely followed in the formative stages of Darwin’s natural selection theory.

196 Ibid., 136.
197 Ibid., 140.
198 Ibid., 140.
199 Wesson, Darwin’s First Theory: Exploring Darwin’s Quest to Find a Theory of the Earth, 106.
200 Ibid., 141.
201 Ibid., 141.
202 Ibid., 141-43.
2.2 The Voyage

Upon his return in August 1831 from North Wales, Darwin received an invitation, by Henslow’s suggestion, to accompany Captain Robert FitzRoy on a two year South American survey voyage onboard the H.M.S Beagle. Darwin was not first, or even second in line to receive the invitation. It only came to him as more prominent men of science had rejected the offer. Darwin fit the characteristics of a gentlemen of science, and upon meeting FitzRoy was accepted to join the voyage. With assistance of Darwin’s London contacts, he excitedly prepared for his journey, collecting geological equipment and natural history testimonies of foreign fauna and flora. Darwin was enthusiastic and excited before his voyage as he corresponded with experts, read related adventure and scientific literature, and gathered geological survey equipment. He intended to make the most of his voyage from the very start of his preparations, apparent through his request of “hidden figure” Francis Beaufort to attain equipment and testimonial on the natural histories of the different regions.

Darwin’s scientific character, his choices, and his theoretical process cannot be fully examined without consideration for the broader cultural contexts that shaped him. The practice of natural history, in the Victorian period, had become guided by cultural and nationalist trends since the seventeenth century. Many elements of Darwin’s life, travel, and work gained their relevance through engagement in a typical naturalist career pattern, both consciously and unconsciously. Due to his family’s elite social standing and passion for science Darwin’s

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203 Browne, Charles Darwin: Voyaging (Volume I of a Biography), 149.
204 Ibid., 149-50.
205 Ibid., 155-56.
206 Ibid., 156; Outram, “New Spaces in Natural History,” 259.
207 Browne, Charles Darwin: Voyaging (Volume I of a Biography), 156.
208 Whitaker, “The Culture of Curiosity,” 82.
gentlemanly status was advantageous. Aside from the immediate exposure to natural history, zoology, and medicine attained from his father and grandfather, Darwin’s privileged social status gained him access to elite circles of science and autonomy in the use of state funds.  

Aboard the Beagle, Darwin encountered “hidden figures” Beaufort, John Lort Stokes, Charles Douglas, and Robert Edward Alison. Beaufort was responsible for attaining used geological survey equipment and teaching Darwin to use it. He put Darwin in touch with naval officers knowledgeable on the natural history of the proposed foreign locations the Beagle will be visiting to gain a degree of preparation and insight into natural phenomenon he may observe. While onboard the Beagle, Darwin shared cramped accommodations with the Crown’s geological surveyor, Stokes, who had been sent to redraft navigational charts of the South American coastline. Through Richard Corfield, Darwin met Robert Edward Alison, a book merchant who aided Darwin with his research and discussed scientific books with him. The assistance received by Douglas makes him a key “hidden figure”, through his collection of beetle specimens and geological observations upon an earthquake in Chiloé, which he provided through continued correspondence after Darwin’s departure from the region.  

The voyage was extended almost three years but was fruitful for Darwin’s natural history and geology research. Starting at St. Jago Island in Cape Verde Darwin’s path to uniformitarianism began. He found support for Lyell’s gradual process of geological activity in his investigation of white lines in rock at varying heights encircling the island. Part of the

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211 Ibid., 155.
212 Ibid., 170.
213 Ibid., 274.
214 Ibid., 284.
curiosity was their location above sea level. With guidance from the ships copy of Lyell’s *Principles of Geology* (1830), Darwin based his gradual elevation theory on observable cause. Similarly, in 1835, Darwin found support for Lyell in Coquimbo observing its raised beaches.

Finding shark teeth, marine shells, and oyster shells upon each level of the successive beaches, Darwin inferred a process of gradual coastal raising with ‘shelves’ cut out from wave action due to interspersed subterranean activity and slow marine degradation. As Darwin transitioned to a natural history focus, so too did his Lyellian uniformitarianism perspective, which established his unique geological approach to biological questions.

I opened Chapter 1 with FitzRoy’s reference to Darwin’s inadequate acknowledgement of Bartholomew James Sullivan, Alexander Usborne, John Lort Stokes, and other naval officers, in their assistance to Darwin through multiple avenues of his voyage and inland expeditions. FitzRoy and his officers ensured the security of in-land specimen collection and transportation, and later storage, freight, and shipment of Darwin’s specimens. Their preference for Darwin is given merit in consideration of their negation of similar duties in service of the enlisted naturalist, Robert McCormick. McCormick departed the voyage early due, in part, to conflict stemming from this very issue. He was perturbed with the crews unyielding support of a private gentleman naturalist over a Crown contracted naturalist who intended to conduct the very activities Darwin was busying himself with. Further, the habitual logbook practices of FitzRoy

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216 Secord, “The Discovery of a Vocation: Darwin’s Early Geology,” 152.
217 Ibid., 152.
218 Wesson, *Darwin’s First Theory: Exploring Darwin’s Quest to Find a Theory of the Earth*, 106.
221 Ibid., 202-6
222 Ibid., 202-6
223 Ibid., 195/202-6.
prompted Darwin to do the same with zoology, botany, and geology journals.\textsuperscript{224} FitzRoy encouraged Darwin to make regular daily and evening entries while onboard the \textit{Beagle} to maintain ‘ship hours’.\textsuperscript{225} He also stressed the necessity of recording exact measurements, noting surrounding observations, and the need to record soon following an observation to maintain detail. The note taking and regularity in routine of recording daily observations imparted to Darwin a routine he would continue to use throughout the voyage and inland excursions.\textsuperscript{226} Adoption of this behavior ensured huge quantities of critical research notes were saved for Darwin’s later work. Without FitzRoy’s influence it is uncertain if Darwin would have reaped the same amount of thorough evidence from his fieldwork as he did. Through his notes he developed an ease and eloquence in natural history writing, and developed his skill in organizing his thoughts to create concrete scientific arguments.\textsuperscript{227} Pieces of his work had already made a splash back in London through Henslow’s publication and presentation of excerpts from Darwin’s well-formed geological observations, specimen notes, and conclusions presented in his correspondence.\textsuperscript{228} These notebooks and journals came to form the backbone of his subsequent \textit{Beagle} publications \textit{The Zoology of the Voyage of the H.M.S. Beagle} (1838-1843), \textit{Journal of Researches} (Voyage of the Beagle) (1839), \textit{Journal of Researches into the Geology and Natural History of the Various Countries Visited by H.M.S. Beagle} (1839), and \textit{Journal of Researches}

\textsuperscript{224} Browne, \textit{Charles Darwin: Voyaging (Volume I of a Biography)}, 194-5.
\textsuperscript{225} Ibid., 194.
\textsuperscript{226} Ibid., 194-5.
\textsuperscript{227} Ibid., 195.
\textsuperscript{228} With his own funds, Henslow published a pamphlet “Extracts from Letters Addressed to Professor Henslow” (1835) and presented it to the Cambridge Philosophical Society on November 16th, 1835; Charles Darwin, \textit{Extracts from letters addressed to Professor Henslow}, Cambridge: privately printed, 1835; In addition, Henslow requested Edward Newman to print Darwin’s entomology content from his pamphlet in \textit{Entomology Magazine} (April 1836); Browne, \textit{Charles Darwin: Voyaging (Volume I of a Biography)}, 335.
into the Natural History and Geology of the Countries Visited During the Voyage of
H.M.S. Beagle round the World (1845).

The observations that Darwin made in the Galápagos Archipelago, contributed to the
 richness of zoological information he gathered. Darwin recognized their relevance only later in
 London in late 1837 during phases of intense review and theoretical postulation, piecing together
evidence of species divergence, speciation, and common ancestry.\textsuperscript{229} Among these was an
observation passed to Darwin by the Vice-Governor of the islands, Nicholas Lawson.\textsuperscript{230} He
described the animals of each island as having minute island-specific variations in morphology
 supported by his accuracy in identifying which island each variant originated.\textsuperscript{231} Darwin
observed this in the Galápagos tortoise, mocking bird, and finch populations. Darwin collected
four mocking bird specimens from four different islands, certain to label each accordingly.\textsuperscript{232} He
did not maintain his six finch specimens from three different islands in the same organized
 fashion.\textsuperscript{233} In London, Darwin hired ornithologist John Gould to classify a collection of
Galápagos finch specimens collected by Darwin, FitzRoy, and Covington.\textsuperscript{234} Gould identified 13
different species of finches and three different species of mocking bird across the islands.\textsuperscript{235} Darwin’s detailed care of his mocking bird specimens held the key, as Gould observed their
shared similarity with a South American mainland species.\textsuperscript{236} This propelled Darwin to suggest

\begin{itemize}
  \item \textsuperscript{229} Costa, “The Darwinian Revelation: Tracing the Origin and Evolution of an Idea,” 889.
  \item \textsuperscript{230} Browne, \textit{Charles Darwin: Voyaging (Volume I of a Biography)}, 304-5.
  \item \textsuperscript{231} Desmond and Moore, \textit{Darwin: The Life of a Tormented Evolutionist}, 182; Browne, \textit{Charles Darwin: Voyaging
  (Volume I of a Biography)}, 170.
  \item \textsuperscript{232} Ibid., 170.
  \item \textsuperscript{233} Ibid., 171.
  \item \textsuperscript{234} Ibid., 227.
  \item \textsuperscript{235} Ibid., 219.
  \item \textsuperscript{236} Ibid., 228.
\end{itemize}
migration of a single common ancestor to the island chain, followed by island-specific speciation events due to geological isolation. More generally, the collection of numerous giant extinct fossilized species, including *Megatherium americanum* (giant sloth), *Glyptodon clavipes* (giant armadillo), and *Toxodon platensis* (giant rodent), in the same locations as Darwin observed extant modern species of similar form indicated a relationship in common lineage, or heredity. Darwin developed his concept of a genealogical tree from these observations, linking all life to a common ancestor that is departed from through instances of divergence and speciation forming new buds (extant species) from the dying branches (extinct species). The most prevalent contemporary perceptions accepted spontaneous generation as responsible for increases in species diversity, with species emerging perfectly accustomed to their environment through God’s design.

### 2.3 The Return Home

After departure from Australia Darwin returned home to London, arriving in late 1836 and returning to Cambridge for a few weeks to recuperate and meet with Charles Lyell, who introduced him to comparative anatomist Richard Owen. Darwin moved to London as means of placing himself at the nexus of English scientific activity, and to provide access to the most progressive specialists and scientific institutions of the age to work on his specimens. Darwin understood the immense task at hand and actively expedited the classification process, avoiding involvement in societies to ensure a complete focus on his own work. Darwin worked publicly

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238 Ibid., 230-32.


on his *Beagle* publications and privately on his transmutation theory. Darwin sought Owen to identify his fossilized mammal specimens, William Buckland worked on aquatic iguanas, Thomas Bell examined the reptile specimens, George R. Waterhouse investigated the insects and extant mammals, Leonard Jenyns examined the fish, and Buckland took the remainder of the specimens.241

By mid-March in 1837 Darwin’s first serious theoretical considerations of transmutation emerge in his notebook A as he battled to understand rhea distribution in South America.242 In mid-July of that year, Darwin was a committed transmutationist exploring further the impact of isolation on inbreeding and exaggerated trait generation in the Galápagos finch populations in his notebook B.243 Moving into notebook C by February 1838, Darwin had hashed out the core of his theory, moving away from understanding life in a progressive chain of higher form but rather based on adaptation to habitat.244 He identified differences in the impact of human-based domestic breeding and breeding in nature. It became clear to him nature was responsible for determining survivorship in natural systems eliminating disadvantageous traits. This factor forced Darwin’s increasing double life due to his intersection in the most prominent circles of London government, religion, and gentlemanly science, disallowing his association with a heretical position. To achieve this undetected, Darwin sent out ‘cryptic’ questions on seemingly-random natural observations to individuals of every social class.245 I detected this ‘questioning period’ between the years 1838 and 1842, in the network and text analysis component of this

project. This methodology maintained the discussion of these content elements with their associated correspondents, affirming Darwin’s incorporation of natural observations from a varying pool of individuals. The critical and interesting element of my application of network analysis was identification of contributing individuals outside of Darwin’s known academic circle and social status.

To differentiate details of each selection mechanism Darwin referred to his *Beagle* research to form his natural understanding, and sent extensive questionnaires on artificial animal breeding and plant crossing to various types of breeders and gardeners. Desmond and Moore characterize the Spring of 1838 as Darwin’s most radical period, when he began to reject Christianity through his progressive dispute of divine invention and promotion of the self-organization of life. A combination of his increasing materialistic view and his exposure to Thomas Malthus’s *Principles of Population* (1798) in September 1838 developed Darwin’s material perspective towards a natural process for transmutation and it’s requirement of a struggle for existence through competition in nature. Darwin identified nature as the selecting force governing speciation and adaptation. With a heavy conscience, Darwin experienced interspersed periods of illness and reclusion as his theory took an increasingly natural and secular tone. Culminating in his move to Down house in 1842, Darwin’s illness caused him to retreat to the English country-side to conduct experimental research after private production of his 35-page sketch outlining his transmutation theory and laws of natural selection in 1842.

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2.4 Correspondents

Browne contextualizes the contributions of various “hidden figures” in Darwin’s work: the British Naval officers of the *Beagle*, Syms Covington, Nicholas Lawson, Charles Douglas, John Lort Stokes, Robert Edward Alison, Francis Beaufort, the Darwin sister’s Caroline, Catherine and Susan, and his cousin’s William Darwin Fox and Heinsleigh Wedgwood. All but Covington and Lawson were present in my selected correspondence collection. Descriptions, or even acknowledgement of these individuals, is helpful to understand unforeseen relationships within Darwin’s correspondence network analysis. Varying in the degree of discussion between Browne’s *Voyaging* and Desmond and Moore’s *The Life of a Tormented Evolutionist*, Browne identified a larger number of “hidden figures” and provided more detailed discussion of their contributions. Desmond and Moore merely allocate a sentence or two to discussion of “hidden figures” in Darwin’s career. Discussion of these “hidden figures” is relatively non-existent in acknowledgements by Darwin.

The role of the Darwin’s sisters in his theoretical process is convoluted due to the social stigma surrounding women in science, their quality of education, and family status. Caroline Darwin seemed to be the most familiar and involved sister in understanding and discussing Darwin’s work. This is evident in the dominantly scientific content and frequency of their

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250 Ibid., 346-48/360.
251 Ibid., 305.
252 Ibid., 226-30.
253 Ibid., 170.
254 Ibid., 274.
255 Ibid., 155.
256 Ibid., 244.
correspondence throughout 1835 to 1842. Topics included gradients of civilization in the human species, social behaviors, Lyellian geological theory, and general observations on Darwin’s Beagle specimens.\textsuperscript{260} The content of Catherine’s correspondence pertained widely to the social goings-on of Shrewsbury while Darwin had been away. She also sent items of clothing, books, and news.\textsuperscript{261} The enthusiastic Darwin sisters made an effort to support Charles’s emergence as a naturalist by reading numerous textbooks on the subject to discuss opinions on current theories.\textsuperscript{262} For women of their time they were incredibly well read, scientifically, made clear in the nature and content of their correspondence. Brinkman noted correspondence between Charles and Caroline shared sensitive scientific matters, such as suggestions of fossil placement into varying English scientific institutions. This matter was sensitive and significant as it predates Darwin’s first discussion of the topic with Henslow, arguably his most important mentor.\textsuperscript{263} Donation of his prized fossils was a delicate matter as leaked or miscommunicated presumptions of his chosen placement could have negative social and academic ramifications. Darwin’s choice to discuss this matter with Caroline, before Henslow, shows Darwin’s use of her as a sounding board within a scientific context. The familial perspective within the project network analysis visualizes the scientific topics present within their correspondence during this theoretically intensive period, providing insight into how this sounding board dynamic functioned.

Desmond and Moore pick up an interesting difference in Darwin’s treatment of his sisters compared to his wife, Emma. Documented clearly as engaging in scientific discussions within their correspondence, Darwin and his sisters regularly conversed on topics Darwin dissuaded

\textsuperscript{261} Ibid., 276.
\textsuperscript{262} Ibid., 352.
Emma from wasting her time with. Emma made an effort to read Lyell’s *Principles of Geology* (1830-1833) but Darwin persuaded her not to yet then engages in discussion on geological topics with his sister Caroline. Emma’s religious stand worried Darwin due to the secular nature of his theoretical perspective, where as his sisters were familiar with his transmutationist views.

Browne describes the relationship of Darwin with his two cousins, William Darwin Fox and Hensleigh Wedgwood. The dynamic between Darwin and Fox is better represented and much closer as they were in direct correspondence since childhood. Fox was Darwin’s mentor in his early life and education at Christ’s College in 1827, along with his brother Erasmus. They shared many passions, including entomology, collecting beetles and insects together, sporting, and hunting. He provided a social stepping stone for Darwin’s entrance into Cambridge’s elite scientific circles after his time at Edinburgh University but before his departure on the *Beagle* in 1831. Fox is more of an active contributor in my network analysis, based on the context of his responses indicating regular reciprocated academic conversation on natural history and geological content. Network analysis results indicated a contrast of Fox’s role in Darwin’s correspondence with Wedgwood. Darwin’s network relationship with Wedgwood is more simplistic, closer to a societal indicator of public response to controversial elements of Darwin’s transmutation work. Wedgwood is referred to by Darwin in this context as his ‘safest

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268 Ibid., 99/103.
269 Ibid., 12.
sparring partner'.\textsuperscript{270} Darwin relied on Wedgwood to give unfiltered feedback, achieved in his frequent responses to Darwin’s postulations as ‘nonsense’ and ‘absurd’.\textsuperscript{271} My analysis suggests that Darwin used Fox and Wedgwood differently, laying in distinction of Fox as a contributor of content and points of consideration, and Wedgwood as a societally indicative gauge for Darwin’s private work.

Fox and Darwin almost accomplished similar career paths but Darwin diverged from this path when he boarded the Beagle. Fox continued a career path in the church but maintained interest and regular correspondence with Darwin in natural history topics and controversies.\textsuperscript{272} An interesting extension of the “hidden figures” perspective of this project would be a similar network analysis of the individuals Fox and Darwin paid to collect entomology specimens in their early life. Some of their finds were previously unknown local British species due to the pervasive popularity of interest in tropical species during the early nineteenth century.\textsuperscript{273} In reference to Darwin’s later treatment of individuals like Covington, with an extreme lack of recognition and acknowledgement,\textsuperscript{274} this ignorance of the role of paid amateur assistance was prevalent in Victorian science. This is an indicator of his lack of representation, as he was a crucial and regular individual in Darwin’s work yet missing from his main form of communication and acknowledgement in publications. This is the nature of “hidden figures”. Likely many more provided assistance but were not corresponded with directly. The project network analysis can only pick up individuals corresponding with Darwin but luckily, in this

\textsuperscript{270} Desmond and Moore, \textit{Darwin: The Life of a Tormented Evolutionist}, 251.
\textsuperscript{271} Ibid., 283.
\textsuperscript{272} Browne, \textit{Charles Darwin: Voyaging (Volume I of a Biography)}, 96.
\textsuperscript{273} Ibid., 99.
circumstance, his necessity for dense responses to lengthy questionnaires from people of various occupations made it a requirement.

It has been set by historical opinion, and Darwin’s own hand, that he considered himself a geologist when boarding the *Beagle*. As much of his public naturalist work was only recently associated with the classification of his *Beagle* specimens, Darwin’s public academic perception amongst his general colleagues was of a geologist. Privately, Darwin considered himself a naturalist long before his work on barnacles began in 1846.\(^{275}\) My analysis detects this transition in the period of 1835 to 1842 through identification of a change in dominant terminology used by Darwin in correspondence, from geological to biological, identified in the text analysis project component. An element of interpretive difficulty emerged in the classification of neutral or context-specific tags returned by the network analysis, requiring resolution based on their specific context of use documented in *Charles Darwin’s Marginalia* (1990) edited by Mario A. Di Gregorio with the assistance of Nicholas W. Gill.\(^{276}\)

\(^{275}\) Wesson, *Darwin’s First Theory: Exploring Darwin’s Quest to Find a Theory of the Earth*, 258.

Chapter 3: Methodology

3.1 TEI letters from Darwin Correspondence Project

Text encoding is an introductory methodology to the digital humanities, standardizing machine-readable texts to achieve data compatibility for collaboration in scholarly digital research. This process has been referred to as the gateway to the digital humanities, offering a relatively straightforward process towards a multitude of data manipulation options. The methodology and application of text encoding has expanded extensively since Roberto Busa’s *Index Thomisticus* in 1949, developing its own scholarly community and subfield within the digital humanities. Computational languages are used to markup texts, guiding both format and layout of digital versions as well as meaning and relationships in the content itself.

A conference held in Poughkeepsie, New York addressed concern of compatibility among computer languages, resulting in the Text Encoding Initiative (TEI), a community-developed set of rules to regulate and standardize machine languages used for text encoding. TEI standards have been predominantly applied to projects within the humanities, and social science fields, providing a means for digital representation of large corpora of texts. When marking up a text, TEI elements are employed, imposing hierarchal structure in digital documents making the structure readable for computer programs. Allocating bracketed tags to specific segments imposes hierarchal text separation and forms these elements, further described by attributes.

278 Green, “Facilitating Communities of Practice in Digital Humanities: Librarian Collaboration for Research and Training in Text Encoding.” 220.
The use of the TEI within digital humanities occurs predominantly with the digitization of historical and literary documents, construction of digital archives, teaching pedagogies, and digital research corpora. The key attraction is its provision of extensive metadata, representation of large and small-scale document structure, linkage between different document locations, named entities, and representation of the rhetorical texture, physical characteristics, genesis and editorial process of a document, corpus or collection. The process of tagging is subject to a large variety of inherent errors, from inconsistencies with text encoding standards laid in the project outline, to human encoding errors increasing with the project size and number of contributors.

The use of the TEI in my current project was restricted to structural markup of digital letters provided by the Darwin Correspondence Project (DCP) team (Appendix Figure 6.1). Of interest are the element tags created for different categories of terminology within the correspondence, indicated by specific attributes. The metadata structure includes a header section with elements for letter title, publisher, publication location, licensing agreement, publication date, subtitle, source of the text, physical description of the document, type of correspondence, name of sender, location of origin, date, name of recipient, an abstract, key word tags, name of transcribers and TEI encoders (Appendix Figure 6.1). Terminology tag categories present in the metadata were included in the project’s social network analysis (‘scientific term’, ‘animal’, ‘place’, ‘geology’, and ‘plant’ tags). In the body section of the code we can determine a division type, place names, opening salutation, letter content, and footnotes (Appendix Figure 6.1). The

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282 Metadata is non-text data, present within the header section of a TEI document listing the texts source, editorial information of encoding process, and specific technical methodology.

283 Flanders, Bauman, Connell, “Text Encoding,” 110.

284 Ibid., 117.
independent researcher at the DCP responsible for designing and assigning TEI element tags to Darwin’s correspondence collection was Nick Gill in 1990, during the process of cataloguing the DCP’s marginalia archive with Mario Di Gregorio.\textsuperscript{285}

The DCP team provided the entire archive of letters. However, only a selection of 280 letters between 1835 and 1842 were included in the project analysis. The number of letters per year were 25 (1835), 26 (1836), 44 (1837), 41 (1838), 57 (1839), 30 (1840), 23 (1841), and 34 (1842). Raw letter data (author, sent or received status, recipient, date, file number and element tags) was separated by year and chronologically organized within an excel spread sheet to be structured for network analysis (Appendix Figure 6.2). This process ensured the maintenance of letter metadata with the original DCP file name creating compatibility with their online archive. If a researcher were interested in viewing the entire letter content, the file name can be entered into the search bar on the DCP website and the digitized letter content will be provided.

3.2 Social Network Analysis

Social network analysis is simply the adoption of network analysis to represent and analyze social relationships. Data collection is often conducted from text-based sources.\textsuperscript{286} In historical application, this provides an avenue to highlight carefully curated primary documents in research, supporting efforts for their conservation and restoration. To investigate the social and scientific dynamics of Darwin’s correspondence network, I conducted social network analysis to separate and visualize the varying types of information contributed by different

individuals. Networks can represent a great diversity of data, applied most often in the humanities to interpret political, economic, literary, historical, and social data.\textsuperscript{287}

The basic structural components of a network include nodes (actors) and edges (relationships). These are then analyzed at the level of the node through focus on dyads (two nodes with one relationship) or triads (three nodes with three relationships).\textsuperscript{288} Clusters of highly connected dyads and triads form subgroups or communities within the network.\textsuperscript{289} In its most basic sense, network analysis allows the visualization of large interconnected data sets. These data sets visualize the social interconnection of large groups or populations of people. Following Manuela Caiani’s suggested process for social network analysis projects, my project began with the identification of network actors in the forms of Darwin’s key influential European scientific colleagues of the mid- to late nineteenth-century.\textsuperscript{290}

Once the raw data spreadsheet format was completed, the data was restructured for network visualization in Gephi. Gephi requires two data matrices\textsuperscript{291} for nodes and edges constructing relationships in the network. A set of matrices were created for each network visualization separately with correspondents categorized by myself into colleagues, family or “hidden figures”. The colleague category required a degree or academic institutional title while “hidden figures” included those of amateur scientific status with no formal training or career.


\textsuperscript{289} Ibid., 387.

\textsuperscript{290} Ibid., 375.

\textsuperscript{291} Two rectangular data matrices (node and edge matrix) were required to structure data for network analysis in Gephi. The node included two columns for an ID number and label (including correspondent name) assigning each correspondent and element a numerical identification number used to construct edge relationship in the following edge matrix. The edge matrix included a row for every singular relationship present in the network analysis, and columns organizing the edge source (where the relationship starts), edge target (where the relationship ends), type (directed/undirected), ID, label (including letter file name and date), and weight (number of letters between Darwin and a correspondent, frequency of term use).
Family members included were those in the immediate and extended Darwin and Wedgwood family. The eight-year project period resulted in generation of 24 separate networks, eight for each category of colleague, “hidden figure”, and familial correspondence.

The Gephi node matrix allocated an ID number to each separate correspondent and element tag to form a node for each data point in the network, providing points of connection to form relationships in the edge matrix (Figure 6.4 a). Once the node data was entered, the edge matrix was created through selection of source and target nodes indicating a relationship between correspondents, their tagged terminology, and Darwin (Figure 6.4 b). Node labels indicate the different entities within the network. Edge direction was depended on the direction of correspondence. Directed edges were assigned to relationships operating in only one direction (Darwin either only sent or received material from the correspondent), while undirected edges represented relationships operating in both directions (Darwin sent and received material from the correspondent). The edge weight (or thickness) of a relationship represented the total number of letters sent between Darwin and a specific correspondent within the year of analysis.

The resultant network visualizations required colour application to increase distinction between correspondents and direction of correspondence. For overall trend analysis in network structure and size, a modularity analysis quantified the structure of the networks by clustering communities of nodes together by colour based on the strength of data divisions. For the separated network analyses, Hyperlink-Induced Topic Search (HITS) values were calculated based on the edge weight and direction of each relationship, consisting of two separate statistics: authority and hub values. Authority measurements quantify the value (determined by the number of edges connecting to a node) of a node, while hub values consider the quality of links

to a node (determined by the weight and number of edges connected to a node).²⁹⁴ HITS reports recording these values were generated for each separate network.

Immediate differentiation between the direction of correspondence and associated tagged terminology was the intention. In the separated networks, colouration was applied manually. Material only received by Darwin (sent by a correspondent) separated contributing correspondents by colour. Material sent by Darwin was coloured in the same dark grey for every network differentiating clearly material that was either sent or received by Darwin. This resulted in many people within certain networks appearing as the same colour, but this is due to those individuals only receiving information from Darwin while a colour change will occur if the material is sent to Darwin. The colour was coded from source to target node with edge color related to its direction, representing the colour of the parent node to show the direction of information movement. Node authority (generated using HITS values) was applied to proportionally increasing the size of statistically significant nodes to reduce ‘clutter’ within the network visualization, increasing readability.²⁹⁵ The analysis was based on the direction and weight of edges leading to a particular node. For example, if Darwin sent a lot of material one year his node would be small, if he received a lot of material in a year his node would be larger. Each network visualization was exported from Gephi in PDF format for the project.

Project conclusions were drawn from the type and context of prominent correspondents and their associated terminology tags in the colleagues, family, and “hidden figures” network analyses. Network analysis isolated scientific conversation specific to each category, and individuals within these categories. Identification of such instances periodizes the discussion of

²⁹⁴ Ibid., 184.
concepts within Darwin’s theoretical formulation process isolating the individuals responsible for propagating conversation around these concepts with Darwin. This functioned to gauge and categorize the nature of incoming influence in the networks, as well as indicate concepts solely presented by Darwin. Social network analysis identified specific letters and correspondents responsible for contribution and exchange of large quantities of scientific information with Darwin during his greatest period of theoretical formulation. The size of the network structure was compared over the eight-year period identifying an overall trend in expansion, with periods of reduction presenting a previously undetected cyclical fluctuation in the pattern of Darwin’s correspondence.

3.3 Text Analysis

To supplement the tag-based network analysis, text analysis of the correspondence content was conducted reinforcing network analysis results and strengthening the dependability of project conclusions. Macroscopic social network and text analysis indicate areas of significance within the correspondence collection for microscopic investigation using traditional close-reading methods. A simple and preliminary text analysis was performed using Google Ngram viewer, a text analysis software drawing from the Google Books archive generating term frequency graphs over customizable period of time. I selected the period between 1800 and 1900, comparing term frequencies for ‘transmutation’, ‘natural selection’, and ‘evolution’ across all accessible English literature. Two comparisons were performed, the first shows difference in the relative frequency of ‘natural selection’ and ‘transmutation’, the second highlights relative frequency differences between ‘natural selection’ and ‘evolution’. The Google Books archive was listed as holding over 25 million books in 2015, unfortunately due to copyright infringement.

the actual content of the books is not available to users, but Google Ngram viewer can access this restricted text data and conducts a comprehensive analysis of the entire collection (Figure 1.1 - 1.3).

To facilitate the second form of text analysis the original DCP TEI letter files were transferred to plaintext file format removing annotations and additional biographical material added by the DCP transcribers. Once plaintext files were produced, they were subjected to text analysis using the desktop server version of Voyant software created by Stéfan Sinclair of McGill University and Geoffrey Rockwell of the University of Alberta. Voyant has a wide range of options for text analysis but ‘bubbleline’ visualizations were used in the present project context to identify key term frequencies over separated document collections allowing analysis over time with a chronologically organized document collection. Text analysis was also separated by year to optimize analysis. Voyant allows upload of multiple documents conducting analysis between and across all documents, creating more specific results. The platform analyzes text by understanding their start and end, allowing relative key term frequencies in relation to document length.

A key term frequency analysis was performed indicating the most common terms in each year of correspondence. Dominant terminology returned by Voyant identified a transition in Darwin’s correspondence focus and terminology, from geological to biological, indicating his arguably unconscious transition into the naturalist phase of his career. A standard list of English words to be excluded from analysis, or a stop word list, was applied in Voyant, along with a customized list of project specific stop words (Appendix Figure 6.4). Non-scientific terminology

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298 Anderson, “Using Voyant for Text Analysis.”
was removed from the original return of term frequencies, eliminating irrelevant terminology to isolate a list of top scientific terminology within the correspondence. This additional list facilitated the removal of redundant and irrelevant terms narrowing the analysis to target distinctly scientific terms. Each year of correspondence text was filtered using the same stop word lists. Lists of the top 25 key terms and frequencies were generated (Appendix Figure 6.5) for each year for use in further bubbleline analysis in Voyant. A bubbleline visualization was produced in Voyant, depicting the top returned geological and biological terminology, separately, over each individual document in the project corpus. The top five letters with the highest density of either terminology were included for comparison (Appendix Figure 6.6), establishing a dominance of each year by a particular term category.\textsuperscript{300} From Voyant, the program definition of the bubbleline visualization is: “Bubblelines visualizes the frequency and repetition of a term’s use in a corpus. Each document in the corpus is represented as a horizontal line and divided into segments of equal length. Each term is represented as a bubble, the size of the bubble indicates its frequency in the corresponding segment of text. The larger the bubble’s radius the more frequently the term occurs.”\textsuperscript{301} Association of the DCP file names connect the terms to a specific date range, chain of letters, person, geographical area, or ideological camp. Images of each visualization were exported from Voyant in PDF format.

\textsuperscript{300} Terms were pulled from top 25 term list generated by Voyant for each year of content, with stopwords applied (Appendix 6.5). Some years did not result in 5 terms for each from the original top 25 terms list return, if only three terms were listed out of the original 25 then these were used.

Chapter 4: Results

4.1 Introduction

The networks analysis and visualizations are provided in four different formats – including colleague correspondents, “hidden figure” correspondents, family correspondents, and an overall visualization combining all groups of correspondents into one visualization for comparison of network size and structure over time. The separated network analyses were created to isolate the impact and influence of each group on Darwin’s work and scientific correspondence.

From a macroscopic perspective, Darwin’s use of his correspondence network can be characterized as years of external contribution, outreach, reclusiveness, or intermediary. The years 1835 and 1836 are characterized by outreach from Darwin to his correspondents while on the Beagle voyage. The year 1836 shows hints of external contribution, but this is the result of delayed delivery of correspondence building as the Beagle travelled. The year 1837 presented the beginning of Darwin’s collaborative phase, growing more diverse by 1838. Peak diversity in external contribution was reached in 1839, Darwin’s scientific correspondence network was the largest and most dynamic of the eight-year period. Declining in diversity as a result of illness, 1840 was a transitional year for Darwin, characterized by a balance between contribution and outreach. The year 1841 maintained this transitional structure, with a slight increase in external contribution over internal outreach by Darwin due to illness. The network for 1842 depicted a similar singular outreach dynamic as 1835 but was rather the result of reclusiveness and limited correspondence.
4.2 Network Analysis

4.2.1 Separated Colleagues Network Analysis

Figure 4.1 – 1835 colleagues network analysis consisting entirely of received scientific correspondence from John Stevens Henslow (grey). Key terminology tags are ‘Scientific fieldwork/fieldtrips’, ‘Geology’, ‘Geography’, ‘Volcanoes and earthquakes’, and ‘Cordillera’. Content and correspondents solely associated with outgoing correspondence from Darwin are labelled in grey.

In 1835, Darwin was onboard the *Beagle*, having left Valparaiso in late 1834 for Chiloé, Concepcion, then to Coquimbo, followed by their departure from South America (Figure 4.1). By September, the *Beagle* arrived in the Galápagos Archipelago and visited Chatham Island, Charles Island, and Albemarle Island, ending on James Island by October. From the Gálapagos, the *Beagle* docked in Tahiti and later in New Zealand towards the end of 1835 to arrive in Sydney, Australia by January 1836. The year 1835 was light for colleague contributions, as John
Stevens Henslow was Darwin’s only source of scientific conversation. Unfortunately, this relationship was unidirectional, with Darwin sending Henslow his observations and conclusions from his research. The one-way direction of correspondence was an artefact of sea-based travel as letters would arrive just as Darwin and the Beagle would leave a location, taking months to catch up.302 Darwin was becoming anxious to hear from Henslow as he wished a response on the safe arrival of his laboriously preserved specimens.303

Darwin sent Henslow three letters with scientific terminology between March 10th and August 12th.304 During this period, the most prominent subjects for discussion from Darwin to Henslow indicated by high frequencies of the tags, were ‘Cordillera’, ‘Geology’, ‘Scientific fieldwork/fieldtrips’, ‘Geography’, and ‘Volcanoes and earthquakes’. The tag ‘Cordillera’ appeared in each letter in reference to the American Cordillera, or mountain chain, inclusive of the Andes, which Darwin planned to traverse. Darwin filled two boxes of specimens to send to Henslow from his Andes expedition alone.305 He came across a petrified forest that indicated the location of the ancient coast of the Atlantic Ocean.306 The land sank underwater due to subsidence, burying the forest in sand which later rose during elevation with the formation of the Andes removing the forest from the salt water, fossilized, and then covered in lava from subsequent eruptions.307 The processes of subsidence and elevation appeared as gradual across long spans of geological time, which resulted in Darwin’s hypothesis of the Andes formation through gradual and constant uplift events resulting in a volcanic mountain chain. Indicated by

302 Desmond and Moore, Darwin: The Life of a Tormented Evolutionist, 183.
303 Ibid., 183.
305 Desmond and Moore, Darwin: The Life of a Tormented Evolutionist, 162.
306 Ibid., 162-165.
307 Ibid., 163-64.
the petrified forest, Darwin concluded the geological history of the Andes included periods of subsidence along a process of overall uplift.

The tag ‘Volcanoes and earthquakes’ indicates Darwin’s observation of a volcanic eruption in Chiloé, which projected rocks and lava along the Chilean coastline, and again in discussion of the formation of the Andes.\(^{308}\) The high frequency of the ‘Geology’ tag is linked to previously discussed tag use, occurring most predominantly in correspondence sent to Henslow, and amateur scientist and naval officer Alexander Burns Usborne\(^ {309}\) in relation to coastal geology. The ‘Geography’ tag emerged as predominant in the analysis through use singularly with Henslow.

At this time, Darwin was engaged in what would come to be the greatest contribution to scientific fieldwork of his life, which is indicated by the presence of the tag ‘Scientific fieldwork/fieldtrips’. He had constantly sent new observations to his colleagues and family members as of the start of the voyage in 1831. Henslow functioned like a research repository for Darwin, securing the safety of his observations, notes, and specimens safely in London until Darwin’s return.

\(^{308}\) Browne, Charles Darwin: Voyaging (Volume I of a Biography), 283.

Figure 4.2 – 1836 colleagues network analysis indicating received scientific content from Anthony Carlisle (purple), Robert FitzRoy (light green), and Charles Lyell (light blue). Content and correspondents solely associated with outgoing correspondence from Darwin are labelled in grey. Key terminology tags for incoming scientific content were ‘Specimens/samples’, ‘Scientific fieldwork/fieldtrip’, ‘Fauna’, and ‘Assessments’. The only key terminology tag associated with outgoing content was ‘Geology’.

In the year 1836 Anthony Carlisle,\textsuperscript{310} Capt. Robert FitzRoy,\textsuperscript{311} and Charles Lyell\textsuperscript{312} provided scientific conversation for Darwin, with the remainder of communication sent from Darwin (Figure 4.2). Compared to 1835, it appears Darwin’s letters are catching up with the Beagle, aside from much anticipated letters from Henslow. Returned scientific correspondence from his colleagues only started in October of 1836, right after the return of the Beagle to


London. The network analysis indicated the most prominent tags this year were
these, all but the ‘Geology’ tag was associated with incoming scientific content. Darwin’s
ongoing engagement in zoological and geological expeditions while traveling with the Beagle
resulted in a higher proportion of discussion of excursion details, theoretical postulations, and
observations indicated by the ‘Specimens/samples’, ‘Fauna’, and ‘Scientific fieldwork/fieldtrip’
tags. Interestingly, part of the conversations in 1836 of ‘Specimens/samples’ and ‘Fauna’ were in
reference to fossil bones received by the Royal College of Surgeons collected in South America
before 1835, likely an artifact of correspondence lag time while traveling.

The ‘assessments’ scientific tag appeared in incoming correspondence from Lyell, and in
outgoing conversation to Owen, Henslow, and Charles Thomas Whitley. This tag
indicated inquiry about the condition, or disposition, of specimens to confirm their safe arrival,
intact, from the Beagle. In discussion with Henslow, Darwin grumbled over the professional
disinterest he was receiving in the assessment of his specimens upon his return to London.
He voiced similar complaints to Whitley.

Darwin’s use of Henslow is a clear continuation from the year 1835, for he sent Henslow
large excerpts of zoological and geological research from his daily journals. Locations

313 Darwin Correspondence Project, “Letter no. 329,” accessed on 21 March 2019,
314 Darwin Correspondence Project, “Letter no. 317,” accessed on 21 March 2019,
315 Darwin Correspondence Project, “Letter no. 314,” accessed on 21 March 2019,
316 Darwin Correspondence Project, “Letter no. 317,” accessed on 21 March 2019,
317 Darwin Correspondence Project, “Letter no. 317,” accessed on 21 March 2019,
318 Darwin Correspondence Project, “Letter no. 314,” accessed on 21 March 2019,
319 Browne, Charles Darwin: Voyaging (Volume I of a Biography), 335.

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discussed with Henslow span from the Galápagos to Australia in one letter, showing Darwin’s propensity for dense reviews of his ongoing work.\textsuperscript{320} In Australia in early 1836, Darwin focused on coral reef formation, mainly that of the Great Barrier reef.\textsuperscript{321} The process required a dual understanding of geological subsidence and biological coral polyp generation, determined to occur at a continual rate as the sea floor sank.\textsuperscript{322} In the context of ‘Fauna’, Darwin sent observations specifically on reptiles and crustacea to Henslow. Stopping only at the Íls de France, the \textit{Beagle} sailed to Cape Town in South Africa in mid-May, leaving by June. During this period Darwin took it upon himself to organize his specimens and catalogues, re-writing his specimen lists before his return.\textsuperscript{323} His theoretical phase started once the \textit{Beagle} headed for Falmouth in anticipation of the flurry of excitement he was told he would receive in London.

Following the pattern of expansion and increased external contribution starting in the year 1835, we see contribution dominated by Henslow in the year 1837 with Darwin’s arrival in London (Figure 4.3). The most prominent scientific terminology tags, ‘Queries/requests’, ‘Information, data, scientific description’, ‘Specimens/samples’, ‘Fauna’, and ‘Coral’, were associated with Henslow. There were seven letters between the two,\textsuperscript{324} and Henslow was Darwin’s main contributing colleague in the year 1837. Falling in line with Darwin’s immediate focus on his travel publications between January and September, the two were in continual contact working through Darwin’s theory of coral reef formation and flora related queries.

\textsuperscript{321} Browne, \textit{Charles Darwin: Voyaging (Volume I of a Biography)}, 315.
\textsuperscript{322} Ibid., 317.
\textsuperscript{323} Ibid., 339.
resulting in high frequencies of ‘Queries/requests’, ‘Information, data, scientific description’, and ‘Specimens/samples’ tags. Henslow guided Darwin in a botanical context, while Charles Lyell\textsuperscript{325} assisted with extensive geological discussion on the matter. Henslow addressed a diverse array of observations throughout Darwin’s Beagle researches indicating his assistance in organizing Darwin’s theories for publication. Henslow’s numerical contribution is larger, but Lyell provided more scientific terminology tags per letter, which indicates a more detailed geological discussion and contribution.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{network_analysis.png}
\caption{1837 colleagues network analysis visualizing received scientific content from John Stevens Henslow (light blue), Charles Lyell (dark green), Charles Babbage (light green), Charles Babington (pink), and John Richardson (teal). Content and correspondents solely associated with outgoing correspondence from Darwin are labelled in grey. Key scientific terminology tags are ‘Queries/requests’, ‘Information, data, scientific description’, ‘Specimens/samples’, ‘Fauna’, and ‘Coral’ in association with incoming content from Henslow.}
\end{figure}

The size of Darwin’s colleagues network also expanded in the year 1837 with his move to London. This is directly related to his active search to secure a number of specialists to classify his specimens. Evidence of his outgoing effort can be seen in the unidirectional movement of correspondence to certain individuals, without a return of scientific information within the year. Characterized as year of seeking assistance, in this period Darwin started the process of labor division in classifying his specimen hoard to further facilitate his public and private work. Known specialists consulted included Richard Owen (fossil mammals), Henslow (plants), Leonard Jenyns (fish), and William Buckland (marine iguanas). Historians have documented these contributions but have not noted the contributions of Frederick William Hope\textsuperscript{326} and Charles Cardale Babington\textsuperscript{327} in the classification of Darwin’s beetles from Hobart Town, Sydney, and King George’s Sound. George R. Waterhouse is often the figure associated with Darwin’s entomology specimens, but the network analysis for the year 1837 indicates more contributing individuals. Similarly, John Richardson’s\textsuperscript{328} contributions on Northern tree species and ecology has not been previously associated with Darwin in the literature.

Another interesting element of the analysis is the high frequency of general terminology tags circulating Darwin’s key areas of focus in the year 1837 due to the specialized nature of external contribution from multiple fields (geology, botany, and zoology). Overlap in introductory discussion of common topics in Darwin’s research represented the top tagged terminology, followed by more specific field-related terminology at a lower frequency. The number of correspondents increased with Darwin’s solicitation for expertise from others.


resulting in greater diversity of scientific terminology as the specialization of incoming scientific information increased.

The year 1837 was a pivotal year for Darwin in multiple contexts. From a theoretical perspective, he began his first private postulations on transmutation in his notebooks in July, described as a period of ‘energetic theorizing’. Janet Browne refers to the period of 1837 to 1839 as one of extraordinary intellectual creativity for Darwin, interpreted in our analytical context as stemming from the diversity of insight he was gaining from his extensive scientific consultations.\(^{329}\) He understood the evolutionary significance of speciation within his Galápagos finch and mocking bird specimens, and their origination from a mainland common ancestor determined by John Gould.\(^{330}\) By mid-1837, transmutation was Darwin’s central focus.\(^{331}\) His ease of attaining assistance from colleagues to interpret and clarify various botanical, biological, zoological, or geological queries accelerated the theoretical progress of his transmutation work resulting in the first glimpses of related thoughts in his red notebook while returning on the Beagle in late 1836. By mid-1837, Darwin had accepted transmutation and made a targeted effort to collect evidence in his notebook B.\(^{332}\) His creation of the first genealogical tree of life from a common origin emerged during this intense theoretical period. From a personal perspective, 1837 marks the year Darwin fully grasped the controversial nature of his transmutation work and it’s immediate challenge to Christianity, and God’s place in nature.

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\(^{331}\) Browne, Charles Darwin: Voyaging (Volume I of a Biography), 363.

\(^{332}\) Herbert, Charles Darwin and the Question of Evolution: A Brief History with Documents, 20.
**Figure 4.4** – 1838 colleagues network analysis visualizing received scientific content from Charles Lyell (dark green) and William Yarrell (dark blue). Content and correspondents solely associated with outgoing correspondence from Darwin are labelled in grey. Key scientific terminology tags are ‘Geology’, ‘Queries/requests’, ‘Fauna’, ‘Assessments’ and ‘Theory (including philosophy)’ entirely from incoming scientific content of Charles Lyell.

In the year 1838, Darwin experienced a slight decrease in the size of his correspondence network but he extended his activities of 1837 (Figure 4.4). Darwin continued to consult with his hired specialists on new or contradictory findings in his specimen collection. The specialists hired had Darwin’s specimens in their hands, resulting in his travel throughout London to monitor and prod their progress.\(^{333}\) Darwin became obsessed with speedy expedition of specimen classification for incorporation into his transmutation evidence and travel publications.\(^{334}\)

\(^{333}\) Desmond and Moore, *Darwin: The Life of a Tormented Evolutionist*, 203.

\(^{334}\) Ibid., 203.
year 1838 was characterized by compulsive notetaking seen in the number of notebooks he filed. In February he started notebook ‘C’, followed by ‘D’ addressing transmutation sequences and ‘M’ considering wider consequences of transmutation by July. In October he commenced another transmutation notebook ‘E’ and ‘N’ addressing metaphysics. Darwin ventured on one geological fieldtrip to study the parallel road phenomenon of Glen Roy, Scotland for 10 days in June.

The year 1838 is contextualized as a year of questioning by Darwin, compiling mass questionnaires for domestic and livestock breeders, farmers, gardeners, landowners, and trade workers. Darwin’s theoretical understanding of transmutation diverged from common belief, removing the requirement for perfection of form in nature – not every individual was perfectly adapted to their environment. As divine design ensured perfect form in nature, imperfect individuals immediately debased this conclusion. Furthering his radical path, Darwin visited the London Zoo to study human similarity to the ape family, reconsidering the human species’ place in nature. He saw humans as part of the natural world, an extension of the ape lineage. Determination of self-organization in atoms eliminated divine influence in the very lowest orders of life.

David Quammen interestingly applied Darwin’s own metaphor to characterize 1838 as a year when ‘the fabric falls’, implying Darwin’s dismantling of natural theology that revealed the “truth” of evolutionary theory by natural selection, behind the fabric. The end of this period

335 Desmond and Moore, Darwin: The Life of a Tormented Evolutionist, 240.
336 Ibid., 268.
337 Ibid., 242.
338 Ibid., 241.
339 Ibid., 243-44.
340 Ibid., 249-50.
341 Herbert, Charles Darwin and the Question of Evolution: A Brief History with Documents, 37.
was capped by Darwin’s discovery of Thomas Malthus’s *An Essay On the Principles of Population* (1798) in September 1838, which resulted in his consideration of a natural mechanism for evolution based on a sense of ‘warring’ species and overall struggle for existence. A materialistic perspective took root, shown in Darwin’s increasingly naturalistic interpretation of evidence of speciation laying down three (out of his later four) principles, or requirements, of natural selection. The first states that heredity is continuous across multiple generations, the second states variation must occur among offspring creating variable fitness of individuals, and the final states more offspring are produced than will survive. The final, or third, principle addresses natural competition between offspring generating a struggle for survival.

The most frequent tags returned in the network analysis of the year 1838 were ‘Geology’, ‘Queries/requests’, ’Fauna’, ‘Assessments’ and ‘Theory (including philosophy)’. The most predominant tagged terminology is associated with Charles Lyell’s substantial contribution of scientific information. Given the growing secrecy of Darwin’s transmutation work, associated terminology tags were not elevated to the same degree as with my analysis of the year 1837. Darwin maintained a duality in his motivations for specimen classification in 1837, to facilitate his public communications and private contemplations. This gave Darwin an avenue to disguise scientific discussion of controversial and transmutation-associated concepts without his professional status being questioned. As his theoretical work intensified and became increasingly

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342 Herbert, *Charles Darwin and the Question of Evolution: A Brief History with Documents*, 43.
343 Ibid., 60.
344 Ibid., 50.
345 Ibid., 50.
secular, Darwin was losing the ability to cover traces of his controversial perspective in his public naturalist activities. This resulted in a heavy geological focus in Darwin’s work and correspondence represented by the high frequency of ‘Geology’, ‘Queries/requests’ and ‘Theory (including philosophy)’, ironically juxtaposed against his most secretive and productive period of transmutation theorizing.

The frequency of ‘Geology’, ‘Queries/requests’, and ‘Theory (including philosophy)’ were used dominantly within a Scottish context as Darwin consulted Lyell, Charles Thomas Whitley,348 and Albert Way349 on his developing theory of parallel road formation. He continued discussion with Henslow of the impact of geographical isolation of islands on species diversity and distribution. Geological discussion extended to that of Newfoundland with J. B. Jukes350 and South America with William Lonsdale.351 Consultation with specialists through correspondence continued with Richard Owen,352 Thomas Bell,353 George Robert Gray,354 and William Yarrell.355 As previously stated, Owen continued classifying Darwin’s mammalian fossils while Bell, Gray, and Yarrell addressed queries on reptiles, birds, pigs, and rabbits, respectively. The variety of fauna discussed with these specialists resulted in the high frequency of the ‘Fauna’ and ‘Queries/requests’ tag.

The correspondence for 1837 and 1838 was dominated by tagged scientific terminology entirely contributed by external colleagues. External contribution for the year 1835 was absent, and 1836 was a transition year for Darwin, for it showed a balance of both sent and received material.

Figure 4.5 – 1839 colleagues network analysis visualizing received scientific content from Robert FitzRoy (yellow), William Herbert (green), John Grant Malcolmson (dark blue), Richard Owen (pink), George Robert Waterhouse (red), John Steven Henslow (light blue), and Alexander von Humboldt (teal). Content and correspondents solely associated with outgoing correspondence from Darwin are labelled in grey. Key scientific terminology tags were ‘Zoology’, ‘Queries/requests’, ‘Specimens/samples’, ‘Geology’, and ‘Information, data, scientific description’. The only tag not associated with incoming contributions is ‘Zoology’.

The year 1839 appeared to be another year of balance between sent and received material, but with an increase in the variety and quantity of external colleague contribution (Figure 4.5). This year was a highly collaborative for Darwin, and a period of transition in scientific terminology in correspondence, from geological to biological. This represented his
career transition to natural history. The transition arguably started in 1837 and continued with increasing disparity in 1838, to clear dominance by naturalist terminology by 1839. Scientific terminology for the years 1835 and 1836 were distinctly geological, a conclusion supported by the accompanying text analysis discussed in section 4.3. Dominant terminology tags in the year 1839 are ‘Zoology’, ‘Queries/requests’, ‘Specimens/samples’, ‘Geology’, and ‘Information, data, scientific description’. The increased variety of colour in the network separating contribution of each different colleague illustrates the diversity of contribution. Darwin’s correspondence network of 1839 was the largest of the eight years I examined, which characterizes it as a peak period of colleague collaboration during his intense theoretical formulation period.

The year 1839 started with Darwin’s election to the Royal Society of London on January 24th, as well as the appearance of his second and third travel publications. *Journal of Researches (Voyage of the Beagle)* (1839) was coming to fruition while he was continuing work on *The Zoology of the Voyage of H.M.S. Beagle* (1838-43), which coincides with the high frequency of the tag ‘Zoology’ with Alexander Young Spearman, Treasurer, and Mr. Fothorp of Smith, Elder & Co. publication. Darwin entered a phase of public promotion of his *Beagle* research in the year 1839, while privately contemplating the randomness of nature. His own horticultural experimentation and returned questionnaires from gentlemen farmers and gardeners pointed to new variations as accidental occurrences in nature. This assertion pushed Darwin away from evolutionary understanding driven by habit, but rather chance. Theoretical contemplation led

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359 Ibid., 284.

360 Ibid., 283.
Darwin to realize the vast geological timeline required for beneficial random variations to spread within a population.\textsuperscript{361} His narrowed focus while isolating the non-divine mechanism of variation in nature placed Darwin farthest from his public image he had yet been. The internal divide began to produce great anxiety in Darwin, manifesting in stress-related illness and reclusiveness.

The context of Darwin’s ‘Queries/requests’ were geological, botanical, and zoological. Darwin sought William Herbert for botanical queries on the \textit{Amaryllidaceae} family and \textit{Hippeastrum} genus, plant crossings and fertility, variation, and heredity in plant populations.\textsuperscript{362} He requested information on his specimens, coinciding with high frequency of the ‘Specimens/samples’ tag, from specialists for his \textit{Journal of Researches} and private transmutation work. Leonard Jenyns,\textsuperscript{363} George Robert Gray,\textsuperscript{364} and Charles Stokes,\textsuperscript{365} contributed work on fishes, birds, and fungi, respectively. Jenyns was sole author of his volume and Gray assisted with John Gould’s ornithological volume. Darwin received queries on artificial breeding from Richard Sutton Ford\textsuperscript{366} and George Tollet.\textsuperscript{367} Additional discussion of ‘Specimens/samples’ started with John Grant Malcolmson\textsuperscript{368} in regard to quality bird

\begin{flushright}
\footnotesize
\textsuperscript{361} Desmond and Moore, \textit{Darwin: The Life of a Tormented Evolutionist}, 283.
\end{flushright}
preservation, W. J. Broderip\textsuperscript{369} debated theories of mold formation, and Darwin requested examination of bird specimens by Thomas Campbell Eyton.\textsuperscript{370}

Geological discussion was prevalent still in the year 1839, represented by high frequency of the ‘Geology’ tag. Incoming discussion came from John Grant Malcolmson\textsuperscript{371} with four incoming letters. Discussion ranged from elevation of the Indian subcontinent (which pulled on geological evidence from India, Southern Asia, and Arabia), to coral specimen identification and formation in the China Sea. Incoming ‘Information, data, scientific description’ was a combination of contribution from Alexander von Humboldt,\textsuperscript{372} and previously mentioned contributions of John Grant Malcolmson and William Herbert.

Figure 4.6 – 1840 colleagues network analysis visualizing received scientific content from John Grant Malcolmson (dark blue), John Stevens Henslow (light blue), Benjamin Silliman (pink), and Richard Owen (teal). Content and correspondents solely associated with outgoing correspondence from Darwin are labelled in grey. Key scientific terminology tags were ‘Theory (including philosophy)’, ‘Volcanoes and earthquakes’, ‘Geology’, ‘Zoology’ and ‘Positive attitude/assessment’. The only tag not associated with incoming contributions is ‘Zoology’.

Decreasing in size to almost half that of the year 1839, Darwin’s 1840 correspondence network displayed the impact of his illness and related reclusive behavior on his productivity and willingness to engage in scientific correspondence. Darwin’s reclusiveness had emerged on the Beagle, increasing in London until his move to Down House in Kent in mid-September 1842.\textsuperscript{373} The separation between public and private was also intensifying due to the growing interrelation of Darwin’s natural interpretation of biological observations, their implications, and his illness.

\textsuperscript{373} Browne, Charles Darwin: Voyaging (Volume I of a Biography), 279; Desmond and Moore, Darwin: The Life of a Tormented Evolutionist, 285.
A timeline of illness can be paralleled with periods of heavy theoretical formulation for Darwin and social unrest. Reoccurring illness started in September 1837, intensifying to a chronic phase by the early 1840s. Darwin’s anxiety was triggered by his own heretical postulations, as much as by the fear of how his work could be used to fuel budding social tensions in situations such as implementation of the Poor Law Amendment Act of 1834 (or the New Poor Law) targeting pauperism in the lower classes. The amendment removed charitable support of the able-bodied ‘poor’ supported by elite Malthusian principles furthering the rift between classes. Darwin’s transmutation theory promoted self-organization and natural regulation of nature from a secular perspective and could be used as justification for civil unrest by the lower classes. Darwin’s concerns were not misplaced as social misappropriation of his theory did occur, beginning in elite families interpreting social stratification as biologically predetermined through concepts of hereditary and evolutionary fitness resulting in a sustained source of condescension towards the lower classes. The unintentional misapplication of Darwinian fitness in nature, to society, stimulated the emergence of social Darwinism.

The political connotations of his developing theory tormented Darwin, as they were perceived through a Unitarian lens due to promotion of self-organizing atoms, lack of divine creation, and natural regulatory mechanism. Self-organization incited individual autonomy without divine intervention, and complete natural regulation proposed achievement of power from below (interpreted as the lower classes). His theory superimposed the historical

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375 Manchester riots; Desmond and Moore, *Darwin: The Life of a Tormented Evolutionist*, 297.
376 Ibid., 196.
377 Ibid., 196.
378 Ibid., 249.
381 Ibid., 249.
innervation of religious elite authority over society and disrupted the divine chain of command from God.\textsuperscript{382} Science of this type was often highjacked to promote political agitation and support atheism by radicals.\textsuperscript{383} Darwin worked to identify controversial elements within his theory, and remove or modify their discussion to more socially suitable contexts.\textsuperscript{384} The lack of fossil evidence showing species in transition was becoming apparent to Darwin as one of the leading barriers to academic acceptance of his theory.\textsuperscript{385}

The extremity of erupting political tensions in the early 1840s led to the violent protests of the Manchester riots in March 14\textsuperscript{th}-16\textsuperscript{th}, 1842.\textsuperscript{386} Along with his theory’s controversial content, Darwin’s publication hesitation was linked to the volatile social environment of these political events.\textsuperscript{387} Darwin had reason for concern as the colleagues and contemporaries propelling his career forward were of elite status. If Darwin published his theory it would arm their lower-class opposition, functioning to thank his colleagues with a slap in the face to their steadfast traditional ideologies.

‘Theory (including philosophy)’, ‘Volcanoes and earthquakes’, ‘Geology’, ‘Zoology’, and ‘Positive attitude/assessment’ were the dominant terminology tags of the year 1840. John

\textsuperscript{382} Desmond and Moore, \textit{Darwin: The Life of a Tormented Evolutionist}, 249.
\textsuperscript{383} Ibid., 249.
\textsuperscript{384} Removal of conscious behaviors driving evolutionary mechanism and human-ape ancestry as natural selection was controversial enough and Darwin needed to avoid political hijacking or unintended association of his work with political radicals; Ibid., 249/296/286.
\textsuperscript{385} Desmond and Moore, \textit{Darwin: The Life of a Tormented Evolutionist}, 272.
\textsuperscript{386} Ibid., 297.
Grant Malcolmson,\textsuperscript{388} Henslow,\textsuperscript{389} and David Milne\textsuperscript{390} made the largest external contributions of scientific content. Discussion of Darwin’s Glen Roy article “Observations on the Parallel Roads of Glen Roy, and of other parts of Lochaber in Scotland, with an attempt to prove that they are of marine origin” (1839) with John Grant Malcolmson and William Buckland\textsuperscript{391} contributed to the frequency of the ‘Theory (including philosophy)’ tag, as did discussion of Darwin’s coral formation theory with Charles Lyell,\textsuperscript{392} and his earthquake observations in Chiléo with David Milne and John Phillips.\textsuperscript{393} Correspondence with Milne and Phillips also contributed frequency to the ‘Volcanoes and earthquake’ tag. Darwin’s parallel road conclusions were deemed incorrect upon Louis Agassiz’s glacial theory of formation.\textsuperscript{394}

Darwin’s productivity in publication returned ‘Positive attitude/assessment’ tags from Benjamin Silliman,\textsuperscript{395} along with two instances of use by Darwin in positive reviews of Capt. Robert FitzRoy’s\textsuperscript{396} and Leonard Jenyns’s\textsuperscript{397} work. The direction of zoological discussion occurred from Darwin to his correspondents only. Use of the ‘Zoology’ tag was dominated by discussion for a second year with Alexander Young Spearman over the publication of the fourth

part of *The Zoology of the Voyage of H.M.S. Beagle* (1838-43). In the year 1840, Darwin’s diverse collaborative period ended. This is evident in the decreasing variety of contribution from his colleagues with high frequency tags increasingly dominated by one or two individuals, rather than a mosaic of collaborators.

![Figure 4.7 – 1841 colleagues network analysis visualizing received scientific content from Charles Lyell (dark green), Leonard Jenyns (purple), William C. Redfield (dark blue), and John Stevens Henslow (light blue). Content and correspondents solely associated with outgoing correspondence from Darwin are labelled in grey. Key scientific terminology tags were all contributed from external colleagues and included ‘Theory (including philosophy)’, ‘Geology’, ‘Ice-action, icebergs, glaciers’, ‘Coral’ and ‘Isolation, islands’.

Representing a continuation of decreasing diversity in colleague contribution, the year 1841 is dominated heavily by scientific correspondence between Darwin and Charles Lyell.

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sharing seven letters, Leonard Jenyns sharing two letters, and William C. Redfield sharing one letter (Figure 4.7). Top returned scientific terminology tags were ‘Theory (including philosophy)’, ‘Geology’, ‘Ice-action, icebergs, glaciers’, ‘Coral’ and ‘Isolation, islands’.

Expansion in the diversity of Darwin’s correspondents fluctuated in the same cyclical manner as the size of his overall correspondence network. Overall expansion of the network is correlated with, and arguably the result of, the growing degree of diversity in correspondents.

Theoretical discussion represented by the ‘Theory (including philosophy)’ tag occurred only from Darwin to his contacts. Writing to Lyell, Darwin further discussed Agassiz’s glacial formation theory of the parallel roads of Glen Roy, which concerned the presence of perched rocks in the Jura supporting hypothesized coverage by a single sheet of ice from The Alps to the Jura mountain range. Darwin’s main preoccupation, aside from his transmutation work, was the transportation of boulders. Erratic boulders are a phenomenon associated with glacial movement transporting rocks from one region to another, indicated by their distinct difference from the regions native rock structure. Presence of such rocks would undoubtedly prove Agassiz correct, disproving Darwin’s gradual elevation theory from a marine origin for the ‘roads’. Darwin’s struggle with his failure over the parallel roads undermined his confidence as a geologist, pushing his theoretical work purely into natural history. Further theoretical discussion with Lyell pertained to the impact of subsidence on coral reef formation increasing the frequency of the ‘Coral’ and ‘Isolation, islands’ terminology tags in the network analysis. A

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403 Ibid., 97.
section of Darwin’s coral reef theory addressed formation of coral islands in the middle of the ocean, a clear item on his agenda with Lyell.

The use of ‘Geology’ was often in combination with ‘Theory (including philosophy)’ due to the diversity of geological theories Darwin developed and critiqued during this year. Additional use of the ‘Geology’ scientific terminology tag was reflected in incoming content from Jenyns and Redfield. Similarly, the tag ‘Ice-action, icebergs, glaciers’ was only associated with outgoing content to Lyell and Louis Agassiz in the context of theoretical debate on Glen Roy’s parallel roads.

Darwin left London to go home to Shrewsbury for June and July of 1841, where he conducted plant experiments and completely cut-off correspondence. Towards August of that year, Darwin’s disdain for London city life came to head as he relentlessly searched for a house in the English country side. He continued to study ape expression and emotion at the London zoo upon his return in August, but restricted visitation from a majority of his colleagues.

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407 Desmond and Moore, Darwin: The Life of a Tormented Evolutionist, 289.
408 Ibid., 291.
Figure 4.8 – 1842 colleagues network analysis visualizing received scientific content solely from Hugh Falconer (blue). Content and correspondents solely associated with outgoing correspondence from Darwin are labelled in grey. Key scientific terminology tags were ‘Theory (including philosophy)’, ‘Geology’, ‘Specimens/samples’, ‘Systematics’, ‘Fauna’, and ‘Positive attitude/assessment’. The ‘Fauna’ tag was the only key tag to be associated with incoming contribution from a colleague.

The year 1842 shows the extremity of Darwin’s reclusive tendencies as his scientific correspondence network was almost entirely comprised of outgoing information. Darwin received only one letter with scientific terminology from his professional colleagues. In June, he moved himself permanently home to Shrewsbury sketching his first 35-page comprehensive draft of his theory of evolution by natural means.\(^\text{409}\) A second revision in mid-July resulted in the final version of his first theoretical sketch. Darwin craved privacy for his family, purchasing Down House in Kent and moving from Shrewsbury in September.

Darwin’s outgoing scientific terminology during this period was dominated by the tags ‘Theory (including philosophy)’, ‘Geology’, ‘Specimens/samples’, ‘Systematics’, ‘Fauna’, and

\(^{409}\) Desmond and Moore, *Darwin: The Life of a Tormented Evolutionist*, 292.
‘Positive attitude/assessment’. Incoming contribution was singularly focused on the ‘Fauna’ tag in a letter from Hugh Falconer discussing ruminant anatomical structures in the metacarpal bones of the extinct *Anoplotherium* genus. Moving into the year 1843, Darwin’s productivity in Kent declined steeply and he began to neglect his work. Darwin’s productive period in London was sandwiched between two reclusive periods, first upon his return from the *Beagle* in Cambridge in 1836 and later in Kent between 1842 and 1843.

4.2.2 Separated “Hidden Figures” Network Analysis

Network analysis of “hidden figures” is separated into two periods: the first *Beagle* period, comprised of network analyses of the years 1835 and 1836, followed by the second London period from the years 1837 to 1842. The years 1835 and 1836 included “hidden figures” Charles D. Douglas, Robert Edward Alison, Charles San Lambert, Henry Stephen Fox, and Alexander Burns Usborne. The year 1836 consisted of one of the two tag contributions

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413 Charles D. Douglas was a geological surveyor and resident of Chiloé; “Charles D. Douglas,” Darwin Correspondence Project, last modified 2018, https://www.darwinproject.ac.uk/letter/?docId=nameregs/nameregs_1362.xml;brand=default

414 Robert Edward Alison was a merchant Darwin met in Valparaiso through Richard Corfield; Browne, *Charles Darwin: Voyaging (Volume I of a Biography)*, 276.

415 Charles San Lambert was a miner and industrialist in Coquimbo, Chile; “Charles San Lambert,” Darwin Correspondence Project, last modified 2018, https://www.darwinproject.ac.uk/letter/?docId=nameregs/nameregs_2790.xml;query=charles%20san%20lambert;brand=default

416 Henry Stephen Fox was an eccentric British ambassador to the United States with a passion for entomology; “An Eccentric Diplomat: The Quaint Personality and Stranger Life of Minister Fox,” *The Intelligencer* (1897).

417 Alexander Burns Usborne was a naval officer and assistant geological surveyor on the *HMS Beagle* and *Consecution*; “Alexander Burns Usborne,” Darwin Correspondence Project, last modified 2018, https://www.darwinproject.ac.uk/letter/?docId=nameregs/nameregs_4847.xml;query=alexander%20burns%20usborne;brand=default.
from Charles D. Douglas (Figure 4.10), and the other associated with correspondence analysis for the year 1835 (Figure 4.9). External contribution was facilitated by Charles San Lambert\footnote{Darwin Correspondence Project, “Letter no. 279,” accessed on 21 March 2019, http://www.darwinproject.ac.uk/DCP-LETT-279.} and Robert Edward Alison\footnote{Darwin Correspondence Project, “Letter no. 277,” accessed on 21 March 2019, http://www.darwinproject.ac.uk/DCP-LETT-277.} while outgoing correspondence was sent to Charles D. Douglas\footnote{Darwin Correspondence Project, “Letter no. 269,” accessed on 21 March 2019, http://www.darwinproject.ac.uk/DCP-LETT-269.}, Henry Stephen Fox\footnote{Darwin Correspondence Project, “Letter no. 284,” accessed on 21 March 2019, http://www.darwinproject.ac.uk/DCP-LETT-284.}, and Alexander Burns Usborne\footnote{Darwin Correspondence Project, “Letter no. 285,” accessed on 21 March 2019, http://www.darwinproject.ac.uk/DCP-LETT-285.} in the year 1835. Terminology tags with the highest frequency of occurrence were ‘Geology’, ‘Geography’, ‘Volcanoes and earthquakes’, ‘Scientific fieldwork/fieldtrips’, and ‘Specimens/samples’ (Figure 4.9). Three of the top tagged scientific terminology was associated with correspondence with a miner and industrialist living in Coquimbo, Chile: Charles San Lambert\footnote{“Charles San Lambert,” Darwin Correspondence Project, last modified 2018, https://www.darwinproject.ac.uk/letter/?docId=nameregs/nameregs_2790.xml;query=charles%20san%20lambert;brand=default}. 
Figure 4.9 – 1835 “hidden figures” network analysis visualizing received scientific content from Charles San Lambert (red) and Robert Edward Alison (purple). Content and correspondents solely associated with outgoing correspondence from Darwin are labelled in grey. Key scientific terminology tags included ‘Geology’, ‘Geography’, ‘Volcanoes and earthquakes’, ‘Scientific fieldwork/fieldtrips’, and ‘Specimens/samples’. The only key terminology tag not associated with incoming contribution is the ‘Scientific fieldwork/fieldtrips’ tag.

Details on the origin and dynamic of the relationship between San Lambert and Darwin are scant in historical literature, but San Lambert is mentioned three times in reference to his observation in Darwin’s *Geological Observations on South America* (1846):

“I was assured by Mr. Lambert, that native copper without a trace of silver has been found in the same vein with native silver without a trace of copper. At the mines of Aristeas, the silver veins are said to be unproductive as soon as they pass into the green strata, whereas at S. Rosa, only two or three miles distant, the reverse happens; and at the time of my visit, the miners were working through a red stratum, in the hopes of the vein becoming productive in the underlying green sedimentary mass. I have a specimen of one of these green rocks, with the usual granules of white calcareous spar and red oxide of iron, abounding with disseminated particles of glittering native and muriate of silver, yet taken at the distance of one yard from any vein,—a circumstance, as I was assured, of very rare occurrence.”

“I may add, that Mr. Lambert, a gentleman well acquainted with this country, informs me, that in ascending the ravine of Santandres (which branches off from the Despoblado) he met with streams of lava and much erupted matter capping all the hills of granite and porphyry, with the exception of some projecting points; he, also, remarked that the valleys had been excavated subsequently to these eruptions. This volcanic formation, which I am informed by Mr. Lambert extends far northward, is of interest, as typifying what has taken place on a grander scale on the corresponding western side of the Cordillera of Peru.”

San Lambert’s observations on volcanic landscapes in Chile in his geological description of the region between Copiapó and Atacama were used by Darwin without full academic acknowledgment or use of his first name. From the first quote, the sense is given that San Lambert may have even included a rock specimen with his observations. A large proportion of the frequency of the ‘Geology’ and ‘Geography’ term tags come from queries sent by Darwin, with the only instances of incoming content containing either of these tags coming from San Lambert. The situation was similar for incoming ‘Volcanoes and earthquakes’ content from San Lambert, in addition to one instance by Robert Edward Alison.

Darwin’s use of his correspondence network allowed him to establish personal relationships along his Beagle travels, which yielded steady reports of geological observations upon his departure. Robert Edward Alison was a scientific book merchant assisting Darwin with research in Valparaiso, Chile in the year 1834. They met through a fellow classmate of Darwin’s in Shrewsbury, Richard Henry Corfield, but Alison also receives little public acknowledgement for use of his geological observations of Valparaiso by Darwin. His findings were sent in June of 1835 contributing frequency of use to the ‘Geology’, ‘Subsidence

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428 Ibid., 274.
and elevation’, and ‘Information, data, scientific description’ tags in the network analysis. As with San Lambert, Darwin refers to Alison’s work without academic credit in *South America* (1846):

“**Valparaiso.**

During two successive years I carefully examined, part of the time in company with Mr. Alison, into all the facts connected with the recent elevation of this neighbourhood. In very many parts a beach of broken shells, about fourteen or fifteen feet above high-water mark, may be observed; and at this level the coast-rocks, where precipitous, are corroded in a band. At one spot, Mr. Alison, by removing some birds' dung, found at this same level barnacles adhering to the rocks.”

“Nor is the land here modelled into terraces: Mr. Alison, however, informs me, that on both sides of one narrow ravine, at the height of 300 feet above the sea, he found a succession of rather indistinct step-formed beaches, composed of broken shells, which together covered a space of about eighty feet vertical.

I can add nothing to the accounts already published of the elevation of the land at Valparaiso, which accompanied the earthquake of 1822: but I heard it confidently asserted, that a sentinel on duty, immediately after the shock, saw a part of a fort, which previously was not within the line of his vision, and this would indicate that the uplifting was not horizontal: it would even appear from some facts collected by Mr. Alison, that only the eastern half of the bay was then elevated. Through the kindness of this same gentleman, I am able to give an interesting account of the changes of level…”

Given the gentlemanly reference, Darwin outlined his opinion on the appropriate degree of academic accreditation of such individuals. Within the same publication, for comparison, Darwin’s reference to theoretical support by his colleague Richard Owen’s observations included a footnote reference accrediting the use of his work:

“These remains consist of, first, the head of *Ctenomys antiquus*, allied to the living *C. Braziliensis*; secondly, a fragment of the remains of a rodent; thirdly, molar teeth and other bones of a large rodent, closely allied to, but distinct from, the existing species of *Hydrochoerus*, and therefore probably an inhabitant of fresh water; fourth and fifthly, portions of vertebrae, limbs, ribs, and other bones of two rodents; sixthly, bones of the extremities of some great megatheroid quadruped.†

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430 Ibid., 34-35.
Footnote: † See Fossil Mammalia (p. 109), by Professor Owen, in the Zoology of the Voyage of the Beagle; and Catalogue (p. 36) of Fossil Remains in Museum of Royal College of Surgeons.”

It is recognized Owen’s work was academically published resulting in more severe professional academic repercussions for inappropriate citation than the rough field notes of a self-trained amateur scientist, yet both are lent similar authority and weight in their use as evidence by Darwin in discussion of his theoretical conclusions. Presence of both forms of citation in the same work indicates Darwin’s consciousness in deciding how he referenced the work of his colleagues and of “hidden figure” amateur scientists. A footnote including San Lambert’s or Alison’s complete title, previous contributions to Darwin’s work, or notes on contributions to other known works would have provided a clearer provenance of Darwin’s theoretical evidence.

The most extreme case from this period is that of Charles D. Douglas in the year 1836 (Figure 4.10), a geological surveyor and resident of Chiloé, an island archipelago off the coast of Chile. Darwin formed a relationship with him upon arrival on the Beagle in 1834. During and after Darwin’s visit, Douglas continued to send geological and entomological observations and specimens to Darwin. In the year 1838 Darwin published a short paper, “On the Connexion of Certain Volcanic Phaenomena in South America” which outlined his theory of simultaneous connection in the volcanic activity of the South American continent. His evidence consisted of a year of data describing reignited volcanic activity in Chiloé following an

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434 Ibid., 284.
earlier earthquake, presented in his ‘3rd Table of Volcanic Phenomenon’. Simultaneous eruptions of volcanoes throughout an area inferred to Darwin subterranean connection. The data and observations proving these claims and constructing the data table were collected by Douglas and sent to Darwin via correspondence, along with elevation measurements following earthquakes, and beetle specimens. In addition, Douglas enclosed a letter from an unknown individual with similar geological recordings to further assist Darwin.

Figure 4.10 – 1836 “hidden figures” network analysis visualizing received scientific content from Charles D. Douglas (yellow). The two scientific terminology tags associated with this year of analysis were ‘Information, data, scientific descriptions,’ and ‘Volcanoes and earthquakes’.

In this publication Darwin’s continual reference to Douglas’s findings on the matter reinforced the need Darwin had of Douglas’s work in the process of understanding this natural phenomenon:

“...Being anxious to trace the effects of the earthquake to the south, I wrote, shortly after visiting Concepcion, to Mr. Douglas, a very intelligent man, with whom I had become acquainted in the island of Chiloe; and the answer, which I have received since my return to England, is full of curious information.”

“The range of the Cordillera opposite Chiloe, a narrow island ninety miles in length, is not nearly so lofty as in Central Chile, and a few only of the culminant peaks, which are all active volcanos, exceed 7000 feet in height. Mr. Douglas has given me a detailed account of the effect produced on them by the shock.”

“Mr. Douglas, however, states, that when that volcano was visible a week afterwards, the snow was seen to have been melted around the N.W. crater. On Yantales, a lofty mountain south of the Corcovado, three black patches having the appearance of craters were observed above the snow-line; and Mr. Douglas did not recollect having seen them before the earthquake.”

“Mr. Douglas states, that on the night of November 11th (ten months after the overthrow of Concepcion), Osorno and Corcovado both burst out in violent action, throwing up stones to a great height, and making much noise. He subsequently heard, that on the same day, Talcahuano, the port of Concepcion, little less than 400 miles distant, was shaken by a severe earthquake...Mr. Douglas in conclusion adds, that on December the 5th his “attention was arrested by the grandest volcanic spectacle he had ever beheld; the S.S.E. side of Osorno had fallen in, thus uniting the two craters, which appeared like one great river of fire. Enormous quantities of ashes and smoke were erupted during the succeeding fortnight.”

Aside from gratitude, Douglas does not receive formal recognition for his findings and provision of essential support for Darwin’s theoretical conclusions. The tendency of Darwin to string together the findings of amateur individuals is exposed in the case of Charles D. Douglas,
as others are not even referenced by name. Without the observations, and willingness, of individuals like Douglas, Darwin would have little ability to collect the appropriate type and quantity of data.

The second London period of “hidden figure” network analysis contextualized contribution from the years 1837 to 1842. The year 1837 constituted a light year of “hidden figure” utilization with no external contribution of scientific terminology purely outgoing query to Beaufort and Stokes (Figure 4.11).

**Figure 4.11** – 1837 “hidden figures” network visualizing received scientific content and correspondents solely associated with outgoing correspondence from Darwin (grey), including Francis Beaufort and John Lort Stokes.

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My analysis demonstrated increased external contribution from Beaufort,\footnote{Darwin Correspondence Project, “Letter no. 421,” accessed on 22 March 2019, http://www.darwinproject.ac.uk/DCP-LETT-421.} Bartholomew James Sulivan, a naval officer enlisted in the service of Capt. FitzRoy onboard the 
\textit{Beagle} with Darwin,\footnote{Darwin Correspondence Project, “Letter no. 429, 13847,” accessed on 22 March 2019, http://www.darwinproject.ac.uk/DCP-LETT-429, http://www.darwinproject.ac.uk/DCP-LETT-13847.} and Francis Walker (Figure 4.12).\footnote{Darwin Correspondence Project, “Letter no. 421,” accessed on 22 March 2019, http://www.darwinproject.ac.uk/DCP-LETT-421.} Outgoing correspondence was sent to Charles Wood\footnote{Darwin Correspondence Project, “Letter no. 415A,” accessed on 22 March 2019, http://www.darwinproject.ac.uk/DCP-LETT-415A.} and an unidentified ‘Mr. Wynne’.\footnote{Darwin Correspondence Project, “Letter no. 399,” accessed on 22 March 2019, http://www.darwinproject.ac.uk/DCP-LETT-399.} Due to the limited size of smaller “hidden figure” networks, the node authority analysis conducted in Gephi could not indicate differences in proportional frequency of tag use as effectively than with the larger colleague network data sets. As a result, scientific terminology tags ‘Geology’ and ‘Geography’ were the only two whose frequency of use were considered statistically different aside from people in the network.\footnote{For further information and proposed solutions to the issue please see Chapter 5.}
Figure 4.12 – 1838 “hidden figures” network visualizing received scientific content from Bartholomew James Sulivan (purple), Francis Beaufort (yellow), and Francis Walker (blue). Content and correspondents solely associated with outgoing correspondence from Darwin are labelled in grey.

Geological discussion with a “hidden figure” is contained to correspondence with Bartholomew James Sulivan. The introduction was opened with FitzRoy’s reference to Darwin’s inadequate acknowledgement of Sulivan, and other naval officers, assisting Darwin through multiple avenues of his voyage and expeditions.453 Naval officers serving the Beagle ensured the security of in-land collection and transportation, and later storage, freight, and shipment of Darwin’s specimens.454 Their preference for Darwin is supported by the crew’s negation of similar duties in service of the enlisted naturalist, Robert McCormick.455 McCormick departed

the voyage early due, in part, to conflict stemming from this very issue.  

He was perturbed with the crew’s unyielding support of a private gentlemen naturalist over a Crown contracted naturalist intended to cover the very activities Darwin was busying himself with.  

Correspondence with Sulivan consisted of strictly incoming contribution and hinted at comraderie with Darwin, as he addressed him as *Philosopher*, or *Philos*, a nickname given by his shipmates. Immediate discussion context included the only use of the ‘Geology’ tag in the “hidden figure” scientific correspondence of the year 1838. In March of 1833, Darwin and Sulivan explored the fauna, flora, and geology of the Falkland Islands. Sulivan’s letters were sent upon his third survey of the area in command of the *H.M.S. Arrow* relaying observations of its formations, cliffs, streams, and elevation. As with Douglas, Sulivan included measurements of barometric pressure, temperature, weather, and local geological descriptions. Philip Stone and Adrian W. A. Rushton have investigated the link between Darwin and Sulivan. Sulivan stands apart from Darwin’s other “hidden figures” by the degree and specificity of his geological observations and sketches. After the *Beagle* voyage, unanswered geological questions spurred Darwin to re-explore the Falkland geology for solutions. Observations and hand-sketched diagrams from the two letters received in the year 1838 entered Darwin’s “On the Geology of the Falkland Islands” (1846). Aligning with my assertion of the inadequacy of Darwin’s academic

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457 Ibid., 202.  
458 Ibid., 195.  
463 Ibid., 156.  
464 Ibid., 170.
recognition of “hidden figures” in his work, Stone and Rushton agree and place further blame on Darwin inhibiting later appreciation of Sulivan.\(^{465}\)

Variation in recognition of Sulivan’s zoological and geological contributions existed due to the amount of contemporary recognition and later historical interest Darwin’s zoological activities received leading to the publication of Origin.\(^{466}\) Treatment of Sulivan in publication by Darwin improved slightly when compared to previously discussed “hidden figure” contributions receiving an opening address referencing his efforts but not recognition for his academic contribution:

“The Falkland Islands being a British colony, and the most southern point at which palæozoic fossils have hitherto been discovered, I am induced to lay a short account of the geological structure of these islands before the Society. They stretch from 51° to 52° 30’ south, and extend about 130 miles in longitude. My examination was confined to the eastern island; but I have received, through the kindness of Captain Sulivan\(^1\) and Mr. Kent,\(^2\) numerous specimens from the western island, together with copious notes, sufficient to show the almost perfect uniformity of the whole group.

Footnote: \(^1\) Bartholemew James Sulivan (1810-1890), 2nd Lieutenant on second voyage of the Beagle with Darwin.\(^{467}\)

An example of Darwin’s standard footnote reference of amateur observations in his work is exemplified with this quick biographical statement. Presence of a footnote recognizing amateur contributions indicates Darwin’s awareness and ability to provide proper citations of assistance, but does not chose to do so for Alison, Douglas, or San Lambert. Sulivan’s efforts went beyond simple observation. He understood Darwin’s need for evidence of clay superimposition on sandstone (including quartz) and took a boat out for a day in search of clay

\(^{466}\) Ibid., 158.
slabs over sandstone, as Darwin had previously observed, but was unable to re-locate.\textsuperscript{468} Darwin was attempting to show the Falkland Islands quartz was exposed to heat in a branch of his geological report:

\begin{quote}
“I nowhere actually saw the superposition of the clay-slate* on the quartz, but in several places on the sea-shore I traced the most gradual transitions between these two widely different formations.

Footnote: * Captain Sulivan seems to have found on the western island subordinate beds of a conglomerate or coarse grauwacke. On this island there appear also to be traces of tertiary and boulder formations, corresponding with those of Tierra del Fuego. Captain Sulivan observed on the western island numerous basaltic dikes.”
\end{quote}

Further, Sulivan contributed proof of elevation in the Sound of the Falkland Islands. Completion of a full geological report of the Falklands based on approximately one month of surveying observations and data would be improbable. Darwin spent almost ten years collecting observations, mainly centered on contribution from Sulivan in this publication:

\begin{quote}
“The many parallel ranges of quartz in the eastern part of the group extend east and west, but in the more westerly parts they run W.N.W. and E.S.E.: on the west side, however, of the great Sound between the two main islands, there is, according to Captain Sulivan, a fine range, 2000 feet in height, at right angles to the usual direction, and extending N.N.E. and S.S.W.”
\end{quote}

The care and effort displayed by Sulivan in his geological endeavors lends credence to the strength of their friendship established onboard the \textit{Beagle}. Sulivan’s interests in geology and zoology were largely inspired by Darwin, igniting a lifelong passion for Sulivan displayed in his steadfast manner of contribution.\textsuperscript{471} He is the first “hidden figure” in Darwin’s network to have


their field diagrams included in one of Darwin’s publications. Interestingly, Stone and Rushton point to difference in the accuracy and descriptiveness of Sulivan’s and Darwin’s diagraming skills, concluding Sulivan far surpassed Darwin resulting in replacement of his own diagram for Table 1:⁴⁷²

“Captain Sulivan, who was so kind as to observe carefully the cleavage of the rocks, has however given me a drawing and minute description of some clay-slate beds, exposed in a cliff on the southern coast, in which the cleavage in some of the beds strikes perpendicularly without having been in the least influenced by the minor flexures; whilst in others it is exactly at right angles to each flexure. The beds have been crushed into numerous successive folds, one of which is represented in the following woodcut.

1.

A. D. F. Beds of clay-slate, with cleavage-laminæ perpendicular to the horizon. E and part of C.
Similar beds, with the cleavage at right angles to every flexure. B and parts of C.
Beds of imperfect, non-laminated clay-slate, with intercalated seams of sandstone represented by the dotted parts.
F. Nucleus or core of clay-slate formed by the lateral crushing of the strata, about two feet high and one foot broad. These nuclei occur in almost all the folds.

Captain Sulivan states, that in some of the strata the cleavage "in every part, however much twisted, was perpendicular to the horizon;" in others "it was perpendicular to every curve." I have never myself seen an instance of this structure, and I believe it is a new and interesting case."473

Darwin’s commitment to academic quality and accuracy in publication resulted from acceptance of as many incoming observations as correspondents were willing to give. Without contribution from individuals like Sulivan, Alison, Douglas, and San Lambert, Darwin would have had a fraction of the theoretical evidence and descriptions to complete as many academic publications as he did. Correspondence relationships facilitated by the Beagle had the most impact on his work. Moving into the period of 1839 to 1842, incoming contribution decreased. Darwin transitioned into a phase dominated by his external query of individuals of varying social class in animal industries.474 Decreased variation of colour with in the network illustrates the decreasing incoming contribution and increasing correspondence from Darwin over time. A vast majority of Darwin’s mailed questionnaires were too cumbersome and timely for most receivers to comply with, resulting in a low return rate seen in the network analysis.475 In the year 1840, the impacts of illness again slowed rates of correspondence with “hidden figures” in general.

475 Ibid., 282.
Figure 4.13 – 1839 “hidden figures” network analysis visualizing outgoing content from Darwin (grey) to William Henry Smith, John Washington, and William Shoberl. Key scientific terminology tags included ‘Geology’, ‘Geography’, and ‘Positive attitude/assessment’. Darwin corresponded with five “hidden figures” in the year 1839, William Henry Smith, Richard Sutton Ford, John Washington, George Tollet, and William Shoberl (Figure 4.13). Darwin’s continual probing for geological observations continued through contact with these individuals without a response within the year resulting in high frequencies of ‘Geology’, ‘Geography’, and ‘Positive attitude/assessment’ scientific terminology tags.

Geological discussion was focused on Smithy’s Islands and provinces of La Rioja in Spain with Smith and Washington, respectively. Due to limited incoming correspondence, received scientific terminology tags were not represented in high frequency within the analysis but the context of the correspondence remains significant. Richard Sutton Ford and George Tollet were the only contributing “hidden figures” of scientific content in the year 1839 through their responses to extensive questionnaires. Both individuals responded with vast amounts of livestock breeding information, indicating their breeding specialization. Darwin’s interest, in this respect, lay in the persistence of old varieties and the emergence of new varieties within a species, and indication of which varieties were dominant within a population. Darwin was working out the difference between artificial and natural selection, along with identifying dominant, co-dominant, and recessive characteristics.

The contributions of Ford and Tollet gave Darwin the observations and evidence to mechanistically understand artificial selection in domestic species. Ford’s responses described sheep and cattle crossing between older established lineages and newer ‘mixed’ lineages, stating older lineages are dominant in progeny characteristics throughout the full process of breeding, birth, maturation, and reproduction of male and female individuals. Smith provided similar but more diverse first-hand accounts discussing pigs, fowl, variation between wild and domestic dogs, foxes, and cattle. Darwin recorded these observations in his Questions and Experiments

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notebook started early in the year 1839. From these observations he designed experimental trials, conducted later at Down House, to isolate and understand the impact of different characteristics. Further, these experiments provided evidence for certain aspects of artificial selection in *Origin.*

Incoming contribution dwindled into the year 1840 as only Bartholomew James Sulivan sent Darwin scientific correspondence, while Darwin sent correspondence to Gilbert Nicholas Smith, William Walton, and Basil Hall (Figure 4.14). The top tagged scientific terminology, ‘Guanaco’ and ‘Fauna’, occurred in an outgoing context while the ‘Geography’ tag occurred at the highest frequency within incoming correspondence. Darwin’s three letters sent to William Walton were dominated entirely by information on the climate, diet, and characteristics of the Guanaco, and variance in wild versus domestic varieties. A formulaic and original contribution comes from Sulivan in geographical and geological discussion with Darwin. He presents a formula for calculating the elevation of distant objects including compensation for the relative ‘dip’ or curvature of the Earth calculated by mile. This equation was intended to assist estimations of the size of geological formations from great distances.

Figure 4.14 – 1840 “hidden figure” network analysis visualizing received scientific content from Bartholomew James Sullivan (purple). Content and correspondents solely associated with outgoing correspondence from Darwin are labelled in grey. Key scientific terminology tags included ‘Guanaco’ and ‘Fauna’ and ‘Geography’, ‘Geography’ is the only terminology tag associated with incoming contributions.

Falling even farther in numerical contribution and complexity, Darwin’s 1841 “hidden figure” network was limited to one individual contributor bearing two scientific terminology tags (‘Seeds’ and ‘Specimens/samples’), in the same context as Ford and Tollet in the year 1839, through questionnaire response. The contact was the Darwin’s family gardener, Abberley. He returned simple information on crossing beans, thyme, and cucumber plants in relation to understanding pollens role in fertilization. An annotation included with the letter indicated Darwin’s request of such crossings to be conducted showing a new platform of intentional, and

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unrecognized, experimental contribution by a “hidden figure”. The network was not included on the basis of its simplicity.

Figure 4.15 – 1842 “hidden figure” network analysis visualizing received scientific content from Thomas Blunt (pink) and John Provis (teal). Content and correspondents solely associated with outgoing correspondence from Darwin are labelled in grey. Key scientific terminology tags included ‘Chemistry, Chemicals’, ‘Reception of Darwinism’, ‘Coral reefs’, and ‘Specimens/samples’ derived from Darwin outgoing correspondence.

Reaching the end of the period under analysis, the year 1842 illustrates a striking visual juxtaposition of Darwin’s outgoing scientific discussions as entirely separate from his incoming discussions, seen in the lack of relationships between scientific tags associated with either group (Figure 4.15). The disconnect in content between Darwin’s outgoing and incoming correspondences in the year 1842 is unique, not detected in any previous networks. Darwin’s outgoing queries presented the most frequently used tags ‘Chemistry, Chemicals’, ‘Reception of Darwinism’, ‘Coral reefs’, and ‘Specimens/samples’. The presence of the ‘Reception of
Darwinism’ tag this early in his career is thought provoking, sent to Anne Susan Horner, Julian Jackson, and Charles Maclaren. These individuals are used by Darwin as social indicators (as with members of his family discussed in Section 4.2.3) of the reception of his work at this stage, interesting because Darwin’s first sketch was not finalized until mid-summer 1842.

Upon further investigation of Darwin’s correspondence use of the term Darwinism, by Darwin and his contemporaries, seemed to apply to reception of any of Darwin’s publications under a clear blanket conceptualization of Darwinism. In correspondence to Jackson, Darwin was prodding for a review of the reception of his coral reef volume proposing involvement of subsidence sea floor action in their formation. This piece had a greater geological focus than his later naturalist work, where he presented the theological base that would form his Darwinian following. “The Structure and Distribution of Coral Reefs” (1842) included limited reference to species modification under environmental conditions or natural selection. In correspondence with Maclaren and Horner, the tag is used in the exact same context resulting in the high frequency of the ‘Coral reefs’ tag. Correspondence sent to Charles Stokes addressed ‘Corals’ and ‘Coral reefs’ but within in context of further investigating individual specimens. Unrelated to coral, Darwin requested two bottles of an unknown chemical from William W. Baxter for use in specimen preservation, slide preparation, or experimentation.

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Incoming scientific terminology tags did not occur at the same frequency as outgoing tags but remain indicative of relevant “hidden figure” contribution. John Provis\textsuperscript{498} and Thomas Blunt\textsuperscript{499} form the two branches of scientific contribution in the year 1842, and comprise three quarters of Darwin’s incoming scientific correspondence this year, including colleagues and family members. This speaks to, and truly represents, the extremity of Darwin’s reclusion by this point in his career and stage of illness. Darwin received more contribution from his “hidden figure” network than any other category of correspondent during this period, arguably due to the awareness of his colleagues of his reclusion, a result of gradual deterioration in correspondence relationships with his closer colleagues as of the year 1840. In comparison, Darwin’s “hidden figure” network was formed through many unrelated weak ties resulting in their existence in the outer periphery of his overall scientific correspondence network from the years 1835 to 1842.

\textbf{4.2.3 Separated Familial Network Analysis}

Familial correspondence for Darwin played a different role in his career and personal life than colleague or “hidden figure” correspondence. His sisters, from oldest to youngest, Caroline, Susan, and Catherine, relayed general news and popular gossip from his home in Shrewsbury, but their contribution went beyond this. While Darwin was on the \textit{Beagle} voyage, their correspondence gave him much stability and encouragement, supporting Darwin’s naturalist pursuit.\textsuperscript{500} Darwin’s earlier familial networks show a great diversity in contribution, likely a result of Darwin’s absence on the \textit{Beagle} until late in the year 1836. William Darwin Fox, Darwin’s cousin and close friend, engages in a different correspondence dynamic more closely


\textsuperscript{500} Browne, \textit{Charles Darwin: Voyaging (Volume I of a Biography)}, 124.
resembling a colleague defined by limited personal content, with a clear focus on scientific content.

The two of lowest representation in the analysis were Darwin’s cousin, Heinsleigh Wedgwood, and wife, Emma Wedgwood. Heinsleigh’s correspondence provided Darwin with a social indicator for the most controversial elements of his theory, seeming not to hold back or cryptically present his perspective.\(^{501}\) Heinsleigh’s response was often disbelief or rejection but it is clear Darwin felt safe in their correspondence or he would not have used him in such a way in the early stages of his career. Heinsleigh functioned as a social indicator for Darwin giving Darwin insight into the type of response he may receive from the general public. Emma’s plight to increase Darwin’s religious awareness through correspondence was confrontational, as she was concerned for his immortal soul as he shared the details of his work.\(^{502}\) Emma provides a contrasting female role to that of Darwin’s sisters in his familial correspondence network. In the few instances where Emma showed interest in geology or natural history, Darwin convinced her to avoid the subject as it was of no interest or use to her. In contrast, Darwin actively engaged in scientific discussion of complex natural and geological theories and observations with his sisters. Their educated knowledge base shows familiarity with a variety of works by Darwin’s colleagues, such as Lyell and Owen.\(^{503}\) The scientific terminology tags derived from their correspondence show little difference in scientific specificity or variety, also comparable to contribution from Darwin’s colleagues.

Contribution from family members decreased in quantity and diversity towards the end of the eight-year period. The years 1835 and 1837 were two of the largest familial networks over the entire period. Susan\(^{504}\) provided the greatest amount of scientific correspondence of the year, and Catherine\(^{505}\) and Fox\(^{506}\) provided the least (Figure 4.16). Caroline existed in an outgoing context, purely receiving correspondence from Darwin.\(^{507}\)

**Figure 4.16** – 1835 familial contribution network analysis visualizing received scientific content from Catherine (green) and Susan (blue). Content and family members solely associated with outgoing correspondence from Darwin are labelled in grey. Key scientific terminology tags included ‘Scientific fieldwork/fieldtrips’, ‘Geology’, ‘Volcanoes and earthquakes’, ‘Geography’, and ‘Specimens/samples’. The ‘Specimens/samples’ terminology tag was the only key tag associated with incoming familial contribution.

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The tags with the highest frequency in the scientific correspondence of the year 1835 were ‘Scientific fieldwork/fieldtrips’, ‘Geology’, ‘Volcanoes and earthquakes’, ‘Geography’, and ‘Specimens/samples’, with only one top tag supported by incoming content. The majority of correspondence this year was from Darwin to his family, as the Beagle voyage inhibited regularity in correspondence. Following the same geological trend as Darwin’s colleague network analysis of the year 1835, geological terminology tags dominated the analysis. Darwin conveyed observations on the earthquake in Concepción in Chile, geological landscape descriptions of his inland excursion from Coquimbo to Copiapò, shared plans for travel over the Andes Cordillera, and his perceptions on the morality of missionary work happening in Tahiti.508 He commented on the high degree of safety and civility of newly converted tribal communities, concluding Tahiti was exemplary in their missionary work. Darwin gives Caroline interesting insight into the maintenance of certain traditional tribal cultural elements incorporated into a Christian religious routine. He presented his thoughts in a joint publication with FitzRoy, “A letter, containing remarks on the moral state of Tahiti, New Zealand, &c.:” (1836). Caroline is noted as the first individual to receive insight on Darwin’s observations but this is not supported by the familial network analysis of the year 1835.509 A letter containing almost identical observations written to Caroline was sent three days earlier to Fox.510 Browne holds Caroline as an important force in Darwin’s process of scientific writing and development of his observations, arguments, and thoughts on varying geological matters encountered on the Beagle.511

511 Browne, Charles Darwin: Voyaging (Volume I of a Biography), 249.
The scientific terminology tags associated with Fox are incredibly similar to those associated with Caroline, suggesting her role more as an active contributor like Fox, than as a casual sounding boards, like Susan and Catherine. Fox received one scientific letter in the year 1835 which provided the same geological observations of the Concepción earthquake, along with plans for travel through the Andes. Darwin’s account of his trip sent to Catherine were much shorter and lighter in geological content than those to Caroline, and Darwin likely intended them as a general interest overview of events rather than engaged discussion of his observations. Catherine’s lack of engagement in geological topics in her response shows her disinterest in further discussion. Her contribution provided reassurance of safe specimen arrival in Plymouth resulting in elevated frequency of the ‘Specimens/samples’ tag. Susan was also involved in reassurance through correspondence of the shipment of specimens from the Beagle to London. Additionally, she kept a finger on the pulse of London scientific activity informing Darwin of the formation of new societies and specimen collections. The condition of specimens at the new Society of Natural History in London received harsh critique by Catherine, showing familiarity with preservation standards and techniques. Acknowledgement by Catherine of the natural history community in London as of interest to Darwin provided evidence for an intentional early focus in natural history. Catherine characterized herself as a social butterfly, and passed greetings and conveyed a summary of missed social engagements or visits by family friends.

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Responsible for the largest proportion of familial scientific correspondence with Darwin, Susan received descriptive geological accounts of his traversing and re-traversing of the Andes Mountain range and his discovery of fossilized shells at high elevations inclusive of explanation of its role in theoretical speculation of a relatively recent geological timeline for the formation of the Andes. The depth of content and quantity of information relayed to Susan in correspondence rivaled that of Caroline in outgoing letters from Darwin. She also functioned as a key avenue for Darwin to relate important financial information to his father, represented as a relationship comprised of maturity and trust. She names herself his ‘nanny’ in correspondence indicating her care of him as a child, as his older female sibling. The Darwin children lost their mother, Susannah, in 1817 when Darwin was only eight years old. His older sisters, Susan and Caroline, provided the majority of care for Darwin. Susan casts herself in a motherly image with Darwin, displaying actions like the correction of his spelling in his journal accounts read for the entire family.
Figure 4.17 – 1836 familial contribution network analysis visualizing received scientific content from Catherine (green) and Heinsleigh (blue). Content and family members solely associated with outgoing correspondence from Darwin are labelled in grey. Key scientific terminology tags included ‘Scientific fieldwork/fieldtrip’, ‘Specimens/samples’, ‘Geology’, ‘Fauna’, and ‘Assessments’. The ‘Scientific fieldwork/fieldtrip’ terminology tag was the only key tag associated with incoming familial contribution.

In the year 1836, Darwin’s correspondence pattern experienced a slight decrease in diversity (Figure 4.17), rekindled in the year 1837, representing fluctuation in the overall trend of decreasing diversity and quantity towards the year 1842. ‘Specimens/samples’, ‘Geology’, ‘Fauna’, and ‘Assessments’ tags attained the highest frequency of use and were exclusive to outgoing content from Darwin, aside from ‘Scientific fieldwork/fieldtrip’ associated with incoming content from Catherine. Correspondence was only returned by Catherine\textsuperscript{517} and his cousin Heinsleigh\textsuperscript{518} largely due to discrepancies related to naval travel, previously discussed in


relation to delayed correspondence in Darwin’s colleague network analysis of the years 1835 and 1836. The largest exchange of scientific content occurred with Catherine\textsuperscript{519} and Caroline,\textsuperscript{520} followed by Susan,\textsuperscript{521} Fox,\textsuperscript{522} and Heinsleigh.\textsuperscript{523}

Conversation with Catherine focused on additional details of his fieldwork and voyage resulting in the use of the ‘Scientific fieldwork/fieldtrip’ terminology tag. She updated him with familial developments, and redirected praise received by the family from his colleagues Owen and Henslow.\textsuperscript{524} Owen and Henslow directly praised Darwin, validating his choice of career and exceptional prospects in the field of natural history stimulating great pride for his father, Robert Waring Darwin.\textsuperscript{525} Securing praise by esteemed scientific professionals established recognition for Darwin’s skill as a naturalist, an important step in the process of his father’s acceptance of a career outside of medicine.\textsuperscript{526}

Darwin reached Australia in February, which spurred conversation on climate. He visited Sydney and King George Sound, and also other English crown colonies in the Falkland Islands and Saint Helena.\textsuperscript{527} Discussion remained summative with Catherine, but outgoing content to

\textsuperscript{525} Browne, Charles Darwin: Voyaging (Volume I of a Biography), 335.
\textsuperscript{526} Ibid., 335.
Caroline remained scientifically detailed beyond his other sisters. Further, the proportion of letter content associated with scientific discussion is more than doubled in correspondence with Caroline. He discussed progress on his theory of coral reef formation and observations on Keeling Island, along with reasoning for his rejection of the current ‘submarine crater’ hypothesis of formation, a point that would not have made conversation with Susan or Catherine. Darwin expanded on his notetaking and documentation process on board the *Beagle*, addressing the challenges of putting his ideas into writing and wish for utility in his research. He later discussed misinterpreted evidence in Saint Helena through his misclassification of shells found at high elevations as sea shells, rather than terrestrial species, after realization. Once arriving back safely in London, Darwin’s correspondence with Caroline takes on a private nature discussing the willingness of geologists and resistance of zoologists in receiving his *Beagle* specimens and research. Discussion of sensitive material, or gossip, reflects safety and comfort in their conversations.

Classification and new findings on fossils collected throughout the journey emerged from Owen’s examination, and Darwin relayed this to Caroline. He described the enormous *Toxodon* skull as a large ‘gnawing creature’, akin to rats, jokingly inferring their predation by cats of equal or greater size. Unknowingly, Darwin was piecing together realization of fossilized specimens belonging to giant extinct lineages of megafauna similar in body plan and form as

extant species in the same locations. Darwin would later base his concept of common ancestry and development of the first genealogical tree from a single origin on this evidence. My analysis supports Browne’s interpretation of Caroline as playing a critical role in the development of Darwin’s observations and arguments.

In contrast to the year 1835, the year 1836 established Caroline as the preliminary receiver and sounding board for Darwin’s observations, even before Fox. Darwin did not include the content he presented to Caroline in his correspondence with Fox this year, but rather focused on the dynamics of London scientific societies Darwin was keeping a tab on during his departure. His second scientific letter to Fox, written upon conclusion of the voyage, provided excellent contrast to his personal tone with Caroline in relation to specimen examination. Darwin did not delve deeply into his personal opinion on the matter, as he had with Caroline, but rather stated in a matter of fact tone the commencement of specimen investigation in London. Preference of Caroline for scientific discussion continued into the year 1837.

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533 Ibid., 231/293.
The diversity of incoming contribution increased in the year 1837, as Darwin received scientific content from Emily Catherine Darwin (previously referenced as Catherine Darwin in tags), Caroline, Susan, and Elizabeth Wedgwood (Sarah Elizabeth Wedgwood), Darwin’s sister-in-law through his marriage to her sister Emma Wedgewood in January 1839 (Figure 4.18).\textsuperscript{537} The highest frequency terminology tags ‘Information, data, scientific descriptions’ and ‘Specimens/samples’ emerged from correspondence with Catherine,\textsuperscript{538} and ‘Queries/requests’

\textsuperscript{537}Browne, \textit{Charles Darwin: Voyaging (Volume I of a Biography)}, 277.

and ‘Geology’ were contributed by Caroline.539 The remaining top terminology tag, ‘Fauna’, was solely associated with outgoing scientific content from Darwin.

A figure of limited representation in Darwin’s familial network analysis is Elizabeth Wedgwood, indirectly related to Darwin through his marriage. She contributed by imparting information from her father Josiah Wedgwood II (Uncle Jos to Darwin), discussing his chalk formation hypotheses, and by relaying thankful reception of Darwin’s mold formation hypothesis.540 She conveyed detailed observations collected by Josiah II on the soil structure and composition of bog meadows and old ‘croft’, or farmland.541 Regardless of the source of contribution, placement of Darwin on a priority platform by both the Darwin and Wedgwood families is evident.

Catherine, tagged as Emily Darwin in the year 1837,542 contributed scientific content describing the academic reception of Darwin’s specimens, their discussion in newspapers, and their reception by the Zoological Society of London.543 She relayed information from Gould that affirmed 11 new species in the Galápagos Island bird specimens, and continued her role as a social maven updating Darwin on scientific happenings he may have missed due to over focusing on his work. An illuminating comment by Catherine points to her contribution and further

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542 Due to variance in transcription format of the names of Darwin’s correspondents by the Darwin Correspondence Project team.

defines Caroline’s role as an active contributor, or research assistant, in Darwin’s work rather than a sounding board:

“Caroline desires me to tell you that neither Procter, Miers, nor Caldcleugh are in the Library, only Head, which C. [Caroline] will read, and examine about what you mention, — and then write to you.”

Darwin’s reliance on Caroline to conduct research in his stead speaks to the recognition and respect he had for her as a scholar and academic resource. Requests of this nature did not pass to Catherine or Susan, but solely to Caroline. Darwin’s interest at this time lay in geological accounts of South America, working towards his presentation at the Geological Society of London in January on his theory of sea floor uplift along the Chilean coast line. Caroline read and took notes on Francis Bond Head’s *Rough Notes Taken during some Rapid Journeys across the Pampas and among the Andes* (1826) and relayed relevant information for Darwin’s theory. Her comfort with the content and relevance of complex geological manuscripts implies a strong educational background, and speaks to her passion for science. Surpassing research, she was inquisitive about the work of Darwin’s colleagues, requesting clarification on points of congruence between he and Lyell’s geological perspective on the age of the Earth. Further, she made continual efforts to be well-read:

546 Alexander Caldcleugh, *Travels in South America, During the Years 1819-20-21 - Containing an Account of the Present State of Brazil, Buenos Ayres and Chile*, London: John Murray, 1825.
547 Francis Bond Head, *Rough Notes Taken during some Rapid Journeys across the Pampas and among the Andes*, London: John Murray, 1826.
549 Desmond and Moore, *Darwin: The Life of a Tormented Evolutionist*, 207.
“Can you (if a few words will do) tell me on what points it is that Lyell
“fully agrees with your views” ‘on subjects you say you talked over together in
London’. The Coral islands I know was one subject—but if I can understand & if
you can without much trouble give me an idea of the other subjects I should be vy
[very] glad.— I thought that Lyell & all the modern Geologists disbelieved, or
thought we did not understand rightly, the chronology of the Old Testament—so I
do not see how what Sir J Herschell says is new.— I should have liked extremely
to have seen the letter.— Do you know whether yours & Capt FitzRoy’s paper on
The Missionaries has ever been sent to England, & what is it called in order to get
it?”551

Geological inquiry by Caroline resulted in increased frequency of the ‘Queries/requests’
and ‘Geology’ tag in scientific correspondence. In certain instances, communication between
Caroline and Darwin can be characterized as debate, as she rebutted the critical quality of
theoretical conclusions, seen in her treatment of Sir John Herschel. The same tone is detected in
Darwin’s response:

“You tell me you do not see what is new in Sir J. Herschell’s idea about the
chronology of the old Testament being wrong.— I have used the word Chronology
in dubious manner, it is not to the days of Creation which he refers, but to the lapse
of years since the first man made his wonderful appearance on this world— As far
as I know everyone has yet thought that the six thousand odd years has been the
right period but Sir J. thinks that a far greater number must have passed since the
Chinese, the [blank], the Caucasian languages separated from one stock.”552

Darwin explains why Herschel’s postulations are ‘new’ compared to current geological
perceptions. He clarifies misinterpretation of his argument in reference to chronology within the
Book of Genesis by Caroline, correcting her by pointing out Herschel’s focus on the inaccuracy
of the 6,000 year timeline of formation as a whole. Similar to Darwin’s use of his
correspondence with Elizabeth Wedgwood, Caroline functioned as a direct line of inquiry with

551 Darwin Correspondence Project, “Letter no. 345,” accessed on 22 March 2019,
http://www.darwinproject.ac.uk/DCP-LETT-345.
552 Darwin Correspondence Project, “Letter no. 346,” accessed on 22 March 2019,
his father Robert.\textsuperscript{553} The context of their conversation was in relation to observations of healthy vessels of people seemingly transferring diseases at varying ports. Darwin noticed characteristics of bacterial resistance and asymptomatic disease carriers without awareness, a concept of disease contagion theory not understood until the early twentieth century.

Detection of a misogynistic tone in the following request of Caroline’s assistance in research reflects the perceived inferiority of women in society and science, perpetuated by Darwin in treatment of Caroline:

“Now will you be a good lady & look at Ellis’ Polynesian Researches, & see if he does not at Tahiti make some remarks about the belief that Capt. Cook’s visits produced some kinds of illness…”\textsuperscript{554}

Her lack of recognition stemmed from this long-standing and negative image of women. This image defined it as appropriate of Darwin not to acknowledge Caroline in his work as a contributing researcher. Darwin’s request of Caroline contributed to the frequency of use of the ‘Queries/requests’ terminology tag. This passage points to an interesting contradiction in Darwin’s character. If Darwin truly thought his sister’s contribution inadequate he would simply remove her assistance from the process. He shows a conscious intention to undermine his sister’s scientific authority while remaining receptive to the academic validity of contributions through his use of her research. Without Darwin’s correspondence recognition of Caroline’s role in Darwin’s work her contributions would disappear entirely, as she receives no recognition in his publications. She received less recognition than Darwin’s “hidden figures” who were awarded brief informal points of recognition throughout Darwin’s publications, previously discussed in Section 4.2.2.


Comparatively speaking, academic debate did not emerge in correspondence with Fox. The conversation with Fox reflected a motivational type of relationship, referencing Fox’s earlier comment to get his next *Beagle* publication ready.\(^555\) Darwin responded by outlining his organization plan for his following geological and zoological publications, becoming his later *Voyage of the Beagle* (1839) (previously a volume of Capt. FitzRoy’s *Journal of Researches*). Their relationship seemed one of comraderie and motivation, rather than scientific debate and research as with Caroline, aside from Darwin’s singular request to view a fossilized piece of lower jaw collected by Fox.\(^556\)

\(^{555}\) Darwin Correspondence Project, “Letter no. 348,” accessed on 22 March 2019, \url{http://www.darwinproject.ac.uk/DCP-LETT-348}.

\(^{556}\) Darwin Correspondence Project, “Letter no. 393,” accessed on 22 March 2019, \url{http://www.darwinproject.ac.uk/DCP-LETT-393}.  

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Figure 4.19 – 1838 familial contribution network analysis visualizing received scientific content from Fox (orange) and Emma (pink). Content and family members solely associated with outgoing correspondence from Darwin are labelled in grey. Key scientific terminology tags included ‘Geology’, ‘Fauna’, ‘Glen Roy’, and “Species, speciation’. The ‘Fauna’ and ‘Species, speciation’ terminology tag were both associated with incoming scientific content.

By far, the most prominent tagged scientific terminology of Darwin’s correspondence of the year 1838 was ‘Geology’, followed by incoming use of the tag ‘Fauna’ and ‘Species, speciation’ from Fox (Figure 4.19). A large decrease in diversity and size is evident in the analysis of the year 1838, with incoming contribution reduced to two individuals, Fox\textsuperscript{557} and

Emma Wedgwood.\textsuperscript{558} Outgoing scientific content was sent to Caroline (now Wedgwood after her marriage to Josiah III Wedgwood)\textsuperscript{559} and Susan.\textsuperscript{560}

Feeding from their motivational friendship, Darwin sent Fox plans of his geological trip to Glen Roy to contribute his opinion to the growing pool of theories of formation of the parallel roads.\textsuperscript{561} Fox referenced Darwin’s passion for animal breeding with Darwin responding by throwing first light on a possible publication addressing species and varieties that would later become his \textit{Origin} (1859).\textsuperscript{562} Fox further propelled the discussion and responded with detailed observations on the production of different varieties within dog and geese breeding, resulting in increased frequency of the ‘Fauna’ and ‘Species, speciation’ tags.\textsuperscript{563} Here, we see Fox move beyond his personal, supportive role and take on one of active evidence collection and contribution to Darwin’s transmutation work.

In the year 1838, Caroline continued to function as Darwin’s primary outlet for familial scientific discussion, continuing to surpass Fox each year. Additional credit is lent to Caroline through her motivation to assist in comparison to Fox. Darwin requested Caroline’s assistance directly resulting in conduction of various researches in his stead. In the case of Fox, and the majority of contributing correspondents, the provision of scientific observations was an easy

task. Caroline’s contributions were guided by Darwin’s requests, requiring allocation of her own time to undertake.

Reducing the network size by over half, the year 1839 continues a steep decline in diversity and contribution (Figure 4.20). The overarching context for reduced scientific correspondence towards the end of the period aligns with development of periods of chronic illness for Darwin, detected in each category of network analysis starting in the year 1839.

![Figure 4.20](image)

**Figure 4.20** – 1839 familial contribution network analysis visualizing received scientific content from Emma (pink). Content and family members solely associated with outgoing correspondence from Darwin are labelled in grey.

The only incoming contributions were from Emma (tagged as Darwin and Wedgwood), now Darwin’s wife after their marriage on January 29th, 1839. The context of

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scientific terminology tags in Emma’s correspondence were in reference to Darwin’s theoretical transmutation work and its incompatibility with her strong religious beliefs.567 After their marriage, her concern for his immortal soul and place in the afterlife grew.568 Addressing these, she composed a letter sent to Darwin in February.569 Emma had become most familiar with his work, Darwin was very open with her about his private evolution work and they shared a close relationship.570 Emma continually presented a religious counter position to transmutation by natural regulatory mechanisms, in hopes of reigniting his religious commitment or at least a bit of faith.571 Due to the limited size of the network, determining prominence in terminology tags was not possible. Similarly, the familial contribution network analysis of the year 1840 consisted of one incoming correspondence authored by both Susan and Catherine, resulting in use of a single ‘Queries/requests’ terminology tag in their returned reference for a requested work, William Smellie’s The Philosophy of Natural History (1790).572 The letter’s significance lies solely in highlighting Susan and Catherine’s use, providing a similar but simpler example of research assistance than Caroline. For these reasons, the network analysis was not included.

567 Browne, Charles Darwin: Voyaging (Volume I of a Biography), 270.
568 Ibid., 270.
570 Herbert, Charles Darwin and the Question of Evolution: A Brief History with Documents, 20.
571 Ibid., 23.
Figure 4.21 – 1841 familial contribution network analysis received scientific content from Catherine (green). Content and family members solely associated with outgoing correspondence from Darwin are labelled in grey. Key scientific terminology tag included was ‘Fauna’, associated with outgoing scientific content from Darwin.

Observing a slight increase in size, the year 1841 comprised familial contribution of scientific content from Catherine and sent to Fox (Figure 4.21). The only tag of prominence in this years network analysis was the ‘Fauna’ terminology tag in an outgoing context from Darwin to Fox. When he requested assistance from Fox, Darwin was apologetic in his correspondence compared to Caroline, and asked Fox to provide observations only if he is not busy and able to attain them without trouble:

“… The smallest contributions, thankfully accepted—descriptions of offspring of all crosses between all domestic birds & animals dogs, cats &c &c very

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—Dont forget, if your half-bred African Cat should die, that I should be very much obliged, for its carcase sent up in little hamper for skeleton.—it or any cross-bred pidgeon, fowl, duck, &c &c will be more acceptable than the finest haunch of Venison or the finest turtle.—Perhaps all this will only bothers you—So I will add no more…”

When compared with Darwin’s previous requests of Caroline, Darwin’s request highlights a condescending sense of inherent requirement and expectation of assistance not present in his communication with men. His cheeky and disrespectful tone, “Now will you be a good lady & look at Ellis’ Polynesian Researches…” illuminated a stark difference in gender-based treatment in his requests for assistance. Increasing the breadth of treatment further, the Darwin sisters were routinely expected to provide Darwin with observations and research without even a simple kind request. Towards the end of the year 1840, Darwin’s sisters continued to contribute at the same rate but instances of Darwin’s formal request for their assistance disappeared. Darwin’s propensity for apologetic requests for observations from his male colleagues, friends, and family members did not implying inherent expectation, as with his sisters. Catherine’s contribution of observations on variation in pistol formation of *Hex. Trigynia* fit this mold. *Hexandria* is the class of plant including six stamens, and *Trigynia* is the order of plant Catherine was recording in her notes to Darwin. This class and order included species like the Common Meadow Saffron (*colchicum autumnale*), Common Sorrel (*rumex acetosa*), and Water Dock (*rumex hydrolapathum*).

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Darwin’s descent into solitude is reflected in the familial network analysis of the year 1842 as scientific discussion occurred only in an outgoing context, from Darwin to Susan\(^{580}\) and Fox\(^{581}\) (Figure 4.22).

**Figure 4.22** – 1842 familial contribution network analysis visualizing outgoing scientific content from Darwin to members of his family. Content and family members solely associated with outgoing correspondence from Darwin are labelled in grey.

Settling in Down House completed a transition in Darwin’s approach to natural history, from fieldwork-based to experimental-based. His scientific correspondence revolved around discussion of publication details, relaying to Susan his frustration with illness inhibiting his

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progress on “The Structure and Distribution of Coral Reefs” in February.\textsuperscript{582} To Fox he confirmed completion of the publication in May 1842 and his commencement of \textit{Geological Observation on the Volcanic Islands} he would complete in the year 1844.\textsuperscript{583}

\textbf{4.2.4 Combined Network Analysis}

Darwin entered the period between 1835 and 1842 as an independent amateur geologist and inexperienced naturalist, and exited as a networking man of high science. He learned to make use of private correspondence for collecting natural observations and evidence, while being publicly in direct contact with experts and specialists due to his \textit{Beagle} specimens, accessible through his London contacts. Rudwick, Desmond, and Moore, argue that Darwin developed distinctly public and private spheres in his London social life. Desmond and Moore, support this with clear evidence of departure by Darwin from his superior, Richard Owen’s, perspective of limited life forces and lifespan’s relative to organism complexity in the year 1837, hashing out the core components of his natural selection theory until the year 1842.\textsuperscript{584}


\textsuperscript{584} Desmond and Moore, \textit{Darwin: The Life of a Tormented Evolutionist}, 231.
Figure 4.23 - Eight-year combined network analysis visualizing contributions from colleagues, “hidden figures”, and family members together from 1835 to 1842.

The eight-year analysis depicts a cyclical expansion and reduction in Darwin’s correspondence network as he formulated his natural selection theory (Figure 4.23). The years 1835, 1836, and 1837 are years of growth, while the year 1838 is a year of reduction due to work on his Zoology of the Voyage of the H.M.S. Beagle (1838). Janet Browne notes this as a year of intense work and stress, when Darwin grasped full understanding of the social and religious implications of his theory.\(^{585}\) Browne extends the period of 1837 to 1839 as one of intensive reading, research, and correspondence for Darwin.\(^{586}\) Her conclusion conflicts slightly with my project analysis as years 1837 and 1839 show growth, but the year 1838 shows a reduction in comparative size. The network size for the year 1839 is still larger in comparison to the years 1835 and 1836.

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Darwin’s realization of his theory’s potential for controversy led to large bouts of stress related illness, which began in the year 1837 and intensified by the 1840s. In relation, the year 1840 displayed a reduction in size. Adrian Desmond and James Moore signify the year 1840 as the start of theoretical stagnation on part of Darwin’s illness, receiving treatment requiring quiet isolation limiting his work to under two hours a day.\textsuperscript{587} Interestingly, we see growth in the years 1841 and 1842. The year 1841 saw growth outside of the months of June and July, as he was completely dedicated to conducting private plant experiments and is recorded as disengaging in correspondence.\textsuperscript{588} The year 1842 saw a slight expansion in network size due to consultation on components of his publication, “The Structure and Distribution of Coral Reefs” (1842). Darwin ended the theoretically intensive period eight-year creating his first 35-page sketch of his evolution theory by means of natural selection in June of 1842 before moving to Down House in Kent.\textsuperscript{589}

I argue that the theoretical variation Darwin was exposed to between the years 1836 and 1842 pushed his commitment to accuracy in explanation through a rejection of a requirement for ‘spontaneous miracles’ in science. By the year 1838, Darwin had a full understanding of the social, political, and religious implications of his transmutation work, but continuously questioned and queried with increasing secrecy. It could be argued Darwin sustained a Dr. Jekyll and Mr. Hyde persona by the end of this period, noted in his journal as jovially socializing with his colleagues at dinner parties and returning home to heavily criticize these same individuals for their subjective and religiously incorporative scientific positions.\textsuperscript{590} The social context of Darwin’s struggle to understand transmutation and its natural mechanisms provided the human

\textsuperscript{587} Desmond and Moore, \textit{Darwin: The Life of a Tormented Evolutionist}, 287.
\textsuperscript{588} Ibid., 290-92.
\textsuperscript{589} Ibid., 292.
\textsuperscript{590} Ibid., 236.
and institutional resources to put his theory on to paper in the year 1842. Darwin himself felt heavily taxed with an immense work load of publications following the *Beagle* voyage. This, along with his private contemplations of evolution, lead to his development of regular bouts of stress-based illness starting in the year 1840, eventually leading to his enthusiastic departure from London.591

**4.3 Text Analysis Terminology Frequencies and Bubblelines**

Text analysis establishes Darwin as working in a vocabulary dominated by terminology that is geological until the year 1836 (Figure 4.24 and 4.25), transitioning in the years 1837 (Figure 4.26) and 1838 (Figure 4.27), to predominantly biological terminology, which implies work solidly rooted in the naturalist field by the year 1839 (Figure 4.28). In the years 1840 (Figure 4.29) and 1842 (Figure 4.31), Darwin’s scientific correspondence terminology was dominated by geological terminology once again, due to publication of his “The Structure and Distribution of Coral Reefs” (1842).

![Figure 4.24](image)

**Figure 4.24** – 1835 Top five letters with highest density of geological (top) and biological (bottom) terminology, suggesting that 1835’s scientific correspondence as geologically dominated.

Figure 4.25 – 1836 Top five letters with highest density of geological (top) and biological (bottom) terminology, suggesting that 1836’s scientific correspondence as geologically dominated.

Figure 4.26 – 1837 Top five letters with highest density of geological (top) and biological (bottom) terminology, suggesting that 1837’s scientific correspondence as biologically dominated.
Figure 4.27 – 1838 Top five letters with highest density of geological (top) and biological (bottom) terminology, suggesting that 1838’s scientific correspondence as biologically dominated.

Figure 4.28 – 1839 Top five letters with highest density of geological (top) and biological (bottom) terminology, suggesting that 1839’s scientific correspondence as biologically dominated.  

Figure 4.29 – 1840 Top five letters with highest density of geological (top) and biological (bottom) terminology, suggesting that 1840’s scientific correspondence as geologically dominated.  

Figure 4.30 – 1841 Top five letters with highest density of geological (top) and biological (bottom) terminology, suggesting that 1841’s scientific correspondence as biologically dominated.


**Figure 4.31** – 1842 Top five letters with highest density of geological (top) and biological (bottom) terminology, suggesting that 1842’s scientific correspondence as geologically dominated.\(^595\)

Identification of a transition in terminology does not imply a conscious recognition by Darwin, rather draws attention to his growing engagement in theoretical postulation, evidence collection, and scientific discussion more closely associated with natural history. The process of professionalization and separation of geology and natural history from natural philosophy was still underway in mid-nineteenth century England. The lack of distinction between the two fields resulted in a large amount of overlap and interdisciplinary approaches to questions from both fields. Often, natural history questions could be answered from a geological perspective and geological questions could be explained from a natural history perspective. This might be viewed as conflicting with Darwin’s public geological involvement in London, but must be considered alongside the fact his naturalist work was under wraps during this period. The transitioning terminology was detectable within his correspondence, not observed through Darwin’s public academic involvement, stemming from his previously discussed public-private duality.

4.4 Conclusion of Results

The pattern of network change throughout Darwin’s separated and overall network analyses exhibited increasing size and density towards the year 1839, decreasing in following towards the year 1842. Darwin’s separated colleagues analysis confirmed and further contextualized the relationships between Darwin and his traditional scientific contemporaries Henslow, Lyell, and Owen. The analysis contextualized their specific contributions, each responsible for developing a different branch of Darwin’s natural history expertise. Lyell contributed Darwin’s uniformitarian geological perspective, while Henslow and Owen contributed classification and understanding of Darwin’s plant and animal specimens, respectively.

Network analysis of the “hidden figures” category of Darwin’s correspondents indicated contribution from a pool of individuals with very little documentation. Charles San Lambert, Charles D. Douglas, Robert Edward Alison, and Bartholomew James Sullivan were figures of significance within the analysis. These men were determined to make contributions to Darwin’s geological survey’s from the Beagle. The data supporting Darwin’s geological work, until the year 1846, was in part facilitated by these men as they amassed more data than a single individual could gather. Given the long geological timeline required for Darwin’s theories of subsidence, elevation, and simultaneous volcanic activity, the time he spent in each location of interest would have yielded only a few days of data, rather than multiple years. In the final branch of the separated network analysis, Darwin’s use of family varied from a means of social indication for his most controversial theoretical elements, to active contribution through research and impartment of natural and geological observations. A difference in tone was detected in Darwin’s requests of assistance between his sisters, and his male cousins.
The application of text analysis to Darwin’s scientific correspondence content solidified vocabulary as dominated by geological terminology until the year 1836, intermediary in the years 1837 and 1838, to predominantly biological terminology by the year 1839. In the years 1840 and 1842, Darwin’s scientific correspondence terminology was dominated by geological terminology once again, due to publication of remaining geological observations from the *Beagle* voyage.
Chapter 5: Conclusion

My application of social network analysis to Darwin’s scientific correspondence identified a steady expansion in the number of correspondents and density of scientific terminology used within the eight-year project period, affirming a branch of Rudwick’s argument for the importance of the years 1835 to 1842. Moving beyond Rudwick, my project analysis confirmed a cyclical network pattern of gradual overall expansion with interspersed years of minute retraction due to illness and reclusion. This supports an additional period of significance by Desmond and Moore pertaining to theoretical stagnation and illness for Darwin from the years 1840 to 1842. Rudwick discusses Darwin’s reclusiveness as increasing after his move to London resulting in his move to Down in a progressive gradient fashion, but Darwin’s verbal statements provided by Browne state he was craving privacy after his return on the Beagle, before moving to London, resulting in his time in Cambridge late in the year 1836. Browne depicts a more cyclical pattern of phasic reclusiveness, rather than the gradual increasing progression supported by Rudwick, Desmond, and Moore. Additional evidence of this trend is seen in Darwin’s fluctuating habits on the Beagle and later at Down. My argument for the cruciality of the period of 1835 to 1842 is further supported by Browne’s analysis, placing it as one of two critically formative periods for Darwin from the years 1835 to 1842 in London and later in the 1850s leading up to his release of Origin (1859). I argue Darwin built on the work of his predecessors, pulling together theories from his colleagues, and culling observations from

598 Browne, Charles Darwin: Voyaging (Volume I of a Biography), 344-345.
599 Browne, Charles Darwin: Voyaging (Volume I of a Biography), 279.
amateur scientists into the first comprehensive theory of evolution by natural means. Further, I argue Darwin facilitated his private transmutation work, and successful public naturalist and geological career, through the assistance of colleagues specialized in varying branches of science.

My work has shown heavy reliance on figures traditionally associated with Darwin, such as Henslow, Owen, and Lyell, but moved beyond this in identification of lesser known figures involved in evidence gathering and specimen identification, such as John Grant Malcolmson, William Herbert, William C. Redfield, and Hugh Falconer. Darwin’s use of his colleague correspondence network, as illustrated by my analysis, strongly supports Browne’s interpretation of Darwin being motivated by a need for labor division.

The degree of diversity of “hidden figures” and amateur scientists involved in many of Darwin’s publications was unexpected, such as Charles San Lambert, Robert Edward Alison, and Bartholomew James Sullivan, yet the most illuminating finding was the number of “hidden figures” that have little to no mention in secondary or primary related literature, such as John Provis, Julian Jackson, and Richard Sutton Ford.

I argue each member of Darwin’s immediate family played a different role in correspondence, his sisters predominantly engaged in casual conversation with elements of scientific content in relation to their provision of research assistance or passing information from his father. Caroline shines in this regard, moving her contribution beyond simple assistance to active debate and engagement with Darwin on varying geological topics. I argue her engagement

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with Darwin on such subjects was of a similar degree to Fox. Fox discussed geological and
naturalist subjects with Darwin, along with providing observations for consideration. Fox did not
conduct research for Darwin, as Caroline did, but both figures were relevant sounding boards to
discuss scientific opinion with and active contributors to his work in the use of Fox’s
observations and Caroline’s research. Heinsleigh’s placement on the outside of Darwin’s close-
knit ring of correspondence with Susan, Catherine, Caroline, and Fox, resulted in his use as a
social indicator of public response to controversial elements of Darwin’s transmutation work.
Social network analysis of each of these groups separately outlined Darwin’s achievement of
success through a strategic use of institutional, familial, and societal networks, often facilitated
through correspondence.

My application of network analysis defined Darwin’s use of correspondence as packaged
into years of external contribution, outreach, reclusiveness, or what I have characterized as an
intermediary. The years 1835 and 1836 are characterized by outreach from Darwin to his
correspondents while on the *Beagle* voyage. The year 1836 shows hints of external contribution,
but this is the result of delayed delivery of correspondence building as the *Beagle* travelled. The
year 1837 presented the beginning of Darwin’s collaborative phase, growing more diverse by the
year 1838. Peak diversity in external contribution was reached in the year 1839, Darwin’s
scientific correspondence network was the largest and most dynamic of the eight-year period.
Declining in diversity as a result of illness, the year 1840 was intermediary emphasizing a
balance between contribution and outreach. The year 1841 continued this intermediary structure,
with a slight increase in external contribution over internal outreach by Darwin due to illness.
The year 1842 had a similar singular outreach dynamic as the year 1835 but was rather the result
of reclusiveness and limited correspondence.
My use of text analysis, via Voyant, highlighted Darwin’s diverse character, and his transition from geological to naturalist work between the years 1835 and 1842. My analysis of the scientific content of Darwin’s correspondence illustrates a slow transition from one to the other. Darwin worked within a vocabulary dominated by terminology that was geological until the year 1836, transitioning in years 1837 and 1838 to predominantly biological terminology, I argue this implies work solidly rooted in the naturalist field by 1839. In the years 1840 and 1842, Darwin’s scientific correspondence terminology was dominated by geological terminology once again, due to publication of remaining geological observations from the Beagle voyage.

I have shown social network analysis is helpful in contextualizing scientific correspondence networks by increasing the ease of visual communication of patterns and relationships improving the understanding of the yearly scientific discussion in Darwin’s correspondence. As an alternative to reading entire collections of letters, network visualizations imparts understanding of the proportion, duration, and context of incoming contributions to Darwin’s scientific work with a quick gland and basic knowledge of networks. Network analysis facilitates investigation of the influence of different groups of people on Darwin through categorical separation. Unfortunately, the methodology is not ideal for use with small data sets following application of manipulative node authority statistic. Application of this type will create an error of misrepresentation, shown in my project through indication of Darwin as the most used tag in the “hidden figures” analysis of the year 1838 (Figure 4.12). This issue is linked to the problem of applying network statistics in Gephi over bimodal node data. As previously mentioned, the size, context, and diversity of contributions were the target of analysis, and indication of Darwin’s mistaken prominence in certain networks did not inhibit my related

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603 See Chapter 3: Methodology, page 68 for node authority definition.
604 Biomodal node data refers to a network created with two distinct types of nodes.
analysis of incoming contribution. Statistically, Darwin’s prominence in the “hidden figure” network of the year 1838 is accurate, as Darwin does receive the most incoming correspondence forming the base of the statistical analysis. However, it visually decreases the size and readability of the surrounding terminology tags of interest to the project. Occurrence of this issue over a smaller data set, as with the “hidden figure’s” category of network data, increases the impact of statistical artefacts within the related network visualizations.

I ignored the incorrect indication of Darwin’s significance in the network and discussed secondary contributions. A similar phenomenon also occurred with Charles Wood in the “hidden figures” network analysis of the year 1838 (Figure 4.12). In smaller data sets, individuals are indicated more frequently as statistically significant, yet this is an artefact due to the number of correspondence contributions being numerically greater than the frequency of tag use within the correspondence content of that year. The greater the number of correspondence associated to an individual as compared to the number of times a terminology tag is used, the greater the reduction in size of related tags within the visualization (Figure 4.12). A limitation of working with TEI tags to derive context from Darwin’s scientific correspondence lay in discrepancies, or inconsistencies, in tagging procedure. In some cases, people were tagged using different variations of their name (eg. Catherine Darwin) making it difficult to keep track of individuals year to year.

The application of digital humanities methods to questions in the history of science is relatively new. In light of this, there are many points of consideration for further related investigation. Expanding the presented analysis across the entirety of Darwin’s correspondence collection is the next logical application of this interdisciplinary methodology. My work has reliably confirmed and brought new context to a crucial and well-documented period of
Darwin’s life. Application of this methodology to periods of Darwin’s life that have received less scholarly focus would be fruitful and insightful. Equally significant would be an extension of the investigation tracing the origin of secularization in science, before Darwin. The correspondence of Georges Louis Leclerc, Comte de Buffon, author of *Histoire Naturelle* (1749) is available. Within this work, and his correspondence, he exhibits early ideas of transmutation theory and natural explanation as France experienced scientific secularization before England in the mid-eighteenth century. Many of these ideas formed the proto-natural sciences and early evolutionary thoughts Darwin was exposed to, an important avenue for further scholarly exploration. If one chose to trace the roots of evolutionary theory, a study of George Louis Leclerc or George Curvier correspondence would be necessary.

In a modern context, Niels Bohr’s correspondence is available, giving insight into the process of science during World War II. An investigation of his correspondence would increase understanding of the impact political influence has on the creation of new technology, such as the atomic bomb. A broader range of correspondence is provided by the Electronic Enlightenment Project containing the largest collection of seventeenth- to twentieth century correspondence including 60,000 letter from 7,000 correspondents prime for similar applications of social network and text analysis. My project methodology is ideal for investigating complex processes of scientific innovation involving large groups of people, increasing the ease of study of complex relationships, and analysis of previously unforeseen significance in correspondence data sets, creating a more dynamic historical perspective.

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Appendix

6.1 TEI encoded letter from Charles Lyell to Charles Darwin (February 13th 1837).

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"I could think of nothing for days after your letter on coral reefs, but of the top of submerged continents. It is all true, but do not flatter yourself that you will be believed, till you are growing bald, like me, with hard work &amp; vexation at the incredulity in the world."
Figure 6.1 - The structure of the TEI includes a header section (red box) including elements for letter title (line 7), digital publisher (line 11), digital publication location (line 12), licensing agreement (line 15 to 24), digital publication date (line 26), subtitle (line 29), source of the text (line 41), physical description of the document (line 50 to 51), type of correspondence (line 59 and 64), name of sender (line 60), location of origin (line 61), date (line 62), name of recipient (line 65), abstract (line 69), key words (line 72 to 80), transcriber (line 83 to 95). Below the header is the body section (yellow box), including the original location of production of correspondence (line 101), the date (line 102), an opening address (line 103), and the text content of the letter followed by annotations created by the DCP (line 115 to 119).
6.2 Raw Microsoft Excel project data spread sheet of four letters in 1837.
6.3 a) Gephi node data matrix for the 1837 colleague contribution network analysis.
6.3 b) Gephi edge data matrix for the 1837 colleague contribution network analysis.
6.4 Customized stop word list applied to text analysis using Voyant.
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6.5 Text analysis return of most frequent terminology generated using Voyant.

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Bibliography

Scholarly Sources


Primary Documents


Caldcleugh, Alexander. *Travels in South America, During the Years 1819-20-21 - Containing an Account of the Present State of Brazil, Buenos Ayres and Chile*, London: John Murray, 1825.


Websites


