Reexamining Taxonomy and Gender: T.H. Huxley, G.H. Lewes, and George Eliot View the Medusa

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Past accounts of science history have tended to mark the year 1859, the publication date of Charles Darwin's *Origin of Species*, as the point in time when everything changed.[1] However, more recently, such works as James A. Secord's *Victorian Sensation* have directed attention to the influence of such pre-*Origin* publications as the 1844 *Vestiges of the Natural History of Creation* on Victorian culture and the general Victorian reading public's response to popular scientific accounts before the appearance of *Origin.* Understanding the history of ideas just prior to *Origin* helps us comprehend why Darwin's work had the widespread popular impact it did. I argue that the intense interest among the general public in collecting natural history specimens prepared the climate for Darwin's reception and that, in particular, the increased awareness of the life cycles of marine invertebrates was important in changing some very basic assumptions about reproduction, growth, and sexuality, both to the scientific community, where many prominent evolutionary scientists focused their attention on describing marine invertebrates, and to a rapidly changing culture in the mid-nineteenth century.

To this end, this study focuses on G.H. Lewes's *Sea-Side Studies at Ilfracombe* (1858), a popular text on tidepool collecting that was designed to take advantage of the intense interest in natural history and in collecting marine specimens – interests that engrossed both men and

women in the mid-Victorian era. It follows W.H. Harvey's 1849 *The Sea-Side Book: Being an Introduction to the Natural History of the British Coasts* and a series of 1850s guides to the seashore: Anne Pratt's *Chapters on the Common Things of the Sea-Side* (1850), Mary Robert's *Popular History of the Mollusca* (1851), Philip Gosse's *The Aquarium* (1854), and Charles Kingsley's *Glaucus: or the Wonders of the Shore* (1855). As the railroad made access to North Devon available to the public in the 1840s and 1850s, guides to the area also became popular, including Gosse's *A Naturalist's Rambles on the Devonshire Coast* (1853), and George Tugwell's *A Manual of the Sea-Anemones Commonly Found on the English Coast* (1856) (Bellanca 22). *Sea-Side Studies* is a response to this publishing marketplace. This collection of essays was originally published in *Blackwood's Magazine* between 1856 and 1857 and in book form in 1858. *Sea-Side Studies* was the first of a series of accessible books that G.H. Lewes produced on the life sciences. The later post-1859 books show the influence of Darwin as Lewes was an early supporter of natural selection. According to Lewes's preface, the book version provides more references than the articles in *Blackwood* since the essays "were chiefly written at the coast, where the command of books was necessarily small, and the literature of each subject could only be given sparingly" (viii). Although only Lewes's name is given on the title page, *Sea-Side Studies* is to some degree (and that degree is, admittedly, subject to debate) a collaborative work authored by three Georges: George Henry Lewes, George Eliot, and George Tugwell, who acts as a guide to collecting in the area.

Sea-Side Studies is of interest in literary studies because it was written at a time when George Eliot was just beginning her career in novel writing – My copy of *Sea-Side Studies* contains an advertisement for Eliot's *Scenes of Clerical Life* (apparently missing from the Google books' digitized version) – and we can trace some influence of her studies with Lewes on her development of metaphoric language, characterization, and on her ability to overcome ethnocentric biases and see individuals as part of a community. The book is of interest to cultural studies

as it offers us a glimpse of the tidepool-collecting mania that swept England in the mid-1800s when "the lovely sea-anemone" became "the ornament of countless drawing rooms, studies, and back parlours" (Lewes 115), a time when, as described by Lynn Merrill, a series of natural history collecting crazes swept England. And it is of interest to the study of the history of science as this work was published just prior to Darwin's *Origin of Species* and indicates the generally overlooked importance of the taxonomic reorganization of marine invertebrates, with the accompanying research into growth and reproduction, in preparing the ground for Darwin's argument for natural selection.

Background on Taxonomic Debates

To get a sense of the sort of questions Lewes and Eliot were investigating in their marine collecting activities requires some historical background on the taxonomic debates of the mid-1800s. The history leading up to this focus on marine biology as seen in *Sea-Side Studies* is quite fascinating. Although traditional taxonomy has taken a backseat in current biological research and is generally overlooked in cultural studies, it was the center of focus in the life sciences during the Victorian period. The sort of careful detailed observations required in sorting out taxonomic relationships and life cycles prepared researchers for the concept of natural selection.[2] The history of how such marine invertebrates as jellyfish came to be studied and classified, the determination of which species was to be the emblematic model of the class, and the separation of the coelenterates (jellyfish, corals, and sea anemones) from the echinoderms (starfish and sea urchins) marks a change in understanding how life is organized and therefore viewed. And the study of marine invertebrates, by both hobbyists and researchers, prepared Victorians for evolutionary biology, which became increasingly separated from the previous more ethnocentric- and moralistic-tinged study by earlier naturalists. As Mary P. Winsor's landmark study in the history of science, *Starfish, Jellyfish, and the Order of Life*, has shown, between the eighteenth and nineteenth century, pre-Darwinian naturalists attempted to determine if taxonomic

relationships were convenient human-imposed organizational categories or whether these similarities among life forms indicated something inherent in the natural order. Additionally, there was a strong desire among nineteenth-century scientists to show that nature was both ordered and moral (Levine). In the 1840s, the focus on "philosophical anatomy" directed researchers to search for a pattern behind various anatomical structures to find what Huxley called "the wonderful unity of plan" (qtd. in Desmond 29). The belief was that "All mollusks were deducible to a common blueprint, all vertebrates to another, insects and crustaceans to a third, starfish to a fourth..." (Desmond 29). This desire and search for order led to an intellectual struggle that particularly focused on the marine invertebrates as many prominent evolutionary scientists directed their attention to this area of the animal kingdom that appeared to be the most disordered: T.H. Huxley (1825-1895) made his initial reputation while on board *The HMS Rattlesnake* with his dissection and description of southern jellyfish, such as the Portuguese Man-of-War (*Physalia*), and his proposed reorganization of the marine invertebrate taxonomy, and his championing of pathogenesis as a reproductive process in invertebrates; Charles Darwin (1809-1882) worked on worms and barnacles and, just prior to *Origin*, wrote a 2-volume *A Monograph of the Sub-Class Cirripedia* (1851, 1854), i.e., the anatomy of barnacles, an animal that was reclassified and moved from Mollusa to Articula. As Phillip Sloan notes, while Darwin's study of barnacles has been seen as an interruption of "a linear sequence of historical stages" leading to *Origin*, these studies focused on classification and the problems inherent in determining species identification (71).

The first half of the nineteenth century saw increasing challenges to earlier classification systems of the natural world. Several major British expeditions, such as the *Endeavor*'s 1770 visit to Australia, brought home first reports of, then specimens of, organisms that did not neatly fit into existing classification schemes. Harriet Ritvo particularly points to the popular impact of two creatures: the marsupials as represented the pocketed kangaroos, which adapted nicely to captivity in England, in-

spiring hopes of naturalizing these creatures to the English country side, and the monotremes' duck-billed platypus, whose egg-laying reproductive behaviors seemed almost designed to upset all nicely designated divisions between mammal, bird, and reptile as they incorporated characteristics of "low" groups by growing outside the mother's body and "high" groups as the young nursed on their mothers' milk (Ritvo 3, 5).

Initially, attempts were made to force-fit these new animals into preexisting categories, then to restructure the class Mammalia. Either approach strained the already overwhelmed business of taxonomic classification as scientific explorations that took place between John Ray's late seventeenth-century species listing and Linnaeus's *Systema Naturae* (1735) increased the number of known quadrupeds from 150 to 300 species. By the late nineteenth century, over a thousand new genera were added each year (Ritvo 10). These new animals tested Linnaeus's taxonomy and found it wanting in sufficient systematic flexibility. The fact that such ancient, well-established, and economically important groups as quadrupeds could not accommodate new animals undermined the very authority of scientific practitioners (Ritvo 11).

At issue was what characteristics would differentiate one group of organisms from another. In the late 1700s, the term *quadrupeds*, so closely associated with Thomas Bewick's *A General History of Quadrupeds* (1824), was replaced with *mammalia* in order to accommodate marine mammals and bats. Mammae became the major identifying characteristic for the group rather than possession of four feet.

New organisms required revisions of taxonomic classification systems. These came with personality clashes since reputations were often on the line. The ability to correctly name and classify an organization separated the true naturalist from a mere collector (Ritvo 16); thus, reclassifications were serious business. While taxonomy lost some of its prominence in the beginning of the nineteenth century, to be replaced by physiology as the flagship scientific discipline, it still marked the study of natural history as being scientific (Ritvo 16). Ritvo notes that the ability to tidily organize and classify the natural world on a systematic basis

soon transitioned into a justification to control the lands occupied by those organisms (18). Naming life forms implied intellectual superiority over any local knowledge. This, in turn, easily became right to ownership.

While the need for classification systems was acknowledged, how to actually organize was a more problematic issue. "Natural systems" such as that of the English John Ray, which considered a wide range of descriptive elements associated with an organism, were contrasted with "artificial systems" that grouped organisms on the basis of only a few characteristics (Ritvo 26). Ideally, a natural system would reflect the natural order of life, but as Darwin commented to a correspondent, "our ignorance of what we are searching after in our natural classifications" made this a difficult procedure (Ritvo 27) [see Correspondence II, 375-76; Ritvo doesn't identify correspondent].

There were several classification methods that competed for attention well into the 1890s. In addition to the competition between John Ray and Linnaeus, metaphoric imagery made use of the *scala naturae* or "chain of being," an ancient one-dimensional visualization that saw species linked in a progression (Ritvo 28-29). Its use moved naturalists to search for "missing links" in this chain. Although the limitations of this image was apparent in the 1830s – Darwin commented in a notebook that "it is capable of demonstration that all animals have never at any one time formed a chain" (qtd. in Ritvo 29) – its use lingers on in such works as T.H. Huxley's *Man's Place in Nature* (1863).

Alternative two-dimensional representations used geometric figures such as William MacLay's quinary system of 1819, which attempted to emphasize "affinity" or anatomical likeness between species by placing groups of animals in embedded circles, something like Venn diagrams. These circles were drawn so that they touched other circles of organisms at five points to indicate analogous structures among animals in similar environments (Ritvo 30-32). Although its numerology-tinged focus triggered complaints from one 1875 reviewer in *Nature* about is "mystical numbers, its fives or its sevens" (qtd. in Ritvo 35), its use in *Vestiges* and

in local natural history collections as late as the 1890s point to the effectiveness of affinities and analogies as a way of organizing the natural world (Ritvo 35).

Other taxonomists focused on a particular function or organ as the basis of classification, but could not agree which function or organ held the essential key to classification. Nehemiah Grew isolated the gut for his comparative studies, while John Walker promoted divisions based on eating – carnivore, herbivore, omnivore (Ritvo 36). Others promoted the size of the head, foot structure, or shape of sexual organs. Privileging one attribute over another led to intense turf wars often associated with particular scholarly divisions or subdivisions. Ritvo concludes that "To participants in a project conventionally hailed as demonstrating the intellectual conquest of nature, the internal history of zoological classification might seem as much a constantly shifting kaleidoscope of competing systems and principles as a steady evolution and elaboration of a dominant paradigm" (38). Although these analyses of the natural world were proclaimed to be objective, they still retained anthropomorphic and moralistic assumptions carried over from ancient animal descriptions that defined nature in terms of its usefulness or relationship to human beings.

Up until the nineteenth century, invertebrate taxonomy followed Pliny's basic ordering of life, one that described starfish and jellyfish as essentially a single creature. Cuvier's *Radiata*, one of his four *embranchements*, included the jellyfish, starfish, and the polyps. Then in the mid-1800s there was an increasing effort to sort out and split up what Huxley called a "lumber room" grouping of invertebrates (Winsor 5).[3] However, the process of imposing order on these creatures was beset with controversy and confusion as the coelenterates were distinguished from echinoderms (Winsor 5). These organisms' life cycles were not well understood until the late nineteenth century, and juvenile forms were initially identified as separate species. Additionally, these scientific discussions between the 1790s and the early twentieth century occurred during a time when natural philosophy was very much part of a shared intellectual culture in Britain. While modern observers commonly associate the jellyfish with

dangerous stings such as those suffered from the Portuguese Man-of-War, earlier observers in northern seas focused on its radial structure, its bioluminescence, and its changing appearance as exhibited by the British compass jellyfish or sea nettle (*Chrysaora hyoscella*), with its dark brown arm-like stripes,[4] and the large moon jellyfish (*Aurelia aurita*), both harmless to humans. Additionally, easily accessible jellyfish, such as the moon jellyfish *Aurelia* have small and not very noticeable tentacles.

Some insight as to how the jellyfish was perceived in the late eighteenth century is provided in Mary Wollstonecraft's *A Short Residence in Sweden, Norway and Denmark* (1796) as she describes her experiences rowing out on a calm lake "disturbing the innumerable young starfish," floating just below the surface of the water. From her description, it is apparent that what Wollstonecraft is describing as "young starfish" are jellyfish medusae.[5] However, this linkage of the soft, flowing jellyfish to the hard rigid starfish gives the modern reader pause since it is difficult to see how these creatures could be seen as similar. But Wollstonecraft notes, "I had never observed them [the jellyfish] before; for they have not a hard shell, like those which I have seen on the sea-shore" (112). This comment can be understood better if we consider that no one knew what juvenile jellyfish or starfish looked like, and that Wollstonecraft is focusing primarily on the radial symmetry of jellyfish structure, which was similar to that of a starfish. This way of observing can be found in Cuvier's taxonomy and Buffon's descriptions, which popularized Linnaeus's *Systema Naturae* (1738). Wollstonecraft was familiar with Buffon's *Natural History*. She most likely used the work in the schoolroom and had reviewed two editions of it for *Analytical Review* (especially a 1791 edition that was published in 8 volumes) in January 1792.

Today, the starfish occupy a separate phylum from jellyfish and they are seen as being distinct; radial symmetry is not a major classifying consideration (Winsor 129) as it was in the eighteenth century. So Wollstonecraft's identification reflects how the organism would have been identified by an eighteenth-century observer with some training in natural history.

The very fact that Wollstonecraft was focusing on jellyfish from her rowboat reflects a major change in how invertebrates were positioned in relationship to other life forms. Lamarck, beginning in 1794, had begun a major restructuring of traditional classifications that went back to Aristotle. Instead of seeing invertebrates as unimportant leftovers of the animal kingdom or degenerate animal forms, Lamarck argued that life should be studied from the bottom up, from the "simple to complex" (Sloan 76). This reversal of ordering broke with Linnaeus, Buffon, and Cuvier's 'top down' system, as observers now saw such creatures as the jellyfish, sea anemones, and starfish as being closest to the mysteries of the origin of life, a view that would have a major impact on the development of British evolutionary theories once it was adopted by Robert Grant of the University of Edinburgh in the 1820s (Sloan 76). Grant, a researcher of sea slugs and sponges, is considered to have been a major influence on Charles Darwin when he was a student at Edinburgh and a member of the Plinian club for undergraduate naturalists.

Beginning in the 1830s, researchers focused greater attention on invertebrates, long ignored in natural history, to better understand the basics of life by examining what was considered to be the most primitive forms. Huxley also saw these understudied life forms as a career opportunity. He initially focused on marine invertebrates in his early research because specimens decayed too quickly to be shipped back to England, providing the field worker with unusual control and ownership of discoveries. Huxley confided to his diary that he would specialize in the "perishable or rare marine productions" as he could anatomize fresh organisms on board ship, draw them, and then discard specimens in route, leaving theorists back home to identify and name new organisms based on the drawings (Desmond 54). This plan attracted Huxley because "All these are things which I can attend to myself and in which I neither interfere with nor need the assistance of any one else" (qtd. in Desmond 54). As he worked, he determined he would follow Richard Owen's advice, observe as a philosophical anatomist and search for some overreaching plan of organization (Desmond 54).

However, by the mid-Victorian period, scientists – and anyone trying to construct moral messages from nature – were faced with the discovery that marine invertebrates exhibit a wide range of reproductive methods. And it is on the issue of reproduction that Huxley sharply diverged from Owen's conclusions. In 1816, the naturalist/Romantic poet Adelbert von Chamisso (1781-1838), during his service as a naturalist on the imperial brig *Rurik* in the South Seas, proposed that sea squirts (Chorodata) in their life cycles moved from a solitary individual in the adult form, anchored to a base, to produce young in the form of a chain of offspring, each producing in turn a free-swimming larval form that eventually attached itself to a base. Chamisso called this process "alternation of generations"; it was generally dismissed at the time. In the 1830s, Norwegian naturalists had observed medusa-like forms emerging from polyp-like organisms and realized that what had been seen as separate classes of animals were forms of the same animal, indicating a new means of reproduction. In 1845, an English translation of Johannes Steenstrup's study became available that described reproduction by an alternation of generations (although Lewes, in his history of the discovery, points to Chamisso as having been the earlier discoverer in 1819 (Lewes 286)). Steenstrup called the first polyp generation Amme, or nurse, "because it generates and nourishes a new brood of individual, of a different form, which is the second generation" (Winsor 56). However, it was unclear when alternation of generations was in operation or whether a single organism was dividing through budding. Huxley held that sea squirts were pathogenetic and reproducing asexually (Desmond 179). Where many researchers saw individual organism, Huxley saw colonies.

T.H. Huxley on the *Rattlesnake*

Huxley's early research centered on his use of embryology in the restructuring of invertebrate taxonomy and his rather public dispute with Owen over the role of alternation of generations and parthenogenesis, connected with the more general problem of individuality. His research

began when, at age 21, Huxley took a berth as an assistant surgeon in the British Navy while under financial stress. Very much an outsider with few social connections, he knew he would be working in dismal, dangerous conditions but was still ambitious and motivated to make his name in scientific research. From Edward Forbes he learned dredging techniques, which were very successful in the calm waters of Brazilian bays. He began his dissections of mollusks, starfish, anemones, jellyfish, and nearly anything he could pull up in a net in 1847. Eventually Huxley would return home with hundreds of pages of drawings and descriptions of mollusks and crustaceans, "two new orders of sea squirts and 40 genera of jellyfish" (Desmond 145). The man-of-war jellyfish soon attracted his attention. They looked simple in structure but no one knew if they were individuals or a colony. This question – colony or individual? – was closely linked to his taxonomic and physiologic studies. It seemed that, as Desmond put it, "The simpler the animals the stranger the question" (145). Huxley needed a month to fully and carefully dissect a specimen, but the individual corpses quickly decayed in the tropic heat; however, Huxley persevered and planned a paper on the man-of-war that concluded that the man-of-war was a single individual (Desmond 60).[6] The resulting paper on *Physalia* was read to the Linnaean Society on 21 November and 5 December 1848 under sponsorship of Forbes. Huxley followed this paper with another ambitious study, which he sent to the Bishop of Norwich with the request that it be presented to the higher status Royal Society. This research, based on hundreds of jellyfish observations, established as defining features the medusa's membrane layers, which Huxley then associated with "stinging *Hydra*-like polyps and men-of-war and plumularian sea firs," concluding that they all shared two "foundation membranes" (Desmond 83) and thus belonged in the same class. In these observations Huxley established unifying characteristics that separated the jellyfish from their previous placement with amoebas and starfish of Cuvier's Radiata group, while also finding similarities between forms, such as siphonophores (the man-of-war) and hydroids, which appeared very different (Di Gregorio 8). His contributions

to taxonomy led to his being elected a Fellow of the Royal Society and receiving the Royal Society Medal at age 26 – the youngest to receive the award. While the term *Coelenterata* was adopted for this group, Huxley resisted using it. The term had been earlier proposed by Frey and Leuckart, but Huxley preferred the name "Nematophora," writing in "Notes on Medusae and Polypes" (1850),"The Hydroid and Sertularian Polyps form one large family which, from their invariable and peculiar 'thread-cell,' I propose to call the 'Nematophora'" (qtd. in Di Gregorio 8). In an 1851 note to the British Association he wrote, "However my own *conclusions* may agree with those of these naturalists [Frey and Leuckart] – I cannot think the physiological reasoning on which they base their proposed name for the class – Coelenterata – is correct – nor do I think that they have properly estimated the essential differences among its members" (qtd. in Di Gregorio 8).

His work on jellyfish and sea squirts made Huxley's reputation, but his finances were still perilous. Upon returning to England he began writing for the *Westminster Review* and met and befriended Lewes, but his connection with Lewes had begun while on the *Rattlesnake*. Fighting depression and in the humid tropical heat, he read Lewes's anonymously published novel *Ranthrope* (Desmond 93) and was moved by the plight of the hero he described as a "poor, dreamy boy, self-taught, self-aided" (qtd. in Desmond 93). The novel is not known for its literary merit, but Huxley, lying depressed in the stifling heat while his ship sailed between the Barrier Reef and Australia, saw in Lewes's hero a reflection of his own struggles amid poverty and self-doubt to achieve success through merit. Thus it is probably not surprising that after Huxley returned to England and found his way into John Chapman's circle, he met and connected with Lewes and in 1853 began writing for the *Westminster Review*; nor is it surprising that when Lewes had questions regarding his own microscopic studies, he would run them past Huxley.

As Huxley reclassified the medusa, he examined the growth and reproduction processes of his invertebrates, extending his study to include organisms from the order of Siphonophora (or sea nettles), including the

Portuguese man-of-war (Physalia) and the wind sailors (Vellela), and began to question some basic assumptions about what it meant to be an individual organism or even if the idea of a separate individual was more cultural than biological. The discovery of alternating generations made the differentiation between classifiable forms of a creature difficult, as naturalists questioned which form of the organism was the archetypal form – the form that exhibited the defining characteristics of a class – and how to treat such massively different forms of a single organism (McCalman 207). Such questions prepared the way for an historical understanding of species modification. After Steenstrup's discovery, all polyp-type organisms were examined to determine if they were jellyfish. Confusion arose over whether a medusa-like organism was a jellyfish medusa or something else. What did it mean to be an individual at some point in the life cycle and a colony at other points? Was the individual form part of a continuing process in growth and reproduction? And what was the true role of sexuality in reproduction? This question is why Lewes and Eliot were focusing on polyps to the extent that they were in *Sea-Side Studies*.

Sea-Side Studies

In general, the investigations that Eliot and Lewes carried out on marine invertebrates emphasized the lessons that Huxley and many researchers were learning: that Nature did not mirror human morality and that the invertebrates – especially the marine invertebrates – were extremely creative in the areas of reproduction. The controversy that centered on biological taxonomies and identification, of reproduction and the individual, directed the questions raised in *Sea-Side Studies*. Because of the popular involvement with tidepool collecting and the general interest in marine organism taxonomies, the jellyfish gradually picked up new symbolic meanings, becoming identified as female-like transformative organisms that provided insight into the beginnings of life and that operated outside of normal gendered biology.[7] They could be asexual maternal nurses, or if sexuality was required, they could function as hermaphrodites.

Initially, the book begins as an entertaining travel account of a visit to Ilfracombe and Tenby, then lightly focuses on anemones in part two, but becomes rather technical in parts three and four, sections that deal with visits to the Scilly Isles and Jersey, where Lewes had spent time as a child around 1828-1829 (Ashton 12). While providing practical advice on collecting, Lewes and Eliot are also very interested in how organisms develop, change, and reproduce. These are not easily observed transformations, however, and *Sea-Side Studies* was written during a time of exciting but also confusing accounts from the scientific community. Lewes's references to literature in the field show an amazing depth and breadth of knowledge. Unlike George Eliot's character Causabon in *Middlemarch*, Lewes is familiar with European studies. He cites German and French sources from fairly obscure works with the assumption that his readers, both researchers and hobbyists, will be interested. Indeed, David Williams in his biography is amazed that Lewes, in one case regarding a reference to a 1744 work, "unearthed ... a book so ancient and obscure" (157).

The narration begins with the plural "we" – "We are a lady and two men" (17), signaling the joint effort in this work. However, it only appears under Lewes's name, Tugwell soon disappears, and no attempt is made to clarify authorship. Occasionally we catch glimpses of George Eliot in such narrative passages as "quick female eyes have discerned, and nimble fingers have delicately secured, one of the loveliest of sea-charmers – an *Eolis*" (25); i.e., a genus of nudibranch or sea slug, which despite the name are actually quite beautiful. And later, "The colour has not changed on the cheek of the lady naturalist, who, astonished at her own fortitude (of stomach), declares dredging preferable to hunting on the rocks" (90). Such passages indicate that Eliot was not squeamish and was actively engaged in tidepool collecting and dredging with nets.

As they made their investigations, Eliot kept notes and later wrote a short essay, "Recollections of Ilfracombe" in her commonplace book, giving an account of the collecting she and Lewes did together during their seven-week holiday during May and June 1856 in the resort town of

Ilfracombe, located on the North Devonshire coast (Bellanca 19). Eliot's journal indicates her interest in theoretical science, and it also marks a point when she is developing her ideas of fiction and looking for ways to incorporate new scientific observations into her own work (Bellanca 20). Eliot had been engrossed with readings in physiology, phrenology, and developmental evolution since the 1840s (Secord 489).[8] Mary Ellen Bellanca has noted that some of Eliot's journal entries made their way into the first two of the four parts of Lewes's account (23, note 7), although she also argues for viewing the essay as a work that should stand on its own. I do not view Eliot's writing as ancillary to *Sea-Side Studies*, but rather that Eliot was a more involved co-author of the work, much as many women were silent collaborators in botanical field work.[9]

Sea-Side Studies begins with a focus on the more accessible anemones (Actiniaria) since "Jellyfish seek the light, and float at the top of the sunny sea," and Lewes and Eliot are collecting in the shade (21). The authors assume that anemones, and nearly anything with a medusa or polyp form, are related. Since T.H. Huxley had (unsuccessfully) argued in 1847 for stinging cells as a unifying feature of his Nematophora group to unite the medusa and polyps (Winsor 79), and Philip Gosse proposed a new genus (Sagartia) that would include anemones that had "peculiar white filaments" with "urticating cells" (Lewes 150-51), Lewes and Eliot explored the issue of whether the presence of stinging cells in anemones might place them in the same class as the jellyfish. However, their attempts to use comparative morphology begin to break down. After acknowledging that many believe all "Polypes" (Lewes's term) sting like nettles, Lewes notes the discovery of cells with little threads inside that are thrown out like lassos (according to the American biologist Agassiz) (Lewes 147). Then Lewes moves back to the anemones at hand, which also have cells but do *not* sting. Lewes concludes that "urticating cells [stinging cells] are present in a *few* Jelly-fish – which urticate; in Actiniae – which urticate; and in all Polypes – which, if they do not urticate, are popularly supposed to do so" but the cells are also present "in the majority of Jelly-fish, which do *not* urticate; in Eolids – which do *not*

urticate; and in Planariae – which do *not* urticate" (Lewes 148). In other words, the cells might be present but that does not indicate whether the creature will effectively sting its prey or not. After much discussion, Lewes concludes that "anatomical deduction" is unreliable and observation of the organism in action is necessary before conclusions can be made (153-54). This detailed observation of stinging cells that do not seem to be responsible for stinging prepares the reader for the more challenging conclusion, by analogy, that what is often described as an ovary or a sperm cell reflects a desire on the part of the observer to see such sexual distinctions when life is not gendered.

Lewes and Eliot next attempt to address the concept of alternating generations. The narrator of *Sea-Side Studies* first observes tiny jellyfish-like medusae coming from a polyp. An attempt is made to connect these observations to a new lesson: the alternation of generations.

> Familiar as this sight [of medusae emerging from polyps] was to me, it had not lost its marvelousness. Here was a Polype, which the uninstructed eye could not distinguish from a seaweed, producing scores of Jelly-fish; and these Jelly-fish, if their days were spared, would in due time produce Polypes. Imagine a lily producing a butterfly and the butterfly in turn producing a lily, and you would scarcely invent a marvel greater than this production of Medusae was to its first discoverers. Nay, the marvel must go further still; the lily must first produce a whole bed of lilies like its own fair self, before giving birth to the butterfly; and this butterfly must separate itself into a crowd of butterflies before giving birth to the lily: when you have thus added marvel upon marvel, you will be ready to listen without skepticism to the phenomenon known as the "alternation of generations," since Steenstrup so baptized it. (Lewes 280-81)

Here alternation of generations challenges the common pedagogical use of the caterpillar-to-butterfly transformation to demonstrate nature's po-

tential, but this is a lesson that can only be realized by those with an instructed "eye."

This passage, in addition to acknowledging Steenstrup's work, further notes that many animals "issue not from an egg, but directly from the substance of the parent's body, by a process analogous to that of the budding of plants," no male required (Lewes 281-82).[10] In fact, as Lewes points out, it is difficult at times to figure out what is being observed. Observation must be combined with experimentation and one cannot make assumptions based on analogies with vertebrates. The creatures Lewes and Eliot observed seemingly ignored any need for heterosexual reproduction. Many populations, such as aphids, according to T.H. Huxley, were completely female and reproduced parthenogenetically while showing no lack of health or vitality in the population. Males might make an appearance almost randomly. Such observations apparently led to some interesting discussions between Eliot and Lewes as Lewes reports:

> Ungallant physiologists, resting on the evidence of some embryological phenomena, have declared the female to be only a male in arrested development; a very impertinent deduction, which was however, flung back on them by a witty friend of mine [possibly Eliot] ... [who declared] "Man is but a woman with a softened brain!" (290)

Lewes then lists a vast number of plants and animals to point out how common such reproduction is before moving on to the jellyfish with its alternation of Medusa and polyp forms, i.e., "alternation of generations," or what Lewes called "Polype-parthenogenesis."

In biology textbooks today, a diagram of jellyfish reproduction shows a uniform cycle with an alternation between sexual and asexual forms; however, such textbook diagrams obscure the oftentimes bewildering chaos that can be encountered in field observations. What Lewes observed was quite confusing: sometimes parthenogenesis was involved; sometimes there were sperm and ova; sometimes medusa produced po-

lypes, sometimes medusa produced medusa by budding; sometimes polyp produced polyp by budding. Many nineteenth-century biologists were convinced that reproduction required egg and sperm, yet the actual union of sperm and egg had not been documented until the late 1870s, suggesting to Lewes that structures, such as oviducts, are seen by observers but that they "only [exist] in their imagination" (160). The earliest image showing spermatozoa approaching an egg is an 1877 illustration by Oscar Hertwig and Hermann Fol in their report on their observation of the fertilization of a starfish egg (*Asterias glacialis*) (Coleman 38).

For Lewes and Eliot in the 1850s it was unclear what was reproduction and what was growth or when there were new individuals or some sort of cloning or metamorphosis. That is probably why Lewes refers to "the identity of Growth and Reproduction," which in his preface he declares to be the "most startling of the new views" he presents (ix), not as two separate processes, but of two processes so closely linked that it is not really possible to separate them. The lines between individual and community are not nearly as distinct as we vertebrates might think. As Lewes puts it: "I differ from the current idea respecting the germ-cell and sperm-cell as essentially *necessary* to the seed .... that Generation is only a form of Growth; because every one has assumed that the union of two dissimilar cells is the necessary commencement of every generation" (309). However, "fecundation" is only necessary for "Generation" in the higher animals: "plants, polypes, insects, and crustaceans, being generated without fecundation" (310). Lewes suspected that where eggs were observed, as in Hydras, it was in response to changing environmental conditions, the exception to the usual process. For the most part, if the basic "primitive" life form was gendered, it was female. Among invertebrates, virgin births were commonplace, not an exception

Literary references to marine invertebrates are not common. Those sightings that occur lurk often on the very margin of a work, but where they do occur in the nineteenth century – as with the mention of zoophytes in an aquarium (160) and the fossil trilobite (240) in Hardy's *A Pair of Blue Eyes*

(1873) and May Kendall's "The Lay of the Trilobite" (1887) and "The Philanthropist and the Jelly-fish" (1887) – they carry symbolic meaning, especially post-*Origin*. So it is of interest to consider what ideas Eliot was likely to be synthesizing as she moved from the microscope and care of captive specimens to her literary work. Concurrent with her work with Lewes's study, Eliot was engaged with her book reviewing work for *The Leader*, which Lewes edited, and the classical myth of Medusa. Although Linnaeus had placed the adult form of the jellyfish into a species he named Medusa, the French word for jellyfish, the connection between the classical Medusa and the jellyfish came slowly to English-speaking observers, and women writers often resisted using the myth of Medusa as it carried misogynist connotations. If they did use the myth, they explored more positive versions of the story. Eliot was aware of the classical Medusa, but her preferred version differed from more common accounts. She was interested in the version given in Adolf Stahr's *Torso: Kunst, Künstler and Kunstwerk den Alten*, which she was reviewing at the time she and Lewes were engaged with *Sea-Side Studies* (Wiesenfarth xviii, 153). In her commonplace book, written during the time she worked with Lewes on *Sea-side Studies* and her novel *Adam Bede* (1859),[11] Eliot records the legend of the Medusa (one found in Ovid) as the story of an innocent victim who did not deserve her fate. In this version, Medusa, a princess, was raped in Athena's temple by the powerful sea god Poseidon. Since Poseidon was too powerful a god for Athena to punish, her wrath came down on the victim.[12] This version, which Eliot alludes to in her description of the Medusa Rondanini sculpture,[13] in turn feeds into Eliot's description of the character of Hetty in *Adam Bede*. When Hetty, seduced and pregnant, searches for a pool to drown herself, she is described as having a face "the sadder for its beauty, like that wondrous Medusa-face, with the passionate, passionless lips" (Chapter 37, p. 322).[14] This Medusa is a tragic, not a threatening figure.[15]

This Medusa's connection with the jellyfish gives insight into why Eliot chose this metaphor to describe a potential drowning victim. While there is no direct linkage with the jellyfish here, it should be noted that Hetty is looking for a black pool, and images of the drowning Ophelia

come quickly to mind – especially John Everett Millais' 1852 *Ophelia* painting, which shows Ophelia drifting in the water with hair streaming in the water like tentacles.

The basic message of *Sea-Side Studies* are that both observation and experimentation are necessary to understand the natural world, that nature is not necessarily gendered, and that our gendered assumptions, appropriate to and appropriated from vertebrate biology, may lead to the wrong conclusions when examining marine invertebrates. Whereas Gillian Beer in *Darwin's Plots*, has traced the influence of Darwin's *Origin* on *Middlemarch*, we can see in *Sea-Side Studies* that Eliot's scientific engagement pre-date Darwinian natural selection and that she and Lewes were thus well prepared to be supportive of natural selection when the *Origin* was published. The observations that Eliot made with Lewes brought her an awareness of the variations in sexual behavior possible in one natural community, an awareness that might have shape her efforts in *Middlemarch* to examine the variety of human behavior in a community in a non-judgmental fashion as a range of reproductive patterns and motives. As Eliot famously put it in *Middlemarch*, "Even with a microscope directed on a water-drop we find ourselves making interpretations which turn out to be rather coarse" (44; chapter 6). Eliot's metaphoric language directs us to look closer with a stronger lens, set aside ethnographic biases, and reexamine previous assumptions: to look closely at the myth of the Medusa and to see the gorgon's decapitated head as but one stage in the tale or the life of a rape victim – and to look closely at tidepool life and note the absence of patriarchy in the natural world.

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Notes

[1] This demarcation carries over to literary studies as evidenced in Peter Morton's *The Vital Science: Biology and the Literary Imagination, 1860-1900*, which as the title denotes, begins the study of the interaction between biology and literature post-*Origin*.

[2] This is not to say that the thorny question of how to determine species demarcation has been solved. Today, researchers still struggle to

establish whether a particular organism is a new species or not, but DNA analysis provides additional ways of addressing such questions.

[3] "Lumber room" was a favorite term of dismissal for Huxley. He called *Vestiges of the Natural History of Creation* (1844) "a lumber-room of second-hand scientific furniture" in his 1854 review of the book (qtd. in Secord 504).

[4] The compass jellyfish matches descriptions of the "round fish" that Jung has traced in Medieval allegory (137).

[5] Richard Holmes's note clarifies Wollstonecraft's description but gives no explanation for her terminology.

[6] Today it is classified as a "large, colonial hydroid with specially adapted cells (zooids) that form float, sail, and tentacles" (Ponsonby and Dussart 30).

[7] I deal with the topic of jellyfish and gender more generally in "'The Starfish that Burns': Gendering the Jellyfish," in *Forces of Nature: Natural(-izing Gender and Gender(-ing) Nature in the Discourses of Western Culture*, ed. Bernadette H. Hyner and Precious McKenzie Stearns (Cambridge: Cambridge Scholars, 2009), 21-50.

[8] See Sally Shuttleworth, *George Eliot and Nineteenth-Century Science: The Make-Believe of a Beginning* (Cambridge UP, 1984) for studies of Eliot's incorporation of scientific research in her novels and short stories, mostly post-*Origin*.

[9] See Ann B. Shteir, "Botany in the Breakfast Room," in *Uneasy Careers and Intimate Lives*, ed. Pnina G. Abir-am and Dorinda Outram (Rutgers UP, 1987), 19-43. Barbara Gates discusses women's often un-acknowledged contributions to natural history publications, especially illustrations. In the area of marine biology. Emily Gosse, for example, illustrated her husband's *The Aquarium* (Gates 74).

[10] Lewes cites Trembley's *Memoirs on the Hydra, or Fresh-water Polype* (1744), then R.Q. Couch for observing that if a Hydra "be merely irritated with a needle, or a ray of the sun, a young one will sprout from the injured parts" (qtd. in Lewes 283).

[11] Published as *George Eliot: A Writer's Notebook 1854-1879 and*

Uncollected Writings, ed. Joseph Wiesenfarth.

[12] Interestingly, Christine de Pizan, writing in medieval France, includes Medusa in a list of celebrated women as having "such striking beauty that not only did she surpass all other women ... but she also attracted to herself, because of her pleasing appearance – her long and curly blond hair spun like gold, along with her beautiful face and body – every mortal creature upon whom she looked, so that she seemed to make people immovable" (203-4). It is because of her beauty, de Pizan argues, that the fable claims people turned to stone.

[13] This sculpture was often described in Italian travel accounts. Eliot may have been aware of Goethe's reflection on the Medusa Rondanini in his *Italian Journey* (April 1788) as "...a wonderful work expressing the conflict between death and life, grief and sensual pleasure, which, like any other dispute, holds an unutterable fascination for us" (441).

[14] See Wiesenfarth's note on 153.

[15] This usage would change later on in *Daniel Deronda* (1876), in which Eliot reverts to the more familiar female monster-gorgon association with the medusa, as Lydia makes "a Medusa-apparition" before Gwendolyn (456; chapter 48).

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