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In from the Periphery: American Women in Science, 1830–1880

Sally Gregory Kohlstedt

Women engaged in scientific work throughout much of the nineteenth century, but they remained on the periphery of the scientific community. Their efforts to participate in and be recognized by that community were cautious and sometimes circuitous, a product of the social and intellectual climate of the times. Disapproval of women considered “too learned” was only one aspect of Victorian notions about women which inhibited their participation. Socialization as helpmates and lack of independent credibility meant that many women assisted male researchers, and they rarely achieved recognition commensurate with their skills. Moreover, the scientific community itself, in its conscious effort to professionalize, to establish an international reputation, and to raise the status of American science, formed national specialized or honorary associations and established journals that were not receptive to women. As the scientific community became more professional, it limited the acceptance of all who presented themselves or were perceived as amateur-like.¹ Thus, women doing research and writing remained

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1. There is a striking absence of women among the groups of leading scientists identified by publication, society membership, or officeholding prior to 1876. See Sally Gregory Kohlstedt, *The Formation of the American Scientific Community: The American Association for the Advancement of Science, 1848–1860* (Urbana: University of Illinois Press, 1976); Clark Elliott, “The American Scientist, 1800–1863: His Origins, Career, and Interests” (Ph.D. diss., Case Western Reserve University, 1970); and Robert V. Bruce, “A Statistical Profile of American Scientists, 1848–1876,” in *Nineteenth-Century American Science: A Reappraisal*, ed. George Daniels (Evanston, Ill.: Northwestern University, 1972).

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largely invisible. Indeed, standard accounts of American science have tended to miss the individual women who pursued scientific study throughout much of the nineteenth century.² During the period from 1800 to 1864 a substantial number of women produced textbooks and illustrations in science, yet a standard index like the Royal Society's catalog of scientific papers identifies only three American women writers in those years and five more from 1865 to 1874. The increase thereafter was dramatic: from 1874 to 1883 there were 36 women and from 1884 to 1900 there were about 400 women publishing articles.³ Both the nature of women's efforts in science and the expansion of visible participation need to be examined.

For purpose of analysis, the women scientists from the 1830s through the 1880s who are the subject of this study will be loosely divided into three generations. The first group, the "independents," active through the early decades of the century, are characterized by their individual, unselfconscious, and largely unrecognized efforts. The second generation of mid-nineteenth-century American women remained within their prescribed sphere, working primarily as educators and popularizers (illustrators and disseminators of science). Their successors and students in the third generation were forced to choose between amateur, local club activity and a more rigorous career within the emerging professional modes of post-Civil War America. Regardless of the choices, this third generation formed study or research groups which reinforced their conviction that scientific investigation was appropriate for women. Familiar with women's rights literature, they were the first to challenge stereotypes and worked toward full opportunity for women in science. An increase in relative numbers of women in science and a growing spirit of camaraderie created a positive environment for those who finally found full-time employment and were accepted as professionals in the 1880s. Although individual examples of these three loosely defined styles—independents, disseminators, and group coordinators—can be found throughout the period under investigation, the descriptive categories do provide a way to distinguish the status and activity of women scientists during the critical period of professionalization in American science.

2. See, however, Margaret Rossiter, "Women Scientists in America before 1920," *American Scientist* 62 (May-June 1974): 312-23. For the earlier period, see Joan Hoff Wilson, "Dancing Dogs of the Colonial Period: Women Scientists," *Early American Literature* 7 (Winter 1973): 225-35.

3. These data were provided by Clark Elliott of Harvard University Archives from the Royal Society of London, *Catalogue of Scientific Papers*, 6 vols. (London: C. J. Clay, 1867). Because of problems with non-sex-typed names and initials, this number may not be fully accurate, but the relative increase in involvement throughout the century cannot be accounted for simply by the increasing number of scientific periodicals.

Independent Correspondents

Women interested in science were inconspicuous and unchallenged during the early decades of the nineteenth century because, among other reasons, they worked as independent investigators apparently asking for and receiving no public recognition. There were relatively more women in natural history and agriculture than in the physical sciences, a fact that applied to men as well. Many of them were drawn by the Romantic movement to a sentimental, even religious attachment to the "beauties of nature." Jane Colden provides the earliest example of an independent researcher. She learned botany with her father on their New York estate (since he approved such constructive use of idle time) and eventually corresponded with leading European and colonial botanists. Following the Linneanean system she prepared a "Flora of New York" containing 340 illustrations, a study in the best eighteenth-century tradition which not only described the plants but also reported on their medicinal qualities. Other colonial naturalists, especially John Bartram near Philadelphia and Alexander Garden of South Carolina, encouraged her to gather and identify local New York plants. Typically cited as "Colden's daughter," her own contribution was eventually recognized and she published (in her own name) a brief plant description in an Edinburgh journal. She remained, however, at the outer rim of the natural history circle.⁴

This pattern of private and relatively isolated study, in which women relied almost exclusively on informal ways of learning and exchanging scientific information, remained until well into the nineteenth century.⁵ After 1810 some academies for girls had more "modern" curricula, with science and contemporary literature, than did those for boys, but the content was rudimentary.⁶ Most often, individual study, interested family members, local lectures, lyceum series, and, later, women's

4. Raymond P. Stearns, *Science in the British Colonies of North America* (Urbana: University of Illinois Press, 1971), pp. 566–67; and Anna Murray Vail, "Jane Colden, an Early New York Botanist," *Contributions from the New York Botanical Garden*, no. 88 (1907), pp. 21–34.

5. Max Meisel, *A Bibliography of American Natural History: The Pioneer Century, 1769–1865*, 3 vols. (New York: Hafner Publishing Co., 1926), 2:114–15, 274.

6. James A. Mulhern (*A History of Secondary Education in Pennsylvania* [Philadelphia: Science Press, 1933]) argues that the sciences, especially natural philosophy, botany, and natural history, were fairly common in women's seminaries by 1829. Also see Willystine Goodsell, ed., *Pioneers of Women's Education in the United States: Emma Willard, Catharine Beecher, and Mary Lyon* (New York: McGraw-Hill Publishing Co., 1931), pp. 87–88. Keith Melder ("Masks of Oppression: The Female Seminary Movement in the Central States," *New York History* 55 [July 1974]: 261–79) stresses the negative side of this alternative education.

clubs provided an introduction to the natural sciences.⁷ Inevitably, the women in science came from the upper educated classes and showed most interest in research when they had fewest family responsibilities.

A number of women maintained herbaria or small collections. As the correspondence files of leading botanists like Asa Gray in Cambridge, John Torrey in New York, and William Darlington in Philadelphia confirm, the women's letters deal with exchange of specimens more often than with theoretical or analytical matters. The Darlington manuscripts provide an especially useful view of this informal activity because there are nearly two volumes of letters from women (bound separately!) primarily from the 1840s and 1850s. As early as 1829 Sarah W. Leaton of Washington, D.C., initiated correspondence with Darlington and offered to send rare specimens and thus "solicit a niche in your Temple of Fame by becoming a contributor."⁸ Although modest about her ability as a naturalist, Leaton was able to identify plants from her conservatory and to solicit unusual specimens from traveling diplomats for Darlington. In subsequent decades, the number of women writing to Darlington who either were only casually interested in science or pursued systematic study increased rapidly. They sought and apparently received specific help from him (specimens, books, and identification of rare or difficult plants), as well as a certain validation of their interest. Darlington became the center of a network created by women who "shared" him with friends. While many of the women were isolated and dependent on this correspondence, some were teachers, like Abigail Kimber, Martha Beach, Mary P. Thomas, and Emma Musser, who asked for help in choosing textbooks and in arranging plants for educational purposes. Still others belonged to informal groups which aimed to learn "that science [botany] peculiarly appropriate to gentle minds";⁹ among the most active was the Female Botanical Society of Wilmington, to which Darlington gave an informal presentation.¹⁰ In their letters, the authors were deferential toward Dr. Darlington and eager to exchange services with him by sending local specimens. They frequently referred to the beauty and inspiration they found in studying the natural world, but some showed unease about their lack of expertise, which they attributed to their inadequate education. Although single women seemed the most active, they joined their married sisters in identifying family responsibilities as a major distraction and a drain on time and energy. Eliza

7. As early as 1800 Dr. John Vaughan gave a lecture in Delaware to a "mixed" audience of men and women and dedicated his published version to "The Female Enquirers of Wilmington." Murphy Smith of the American Philosophical Society Library kindly brought this pamphlet to my attention: *Valedictory Lecture Delivered before the Philosophical Society of Delaware* (Wilmington, Del.: Franklin Press, 1800).

8. Leaton to Darlington, December 7, 1828. William Darlington manuscripts, New York Historical Society Library (hereafter cited as Darlington).

9. Sarah Ann Fell to Darlington, May 7, 1944, Darlington.

10. Letter and report from Mary M'Caulley to Darlington, February 16, 1846, Darlington.

Fell, who corresponded with Darlington from 1848 to 1856, pointed out, "As is often the case of single ladies, who can and want to be useful, I am prone to be ready at the beck and call of many to serve them, thereby I sometimes find I have allowed an unnecessary infringement upon my time and pleasure [in botany]." ¹¹ Intellectual activity was considered a luxury.

The Morris sisters—Margaretta Hare Morris and Elizabeth Morris—demonstrate the possibilities for women in the early national period and the obstacles they faced. Elizabeth Morris was the more frequent correspondent of Darlington and, through him, met Asa Gray at Harvard. ¹² She was eager to make some contribution and offered to prepare sketches for his publications, noting that Thomas Nuttall had praised her work as attractive and "botanically correct"; she also completed at least one set of woodcuts for Darlington. But as she recorded in November of 1845, her study, too, came second to other demands: "All out of doors looks wintry and dreary, and in the house *woman's work* must continue for some time to engross every faculty so completely, that it will be more by good luck than good arrangement if I lose not the little brains I have, and degenerate into a complete household drudge." ¹³ Her younger sister Margaretta Morris was educated in local schools in Germantown and attended scientific lecture series, including those by Charles John Wister on geology and mineralogy; but she concentrated her own research efforts on entomology, raised insects for study, and worked out the life cycles of several destructive species such as the locust and the so-called Hessian fly. Her results on the fly were presented to the American Philosophical Society (APS) in 1840 (through the "courtesy of a member"), and her observations on the locust were read before the American Association for the Advancement of Science in 1850. ¹⁴ After years of unaffiliated status, she was made an honorary (or corresponding) member of the APS as well as of the Academy of Natural Science in Philadelphia, the Boston Society of Natural History, and the New York State Agricultural Society. These associations served as a stimulus to her work and correspondence. In 1853, when she gave Darlington permission to publish her results, Margaretta Morris noted, "I have arrived at that time of life where *fastidiousness* appears wrong when *good may* be

11. Fell to Darlington, November 12, 1854, Darlington. Fell's correspondence became more frequent after a visit to Darlington's herbarium and library in 1851. She often noted that her study of botany was a "solace" to her otherwise busy and sometimes unhappy life.

12. Elizabeth Morris's propriety nearly prevented the correspondence: "Highly as I should prize a botanical correspondence with Dr. Gray I really want courage to obstruce [*sic*] myself upon his notice by opening a communication with a perfect stranger!" (Morris to Darlington, November 15, 1846, Darlington). The problem was resolved when Darlington sent seeds with her name to Gray, who then wrote first to her. See letters of December 12, 1842 and March 18, 1843, Darlington.

13. Elizabeth Morris to Darlington, November 3, 1845, Darlington.

14. Similar entomological work was done by Charlotte DeBernier Scarbrough Taylor of Georgia and published in *Harpers New Monthly* in the 1850s; see *Dictionary of American Biography*, s.v. "Taylor, Charlotte DeBernier."

done so I often shock the more sensitive feelings of those who have not been so much accustomed [to women in science]" and gave Darlington permission to publish her results.¹⁵

Morris's expanding aspirations suggested that self-confidence and better education would create new patterns for the younger generation of women. Private study and romantic notions about natural history were not sufficient for women as they made contact with men of achievement and the environment of research.

Teachers and Illustrators

The popularization of natural history in the 1820s and 1830s served to spur women's interest. Lyceum lectures (given by men, since only "radicals" like Fanny Wright dared to speak before a mixed audience) were open to women attending with friends or family.¹⁶ Increased education, private and public, gave women further opportunity to learn and to teach. Indeed, as women organized secondary schools for young women and found few materials appropriate to their students, they produced general descriptive textbooks and classroom maps and charts. Although some published aids were based on traditional texts and explained facts that were well established, others attempted to add new descriptions or to organize their books in a format appropriate for classroom teaching.¹⁷ Several early proponents of science education for women—Mary Lyons, Emma Hart Willard, and Almira Hart Lincoln

15. Margaretta Morris to Darlington, February 3, 1853, Darlington. Margaretta Morris published five articles prior to 1863. Her sister Elizabeth apparently wrote a review of Darlington's *Agricultural Botany* for the *American Agriculturalist* but she urged, with bold underline, that "my name must not be known as the author" (Morris to Darlington, December 3, 1848, Darlington). Women may have been among the "anonymous" authors on scientific matters in popular journals. E.g., Darlington's friend, Isabella Ratchelder, admitted (in a letter dated January 5, 1850 [Darlington]) that she was the reviewer of his *Memorial of John Bartram and Humphrey Marshall* in the *North American Review* 70 (January 1850): 210–25. Some geneological details on the Morris sisters are in Robert C. Moon, *The Morris Family of Philadelphia*, 5 vols. (Philadelphia: R. C. Moon, 1898–1909), 2:581–83.

16. E.g., Benjamin Tucker, a teacher at the Young Ladies Academy of Philadelphia, offered a lecture series in chemistry for women and their families which was apparently renewed in subsequent years. See Wyndham Miles, "Public Lectures on Chemistry in the United States," *Ambix* 15 (October 1968): 136–37.

17. The titles suggest the educational intention of most of these textbook authors: James Rennie and Arabella Clark, *Alphabet of Botany for the Use of Beginners* (New York: P. Hill, 1833); Mary A. Holley, *Texas: Observations: Historical, Geographical and Descriptive* (Baltimore: Armstrong & Plaskitt, 1833); Lucy Hooper, ed., *The Lady's Book of Flowers and Poetry* (New York: Claxton, Remsec, & Haffelfinger, 1843); Laura Johnson and Amos Eaton, *Botanical Teacher for North America* (Albany, N.Y.: Oliver Steele, 1843); Louisa Johnson, *Every Lady Her Own Flower Garden* (Charleston, S.C.: S. Babcock & Co., 1842); Jane Kilby Welsh, *Familiar Lessons in Mineralogy and Geology* (Hallowell, Me., 1832–33); Mary Swift, *First Lessons in Natural Philosophy for Children* (Hartford, Conn.: W. J. Hamersley, 1955).

Phelps—were friends of Amos Eaton. Eaton had offered natural science courses in Connecticut and in the Albany area, organized popular education at the Troy Lyceum, and subsequently became a special instructor at Emma Willard's seminary. A letter of support in 1817 noted: "As his first class consists chiefly of ladies, and as these branches of learning have not hitherto generally engaged the attention of that sex . . . from this experience we feel authorized to recommend these branches as a very useful part of female education."¹⁸ Since Eaton believed that more science generally should be taught in the schools he encouraged his students to teach rather than do research. His most famous pupil was Almira Hart Lincoln Phelps, who gained a scientific background from the lyceum lectures on science at Brattleboro, Vermont, and the open lectures at the Rensselaer technical institute. Her first textbook, *Familiar Lectures on Botany* (1829), was enormously successful; it went through seventeen editions by 1842 and had sold 275,000 copies by 1872. A review in the leading scientific journal, edited by Benjamin Silliman of Yale, was positive, if patronizing: "The intention of the work is expressed in the title page . . . and it cannot fail of answering the principle intention of its amiable authoress, of engaging persons of her own sex in a study eminently calculated to interest and instruct them."¹⁹ Phelps's textbook, which included history, poetry, and bibliographical sketches along with the descriptions of specific specimens, was a teaching tool, an "aid to inductive reasoning" intended to show the natural order of the physical world without being too technical. Although she became one of the first women members of the American Association for the Advancement of Science, she remained primarily a teacher. Explaining her lack of scientific work, she wrote somewhat apologetically to Darlington, "My pages at present are the hearts and minds of the young."²⁰ A pioneer in the education of women in the sciences, Phelps was, however, also a product of her own time, who sought not to change women's role by the study of science but to enrich its content. She wished to educate "good women rather than fine ladies" and believed that a lively intellect contributed to a full, happy life.²¹ Her aspirations and limitations are

18. "To Whom It May Concern," Northampton, November 24, 1817, Smallwood Collection, Bird Library, Syracuse University (hereafter cited as Smallwood). Signatories were Josiah Dwight, Caleb Strong, Solomon Williams, Elyah H. Mills, Eben Hunt, and David Hunt. William Smallwood, "Amos Eaton, Naturalist," *New York History* 18 (April 1937): 167-88; and with Mable Smallwood, *Natural History and the American Mind* (New York: Columbia University Press, 1935).

19. Quoted in Emma Lycia Bolzau, "Almira Hart Lincoln Phelps: Her Life and Work" (Ph.D. diss., University of Pennsylvania, 1936), p. 261.

20. Phelps to Darlington, May 1844 and November 14, 1859, Darlington.

21. Goodsell, *Pioneers of Women's Education* (n. 6 above), pp. 561-62. Phelps's sister, Emma Hart Willard, argued: "Natural Philosophy has not often been taught to our sex. Yet why should we be kept in ignorance of the great machinery of nature, and left to the vulgar notion, that nothing is curious but what deviates from her common course? If mothers were acquainted with this science, they would communicate very many of its principles to their children in early youth."

revealed in a letter to Eaton, her mentor: "... I am afraid you will be severe with me about this book—you were never much in favor of my attempting any thing of the kind; but you know I have long thought that I might do a little towards rendering the sciences more popular among my own sex—I make no pretense at being a *geologist* myself; but I love the science, and want others to do the same."²² Her concern about the quality of her work is a persistent theme of her letters: "I hope you will find in it [the newest textbook] no gross errors, as I have endeavored to keep under the shadow of good authorities."²³ The textbooks she wrote were built on the work of others and stressed the enjoyment and relevance of science. Her chemistry textbook, for example, showed the uses of that science in housewifery. It must also be noted that, while the young women's seminaries in West Chester, Pennsylvania, and in Ellicott's Mills outside Baltimore, which Philips headed, offered a stronger science curriculum than most schools, many women's institutions by the 1850s included some scientific study.²⁴

The debate on the appropriateness of science to women, even teachers, was far from settled. By 1825, New York's state-sponsored *New York Teacher* and the *American Institute of Instruction* encouraged more general education for women in the natural sciences.²⁵ Still skeptical, the governor of New York wrote more than a decade later that women teachers had "a quality for excellence in all departments of learning except perhaps the physical sciences."²⁶ Echoing Phelps's position, Dr. Raymond, founding president of Vassar, supported science education for women with the following rationale: "Physiology, chemistry, physics, and the various branches of natural history—have all of them a womanly side, and may be taught throughout, with reference to practical application, in women's acknowledged domain."²⁷ Even as the debate concerning the appropriateness of science for women took shape, secondary educational training and practical experience permitted the entry of an increasing number of women to science. The discussion of women's roles and of the dedication of women science teachers helped the next generation realize that they had choices beyond private employment by friends or elementary teaching.

Sometimes equipped by seminary training and inevitably socialized as helpmates, a number of nineteenth-century women also worked as

22. Phelps to Eaton, June 21, 1838, Smallwood.

23. Ibid.; also see Phelps to Darlington, July 18, 1838 and March 20, 1852, Darlington.

24. Bolzau, pp. 98–99 and 271–72; Thomas Woody, *A History of Women's Education in the United States*, 2 vols. (New York, 1929), 1:474–80.

25. See, e.g., *American Institute of Instruction, Annual Meeting*, no. 2 (1831), pp. 29–32.

26. Quoted in Paul Monroe, *Founding of the American Public School*, 2 vols. (New York: Macmillan Co., 1940), 1:486.

27. James Orton, ed., *The Liberal Education of Women: The Demand and the Method, Current Thoughts in America and England* (New York: A. S. Barnes & Co., 1973), p. 35.

scientific illustrators or collaborators with relatives or friends. A teacher, Lucy Say, developed an active interest in conchology and assisted her husband's research in New Harmony, Indiana, by "making drawings for the plates and supervising and helping in the coloration."²⁸ Orra White Hitchcock and Sarah Aiken Hall, although seldom mentioned in histories of American science, also worked creatively as illustrators with their established, professionally recognized husbands.²⁹ Credit was typically given to the employed member of such a team, but more research in the family papers of scientists is needed to reveal the nature and extent of such coordinate production. Helen Lawson, who was introduced to the world of science by her father, an engraver, learned sufficient natural history to illustrate publications by well-known naturalists, including Samuel S. Haldeman and Amos Binney. Such activities aroused little attention in the 1830s and 1840s because the work was completed privately and in ways deemed appropriate for women.

The Third Generation: Private Study or Professionalism

If the mid-century illustrators and textbook writers attracted little attention, Maria Mitchell's discovery of a comet in 1847 was widely acclaimed as proof of the capabilities of woman scientists.³⁰ After receiving an award from the King of Denmark, she became the first female member of the American Academy of Arts and Sciences. Feminists noted her achievement: she was acclaimed by Lucretia Mott at the Seneca Falls Convention in 1848 and discussed by the editor of *Godey's Ladies Book*. Mitchell was cautious about what she said and did concerning women in science during the 1850s but became increasingly aware of the uniqueness of her opportunities and the problems faced by aspiring women scientists. Born a generation after Phelps, Mitchell would even-

28. Harry Weiss and Grace Ziegler, *Thomas Say, Early American Naturalist* (Springfield, Ill.: Charles C. Thomas, 1931), pp. 213–20. Lucy Say drew sixty-six of the sixty-eight plates for her husband's book on conchology; five drawings are at the Houghton Library, Harvard. After his death, she continued writing to D. Humphreys Storer, Thaddeus W. Harris, and Samuel S. Haldeman and became a corresponding member of the Academy of Natural Sciences of Philadelphia.

29. Hitchcock is mentioned in the sketch of her husband, *Dictionary of Scientific Biography*, s.v. "Hitchcock, Edward," and some of her work is at the Amherst College Archives. Also see John M. Clarke, *James Hall of Albany, Geologist and Paleontologist, 1811–1898*, 2d ed. (Albany, N.Y., 1923), p. 180. Although Lucy Bakewell Audubon has also been credited with illustrations, Alice Ford's *John James Audubon* (Norman: University of Oklahoma Press, 1964) suggests that the plates were done by her husband (p. 245). Ford elaborates on Maria Martin's contribution to the work of John Bachman. Also see Andrew Rodgers III, ("Noble Fellow" William Sullivant [New York: G. P. Putnam's Sons, 1940]) on the role of Eliza Sullivant.

30. Sally Gregory Kohlstedt, "Maria Mitchell and the Advancement of Women in Science," *New England Quarterly* 51 (March 1978): 39–63.

tually lead a movement to help women enter regular scientific occupations.

Educated into the "cult of true womanhood," most women were taught that intellectual achievement for its own sake was not a virtue. Commenting favorably on Mary Treat, a popular botanist, a contemporary male noted with approval that she had a "modesty so shrinking as to make any public recognition of her services painful to her."³¹ Even more, the female intellectual was regarded as a decided oddity. One editor suggested that if an educated woman was a curiosity, a woman scientist was nothing less than peculiar; thus, if "an unfortunate female should happen to possess a lurking fondness for any special scientific pursuit she is careful (if of any social position) to hide it as she would some deformity."³² If interest in science appeared inappropriate, achievement seemed impossible. Experts on human species used arguments from Darwin and Francis Galton to assert that in evolution woman had been "the loser in the intellectual race as regards acquisition, origination and judgment."³³ Faced by these pervasive stereotypes, many women continued to be amateurs when given a choice between private study or professional participation. Of course, participation at meetings, presentation of research papers, and public visibility, increasingly important professional activities, seemed a violation of established social norms. At best, some male scientists in the nineteenth century supported women in adjunct roles. Prominent scientific educators like Eaton in the 1830s, Louis Agassiz in the 1860s and 1870s, and David Starr Jordan in the 1880s encouraged women to be teachers and assistants, but not peers. Discussion about the level of female participation increased, however, as women became more visible and articulate. During the 1850s, the American Association for the Advancement of Science (AAAS), the major forum for science, heard occasionally sarcastic discussions about whether or not women should attend meetings or become members, even though Mitchell's membership in the AAAS made the general question irrelevant.³⁴ It is not surprising that no woman presented a paper on her own work at annual meetings in the pre-Civil War period. The public, however, appeared more receptive to women scientists than the professional scientific community. The popular *Scientific American*,

31. John W. Harshberger, *The Botanists of Philadelphia and Their Work* (Philadelphia: T. C. Davis & Son, 1899), p. 300. Treat was active as a researcher. See, e.g., her letters to Samuel H. Scudder, December 18, 1876, August 28, 1877, and January 8, 1878. Scudder manuscripts, Museum of Science, Boston, Massachusetts.

32. Quoted in Helen Wright, *Sweeper in the Sky: The Life of Maria Mitchell, First Woman Astronomer in America* (New York: E. P. Dutton & Co., 1966), p. 140. Also see Barbara Welter, "Anti-Intellectualism and the American Women: 1800-1860," *Mid-America* 48 (October 1960): 258-72.

33. George J. Romanes, "Mental Differences in Men and Women," *Popular Science Monthly* 31 (July 1887): 383-401, quotation from p. 385; J. Stall Patterson, "Women and Science" *The Radical* 7 (March 1870): 169-85 and (April 1870): 287-300.

34. Kohlstedt, *The Formation of the American Scientific Community* (n. 1 above), p. 103.

which was read by women, pointed to the specific achievements of women like Mitchell and suggested in editorials women's potential for science and invention.³⁵ And when Edward Fisk Youmans founded the *Popular Science Monthly* in 1872 he made the magazine a forum for discussion of women's roles, perhaps influenced by his sister Eliza's own efforts in science.

The ongoing interest and achievement of women in science was undeniable. By the 1850s women like Elizabeth Agassiz were not only assisting their husbands but also writing their own texts (although her *First Lesson in Natural History* was published under a pseudonym in 1859).³⁶ Some women were working as curators and librarians in all-male natural history societies. Cautiously, women were expanding their activities, testing alternative roles, and enjoying new challenges. The discussion did signal the need for women to move to one side or the other of a widening chasm between those who were avocationally involved and those who were engaged in scientific research.

Private Study and Avocation

The organization of small, local, scientific study groups paralleled the general women's club movement across the country and the cooperative tendencies among women in religious and reform efforts. The Dana Society of Natural History of the Albany Female Academy was only one of several such clubs founded in the 1860s under the encouragement of Adrian J. Ebell, professor at Rensselaer Polytechnic Institute. Taken over by local women in Albany, the club's stated purpose was "to awaken in ourselves and in others a growing interest in the study of nature, and increase our knowledge of the natural sciences in both their practical and scientific bearings."³⁷ Since it reflected an older approach and an alternative to the modern demands of professional science, one member could acknowledge without regret: "We do not claim to have made any original discoveries, nor added to the store of scientific knowledge."³⁸ Rather, the society stressed self-development by maintaining a small

35. Deborah J. Warner, "Scientific American and Women's Rights, 1845-1870." Available from the author, Smithsonian Institution, Washington, D.C.

36. Elizabeth Agassiz was undoubtedly an important force in the subsequent movement for women in science. She published books and pamphlets on science, helped establish a summer school in natural history, became prime mover for the "Harvard Annex," and was first president of Radcliffe College.

37. Janet McNaughton, "A Sketch of the Dana Natural History Society," *Albany Argus* (November 18, 1876); manuscripts are deposited at the Albany Institute and Historical and Arts Society. Also see James M. Hobbins, "The Albany Institute and Vicissitude in the Learned Culture" (paper presented at a symposium of the American Academy of Arts and Sciences, June 1975).

38. McNaughton. Membership varied from thirty to 100 members, although attendance at monthly meetings usually numbered twenty persons.

library and cabinet of specimens and taking numerous summer excursions led by state science employees, including paleontologist James Hall. Similar private and group study was encouraged in the 1880s by the Chatauqua Library and Scientific Circle, whose large membership was dominated by women, and the Society for the Encouragement of Study at Home, which operated out of Boston.³⁹ Some of these local scientific societies provided an alternative to closed men's groups such as the Botanical Society of Pennsylvania, whose counterpart became the female Philadelphia Botanical Club. Educated, active, but dedicated first to private study and socializing, the members of these societies had little contact with practicing research scientists. A few groups, however, like the Syracuse Botanical Club, undertook publication of local guides to flora and fauna and maintained limited correspondence with scientists describing specimens not previously known to be in their vicinity.⁴⁰ Many became involved with animal and land conservation at the end of the century, supporting local parks and zoos. Their efforts also supported the "nature study" movement of Anna Botsford Comstock, which coordinated teachers and community leaders in out-of-door education.⁴¹ Whether the societies assisted other women who sought to do research or gain advanced training remains unclear.

The Professional Alternative

After the Civil War several women reformers and teachers encouraged their best students to pursue employment in science and tried to persuade the scientific community to grant them access. Their efforts were underscored by a number of articles and books. Caroline H. Dall's published lectures on women's education, legal status, and career opportunities were among the first to point out the lack of real employment

39. Charles R. Kniker ("The Chatauqua Literary and Scientific Circle, 1876-1914" [Ph.D. diss., Columbia University, 1969]) suggests that, of the 500,000 members enrolled between 1878 and 1914, approximately two-thirds were women. The *Chautauquan* occasionally published articles on women in science, including Esther Singleton, "Women as Astronomers" 14 (November 1891): 209-12 and (December 1891): 340-42, and Katherine Lee Bates, "Woman as Scholar" 13 (April 1891): 77-79. Science was one of the major component areas of the home study movement, from the 1870s into the 1890s; see Madame Marie Theresa Blanc, *The Condition of Women in the United States A Traveler's Notes*, trans. Abby Langton Alger (Boston: Roberts Brothers, 1895), pp. 115-122.

40. See the folder of undated clippings at the Onondaga Historical Society, Syracuse, New York.

41. Material on this movement is in the Comstock manuscripts at Cornell University Archives. Lydia E. Becker, "On the Study of Science by Women," *Contemporary Review* 10 (April 1869): 386-404; Frances Emily White, "Woman's Place in Nature," *Popular Science Monthly* 6 (January 1875): 292-301; Department of Public Instruction of the State of New York, *Annual Report*, no. 8 (Albany, 1862).

opportunities for women in science.⁴² Even more direct was an article by the English feminist, Lydia Becker, who rejected the idea that there were relatively few women in science because "of a natural distaste or capacity for scientific pursuits among women." Becker argued, to the contrary, that society denied women access to scientific learning and discredited their interest, a particularly unfortunate tendency since science stressed structured, systematic approaches to problem solving which women might not otherwise learn.⁴³ Debate on this issue became an ongoing feature of the new *Popular Science Monthly*, and the discussion was vigorously pursued by the Association for the Advancement of Women.

In some cases, the initiative for educating women in science came from women's reform groups. The philanthropic New England Women's Club, for example, established a horticultural school in 1870. Led by Ednah Dow Cheney, the school was intended to train women in the theory and practice of agriculture in the hope that some graduates would become teachers, while others would simply increase their "taste for gardening and the care of flowers and fruits."⁴⁴ Plagued by financial and administrative problems, the school's assets were absorbed by the Bussey agricultural school at Harvard, which agreed to admit women.⁴⁵ Similar schools were planned in New York and Chicago, but prospective horticulturists apparently found these schools inadequate, as vocational training and enrollment was not sufficient to sustain the program.

The impetus to provide advanced study of science to women came from individuals as well. Bostonian Lucretia Crocker, whose interest in mathematics and physical science earned her a faculty position first at her own alma mater, West Newton Normal School, then at Antioch College under Horace Mann, and, finally, in the Boston public schools, where she was among the first women elected to the school board, sought ways to improve the education of teachers.⁴⁶ Convinced that most

42. Caroline H. Dall, *Woman: The College, the Market, and the Court, or Woman's Relation to Education, Law, and Labor* (Boston: Lee & Shephard, 1867). Also see the review in *The Radical* 3 (January 1868): 353-64.

43. Janice Law Trecher, "Sex, Science and Education," *American Quarterly* 26 (October 1974): 352-66. American educator Catharine Beecher argued, "Still more unjust is the custom which gives superior advantages to men for the scientific and practical training for a profession by which an honorable independence may be secured and almost none at all are provided for women" (quoted in Kathryn Kish Sklar, *Catharine Beecher: A Study in American Domesticity* [New Haven, Conn.: Yale University Press, 1973], p. 269).

44. The manuscript records of the committee assigned to oversee the horticultural school are in the Social Meetings Record Book, 1869-1871, New England Women's Club manuscripts, Schlesinger Library, Radcliffe.

45. *Ibid.*, October 27, 1871.

46. There is no biography, nor apparently any major manuscript collection, of Crocker. See, however, *Memoirs of Lucretia Crocker and Abby W. May, Prepared for Private Circulation by Ednah Dow Cheney* (Boston, 1893) and "Lucretia Crocker," *Report of the Association for the Advancement of Women, Fifteenth Women's Congress, 1887* (Fall River, Mass.: J. H. Franklin & Co., 1888).

women lacked opportunities to study science, she persuaded Alpheus Hyatt, curator of the Museum of the Boston Society of Natural History, to sponsor evening and Saturday lecture series for the postgraduate education of elementary and secondary teachers.⁴⁷ She also organized the science department of the Society to Encourage Studies at Home and was an active honorary member of an informal science club of local women who sought to do research and to publish.⁴⁸ By the 1870s Louis Agassiz, a prominent zoologist at Harvard, had also accepted a number of young women assistants in his laboratory and pioneered a summer school near Woods Hole which welcomed women. As Joan Burstyn has demonstrated, this school was enormously important to those thirty women who attended in 1873 and 1874.⁴⁹ Most of them returned to teach at colleges and public schools, and their students constituted an important segment of the next generation of zoologists. Similarly, Alpheus Hyatt, a supporter of Crocker's lecture program, determined to use his home at Annisquam as a summer school. While this school was of short duration—partly because of Hyatt's impatience with administration and with the "raw recruits" who took more time than anticipated—his interest led Boston women to establish the Marine Biological Laboratory at Woods Hole.⁵⁰ Several other summer schools, which aimed to supplement the education of the normal schools, were also founded in the 1870s and 1880s.⁵¹

Because these special study groups and summer schools proved insufficient as a career base, it was the women's colleges with women

47. Society sponsorship was nominal; assistant librarian Harriet Biddle took personal responsibility for the circulars and tickets, a number of community women financially underwrote the program, and Crocker herself arranged most of the lectures. For a detailed discussion of the program, see participant Frances Zirngiebel, "Teacher's School for Science," *Popular Science Monthly* 55 (August 1899): 451–65 and (September 1899): 640–52. A typescript summary of Biddle's work from 1885 to 1925 is at the Museum of Comparative Zoology, Harvard University.

48. The club was discussed in a series of letters from Cora Clark to Miss Alexander in the summer of 1882 while Clark was abroad (Alexander manuscripts, Houghton Library, Harvard University). For evidence of Crocker's efforts to assist women applying for positions and seeking society membership, see her notes to Alpheus Hyatt on February 15, 1883, October 21, 1884, and November 3, 1884 in Boston Society of Natural History manuscripts, Boston Museum of Science.

49. Much of this information is derived from a paper by Joan Burstyn and my comment at the Centennial Commemoration of the Founding of the Anderson School of Natural History, August 14, 1973. A revised version of Joan Burstyn's paper was published as "Early Women in Higher Education: The Role of the Anderson School of Natural History," *Journal of Education* 159, no. 3 (August 1977): 50–64.

50. See the Hyatt-Beebe manuscripts, Syracuse University Manuscript and Archives. Parts of the correspondence are reproduced in Ralph W. Dexter, "Views of Alpheus Hyatt's Sea-Side Laboratory and Excerpts from his Expeditionary Correspondence," *The Biologist* 39 (May–September 1956): 5–11.

51. See William A. Smith, *A History of the Summer Session, Cornell University: The First Seventy-five Years, 1862–1966* (private printing, 1974), pp. 1–5.

faculty in the postwar years that offered perhaps the single largest support for women in science. Certain schools took an early lead. Mary Lyon at Mount Holyoke hired naturalist Lydia Marie Shattuck, an expert on the Connecticut Valley region of Massachusetts. She attended Agassiz's Anderson School on Penikese Island in 1873 and made sure that her younger colleague, Cornelia Clapp, had an opportunity to study there as well.⁵² Intrepid women, who went on summer excursions with David Starr Jordan and attended national scientific meetings, Shattuck and Clapp were also dedicated scholars. Although Shattuck never became well known outside Mount Holyoke, Clapp was one of the first scholars at Woods Hole and helped support the Naples Zoological Station.⁵³ No less important, their students maintained an interest in science and, even when they chose religion over science and became foreign missionaries, sent back rare specimens from India and South Africa.⁵⁴ At Vassar, students tended to study astronomy and mathematics, thanks to the influence of Maria Mitchell. Through annual reports before the Association for the Advancement of Women which detailed accomplishments of women in science, Mitchell worked to encourage women to study science or support others pursuing a science career. Teaching was the profession of most college graduates, although some astronomers became members of observatory teams and biologists joined private and governmental laboratories.

As women gained qualifications and confidence, they showed interest in joining the associations dominated by men. With few exceptions, the women admitted through the 1860s were, like Margaretta Hare Morris, only "corresponding members," who were not expected to attend meetings or permitted to vote. In the 1870s and 1880s, women gained nominal membership in such local groups as the New York Lyceum and the Boston Society of Natural History, as well as in the newly established disciplinary societies. By the time women were admitted as members many had already worked as librarians, curators, and assistants. The authors of the Boston Society of Natural History's

52. A lively description of Shattuck and of the Penikese school is found in the typescript of an oral history interview with Clapp conducted by Ann Morgan in 1921. Clapp manuscripts, Williston Library, Mount Holyoke College.

53. Shattuck's letterbook indicates that she actively did local research and corresponded with scientists concerning her findings. Even active women could be overlooked, however. Shattuck attended a chemistry meeting in 1874 but was not officially listed in the minutes of the meeting. Also see S. Jean Crawford, "The Association to Aid Scientific Research by Women," *Science* 126 (July-December 1932): 492-93; and Donna Jeanne Haraway, "The Marine Biological Laboratory at Woods Hole" (paper presented at the Symposium on Learned Societies of the American Academy of Arts and Sciences, June 1975).

54. Clapp's "Report of the Zoological Department" (1875) notes that two students hoped to go into medicine. Letters from missionaries are found in both the Clapp and Shattuck manuscript collections, Williston Library, Mount Holyoke College.

guidebook series for teachers, for example, included Jennie Arms Sheldon, Elizabeth Agassiz, and Ellen Swallow Richards.⁵⁵ These long-sought affiliations were symbolic, but even a cursory look at the record of several such groups indicates that women largely remained adjuncts rather than fully recognized participants.

The hopes and triumphs of women in the 1880s indicate that they were a "first generation" of public achievers. Their success, however, was built on the persistent efforts of women who had worked quietly in science throughout the century, women who both reflected and expanded contemporary expectations. The female illustrators and textbook writers had not challenged the boundaries of women's sphere, but their work refuted glib assertions about women's capability to understand science. Although educators like Phelps had consciously presented science as compatible with the traditional responsibilities of women, they had also provided the requisite learning for the next generation to achieve some public success. The women working on the periphery provided the foundation that helped gain the third generation access to advanced training and scientific associations. Most important, by their own example, the forerunners demonstrated to those who chose to notice the capabilities of women in science, and they established cooperative networks which would be essential for expanding women's opportunities in science.

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55. Sally Gregory Kohlstedt, "The Nineteenth-Century Amateur Tradition: The Case of the Boston Society of Natural History," in *Science and Its Public*, ed. Gerald Holton and William Blanpied (Dordrecht: Reidel Publishing Co., 1976), pp. 183–86.