

Women in Modern Science

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THIS SURVEY ON women in science was inspired by several girls at Cornell University who inquired about choosing science as a career. In planning a college program with the future in mind, these girls and others like them could, perhaps, profit by looking at the lives of women who did plan and did continue to follow their chosen field through a successful life. Some of these women have been able to combine their work with raising children, whereas others without children are either wives as well as career women or have dedicated themselves completely to their careers.

The women who participated in the survey (names found at the end of the paper) were named as outstanding in their fields by their colleagues from universities throughout the country. They are individuals whom their fellow workers considered especially successful. Twenty-one women filled out the required questionnaires, and the compiled results should provide a look into what might lie ahead for girls going into a particular field, in this case, the study of science.

What branches of science did these ladies represent? Eight of them were working with subjects closely related to physics, such as biophysics, radiology, solar energy, astronomy, and physics itself. One woman was a pure mathematician, 6 were chemists, and 5, biologists. Another was a specialist in nutrition.

ENTERING A "MAN'S" FIELD

Before presenting portions of the lives of these women, including the reasons for their choice of a career, the advice that they offer for young girls is worth examining. The most commonly mentioned advice was that it is

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essential for a person entering science as a career to have a strong natural instinct for the subject. A girl going into science "should have a lively curiosity, be skillful in the use of her hands, and be prepared to get them dirty." (*E.H.Q.*) One woman points out that "unremitting attention to the job is essential in scientific work, and it is not worthwhile for any girl to choose this field if her enjoyment of the work is not itself enough reward." (*A.F.M.*) Along similar lines, another individual emphasizes that there should be a quest for knowledge which surpasses all other interests or the person will not succeed. (*R.P.*) On the other hand, someone should "not be persuaded to take up science, for she will be wasting her time and soon quit, having lost considerable time and money." (*M.E.L. McB.*) "Consultation with vocational guidance personnel or with persons who have made a career in science would be helpful. I had little advice or guidance." (*L.K.*)

Several women agreed that one should not have glamorous ideas about the excitement of doing research. Girls must realize that "there is a lot of routine work in any job, though, perhaps, less in science than in some others." (*E.H.Q.*) According to some women, science is a very hard, long road. There is much competition. "One should recognize at the start that many positions and activities are closed to women. . . . [One] must be prepared for a long series of disappointments and discouragements and far more criticism than would fall to a man in a similar situation." (*C.P.G.*) "Accept the fact that prejudice exists without accepting the implication that it cannot be eradicated." (*B.W.L.*) One woman looks at the situation in the following manner: "Girls should understand that the upper ranks in science are likely to be closed to them. For a woman to obtain a tenure position in a good college or university, for example, takes a strong element of luck." (*F.M.*)

To take a more positive point of view, one

THE NAMES OF THE WOMEN, THEIR PLACES OF BIRTH, AND THEIR FIELDS

Tikvah Alper	Capetown, South Africa	Physics
Katharine B. Blodgett	Schenectady, New York	Physics
Cecilia Payne Gaposchkin	Wendover, England	Astrophysics
Icie G. Macy Hoobler	Gallatin, Missouri	Biochemistry
Libbie H. Hyman	Des Moines, Iowa	Zoology
Louise Kelley	Franklin, New Hampshire	Chemistry
Barbara Wharton Low	Lancaster, England	Chemistry
Maria Goeppert Mayer	Germany	Physics
Mary Evelyn Laing McBain	Alcester, England	Chemistry
Florence Moog	Brooklyn, New York	Zoology
Agnes Fay Morgan	Peoria, Illinois	Nutrition
Jane Oppenheimer	U. S. A.	Biology
Ruth Patrick	Topeka, Kansas	Botany
Mary Locke Peterman	Laurium, Michigan	Biochemistry
Edith Hinkley Quimby	Rockford, Illinois	Physics
Mary L. Sherrill	Salisbury, North Carolina	Physics
Charlotte Moore Sitterly	Ercildown, Pennsylvania	Physics
Maria Telkes	Budapest, Hungary	Physics
Anna Pell Wheeler	Howarden, Iowa	Mathematics
Anna Rachel Young Whiting	Saugerties, New York	Genetics
Chien-Shiung Wu	Shanghai, China	Physics

scientist writes that now there are "so many openings that no woman need fear no congenial career will open to her." (*A.P.W.*) Another states that girls shouldn't listen to "foolish comments that science is not a woman's field. There have been and are outstanding women scientists." (*B.W.L.*) "To devote one's life to science is the happiest thing that could happen." (*C.S.W.*) "It's a very satisfying life; continued challenge and the stimulus of teaching cannot be imagined unless experienced." (*M.L.S.*) There is "great joy and satisfaction in a job well done. Be willing to do a bit more than expected to compensate for one's own shortcomings." (*I.M.H.*) "Has no regrets — loved it all" (*C.P.G.*) "Contacts with students, with fellow workers . . . and the joy of discovery have made for a satisfying career." (*A.Y.W.*) In medical science one has "the great satisfaction of being of service to mankind." (*M.L.P.*)

Some of the married women have presented a few ideas on marriage and a career. "Science training is extremely valuable in helping run a home, bringing up children—practical laboratory training is invaluable." (*M.E.L. McB.*) One woman attributes her success to an "understanding husband and good health—a necessity for a woman who wants to combine a career and marriage." She was honest enough to admit that, had she not married, she "wouldn't have had the emotional stability

to carry it off." (*C.P.G.*) Another woman mentions the help of her husband by stating her potential discontent because of having no children was prevented by a renewal of interest in her field of work encouraged by her husband who had been active in the field. She was discouraged by the small number of women listed in the standard compilations of scientists and wrote that she would like to see girls go into scientific work, not as research assistants in order to mark time until marriage but rather with the idea of continuing with it after taking time out for bringing up the children. (*A.Y.W.*)

The purpose of asking these women scientists to offer comments for helping young girls going into science was not to get a detailed description of necessary academic courses. However, since so many women did mention the necessity of having more mathematics, it is of importance to emphasize this fact here. Such statements as the following were given. Mathematics is essential. "Take all the math. possible." (*T.A.*) "Should have taken more math. . . ." (*L.K.*) It is hoped that any girls planning careers in science will benefit from this advice.

WHY A SCIENTIST?

Why did these women decide to become scientists? Eight of them had an early interest

in science and followed a natural bent. Eight were stimulated by an introductory course, indicating the necessity of excellence in freshman science teaching. The remainder were influenced by various factors such as father's opinion (2), departmental encouragement (2), rebellion against parents (1), and the lack of the desire to teach (1).

It has been often said that when women follow a profession they pick one similar to that of their parents. In the present survey this observation does not hold at all. Only 4 women out of the 21 went into a field which was even remotely related to that of their parents. The fathers of the remaining 17 were of a wide variety of professions from farmers to bank managers to architects. None of the mothers of these women were scientists. In fact, only 5 mothers had a job other than that of a housewife. Two of them were teachers, 2 were business women, and 1 was a painter.

Three of the women were only children. As far as brothers and sisters were concerned, no patterns in similar professions were evident. Three out of 20 brothers were scientists and 6, engineers. Of 16 sisters, only 3 held scientific jobs. Nothing significant was indicated as to whether there were brothers or sisters in the family or whether the brothers and sisters were older or younger than the subject of the survey.

After a woman decided to enter science, what were her parents' opinion of her choice? Twelve women stated that their parents' opinion was favorable. The other comments were as follows: "no opinion" (2), "against decision" (1), "free to choose" (4), "preferred something else" (1), "resigned to it" (1). The parents of one woman felt that "brains were not a social asset and should be played down."

Did friends express any opinions on a decision to enter science? Seven women reported that their friends were in favor of the choice. Six had no idea what their friends thought. Others did not comment.

MEANWHILE, BACK ON THE CAMPUS

When the time comes for a girl to pick a university she desires to attend, there are any number of reasons why she chooses one over another. The women who were to become outstanding scientists also had a variety of reasons for their choices. As far as undergraduate work was concerned, the greatest

number (9) chose a school because it was the best in its particular field. The other reasons included the following: convenient location (2), family preference (2), best scholarship (2), purely social reasons (1), and a combination of reasons (3).

For graduate work, as one would expect, most women (15) chose the university offering the best training in their particular field. However, 2 picked their school because of its location, and 1 took advantage of the facilities at her husband's school. Another went because of the opportunities; the 2 remaining ones did not obtain Ph.D. degrees.

After graduating from college with an A.B. degree these women allowed a varied period of time to lapse before obtaining their Ph.D. degrees. The average number of years was 8 (range, 2-14).

The average age of those receiving a bachelor's degree was 21 years (range, 18-24), whereas the average age for those receiving a Ph.D. degree was 28 years (range, 24-35). Six women went to foreign universities for their bachelor's degrees and 5 for Ph.D. degrees. Seven attended universities in the northeastern section of the United States for their bachelor's degrees: These schools included Mt. Holyoke (1), Swarthmore (1), Smith (2), Bryn Mawr (2), and New York University (1). Of the 4 women who attended schools in the middle west, 3 of them went to the University of Chicago and the other one to the University of South Dakota. Two women studied at southern universities, Randolph-Macon Woman's College and Coker College. One was a student at Whitmore College in the northwest. Five women enrolled in northeastern universities to work for their Ph.D. degrees—Columbia (1), Yale (2), Radcliffe (1), and Cornell (1); 6 in middle western schools—University of Chicago (4), University of Wisconsin (1), State University of Iowa (1). Two attended the University of California at Berkeley and 1, the University of Virginia.

About half of the women relied completely upon their families for support during their undergraduate years. One went through college on scholarships alone, and 5 benefited from the combination of scholarships and family aid. Five women held jobs while attending school. Of these 5, 4 also had scholarships and 1 depended upon her family for additional support.

In contrast to the large number who leaned heavily on their families in undergraduate school, only 3 needed to rely completely on their parents for financial support of their graduate work and 1 received assistance from her husband. All of the others obtained teaching or research assistantships, scholarships, or held outside jobs.

Did these women have time for extracurricular activities while in college? During the undergraduate years, over half of them partook in activities; some (3) were extremely active and others (9) moderately so. Four people reported that they had no outside activities at all, whereas the remainder either spent their spare time reading or they did not answer the question. As would be expected, few had time for projects aside from their graduate work. Some (8), however, continued to participate in sports and music and 2 added housekeeping to their duties.

MARRIAGE

Thirteen of the women were married, and 7 of them had children. The women scientists married at an average age of 26 years (range, 23-39). The average age of the husbands at the time of marriage was 32 years (range, 22-47). Six of the women were in a field identical to that of their husband's and 5 followed professions related to their husband's. Only 1 woman was married to a man who was not a scientist or associated with a university. He was a salesman. The average age of the woman scientist at the birth of her first child was 34 years (range, 26-43). Of the male children born to these women all 7 of those 17 years or older indicated science or engineering interests. Neither of the 2 daughters over 20 were working towards careers in science.

DEVELOPMENT OF CAREER

In following the development of the careers the most logical approach appeared to be a separation of the women with children from those without children, as the former interrupted their careers from a few months to several years. Of the 7 women with children, 3 had reached the position of full professor at the time of answering the questionnaire. Two were associate professors, and one was a lecturer. Five were research directors, either as a sole profession or in combination with academic titles.

A summary of the advancement of the women with children is as follows. (The abbreviations used are: R.A., research assistant; R. Assoc., research associate; P.D., post doctorate; In., instructor; L., lecturer; A.P., assistant professor; Assoc. P., associate professor; P., professor; R.D. research director.)

- | | |
|--|---|
| (a) 13 years as R.A.
18 years as In.
1 year as P.
32 years as R.D. | 5 years as A.P. and
L.
(d) 5 years as R.A.
3 years as In.
4 years as A.P.
4 years as Assoc. P.
31 years as P.
39 years as R.D. |
| (b) 2 years as P.D.
3 years as R.A.
several years as
R. Assoc. | (e) early career did
not take place in
U.S.
2 years as In.
4¼ years as L. |
| (c) 2 years as R.A.
8 years as R. Assoc.
2 years in Europe
as In.
3 years in U.S. as
In. | (f) 3 years as R.A.
10 years as R.D. |
| (g) 1 semester as In.
4 years as A.P. ½ time
3 years as Assoc. P.
9 years as P.
11 years as senior scientist
concurrent with P. | |

Thus, it can be said that 2 women with children climbed the academic ladder in a reasonable time and order. One exhibited an extremely unusual pattern of advancement and the others moderately unusual ones.

Now, in contrast, let us look at the manner of advancement of the women without children. Five of the six married women in this group followed what is considered to be a normal rise in academic rank, leaving only one with varied appointments. Three reached the position of full professor, 1 of associate professor, and 1 a research director.

Of the 8 unmarried women, all progressed in the normal fashion—5 in academic work and 3 in research. Similar to the married women, both with and without children, 3 unmarried women reached the position of full professor. At the time of the survey, 2 were associate professors, 1 a research director, and 2 research associates.

The question may arise as to how these women organized their time to carry out such active lives. Since, at the time of the survey, the majority of the women were past the

stage when demands were made upon them by small children, they could work away from home full time. For them 10 hours was the average working day. One woman with young children found she could work away from home in the mornings and evenings. Whether most of the women had children or not the average time spent at household chores was 4 hours each day. Most of the women hired housekeepers to care for the children when they were young. Grandmothers did not play a role in caring for the children while the mother worked as apparently happens in Russia.

The publications by these women ranged considerably. Ten women scientists published between 2 and 25 papers by themselves, 6 published between 25 and 50 papers, and 3 between 100 and 200. As joint authors, 16 published up to 50, 2 between 50 and 100, and 1 between 100 and 200. Thirteen women wrote either parts of, or complete books. The publications in book form ranged from chapters in a book, to 18 or more books and monographs for 1 woman.

CONTRIBUTIONS TO SCIENCE

When asked what they considered to be their greatest single contribution to science some of the women gave the following modest answers. "My work has all been related to medical uses of X-rays, radium, and other radioactive materials. I consider my greatest single contribution the development of methods of accurate determination of the dose of radiation delivered to the specific region under treatment. My charts and tables are very widely used in the U.S. and to a lesser extent in Europe." (E.H.Q.) Another woman commented on her contributions: "teaching young people who have gone on to do graduate work or research or to study medicine . . . editorial work on *Chemical Reviews* and the *Journal of Physical Chemistry* . . . the books I have written either as a joint author or alone." (L.K.) The "discovery of the extent and nature of the changes produced by heating in food proteins" was justly given as a significant contribution. (A.F.M.) One woman mentioned the "studies on cytoplasmic nucleoprotein which plays a fundamental role in protein synthesis." (M.L.P.) A woman who has devoted her life to problems in solar energy "developed solar stills for life rafts during

the war, designed the solar thermoelectric generators, completed the study of solar cooking ovens, and holds several patents on heat storage materials." (T.A.) Another's most worthwhile contribution was the work published in a paper, "Films built by depositing successive monomolecular layers on a solid surface." (K.B.B.) After all of these positive comments on single important contributions, one scientist wrote that "it isn't given to most scientists to do anything that could be justly signified by such a term." (F.M.)

INTERESTS AND HOBBIES

Some of the women answered questions on miscellaneous information such as with what nonscientific organizations were they associated, and how did they spend their vacations? Thirteen women participated in organizations which were nonscientific, and 5 took part in church activities. Their vacation time was predominantly taken up by travel, but 4 of the women worked continuously through vacation periods.

In later years gardening had become the most popular hobby. Many of the women still enjoyed sports. Other outside interests included a variety of things, such as travel, reading, theater, music, art, educational institutions, and foreign languages.

Do women who spend the majority of their time with scientific work have an interest in home entertaining as do most housewives? The greatest number of the women scientists were definite about 2 things—namely, they did not like to prepare dinners for large numbers, and they did like to cook for a few guests. A minority preferred to have large parties in their homes after dinner. A good many enjoyed entertaining a small group of friends after dinner. The point to be made is that scientific women do make time for and do enjoy entertaining in their homes. In fact, 1 woman with 3 children and approximately 200 scientific papers to her credit stated that she should have been a cook!

SUMMARY

Most women who entered science either had an early interest or were stimulated by an introductory course. The women did not

follow in the family footsteps in choosing science as a career. Many of the parents were in favor of the women's choice to enter science.

For graduate training, most women attended that university which they thought offered the best conditions for study in their chosen field. The average age of a woman receiving her bachelor's degree was 21 years and her Ph.D. degree, 28 years. Only half the women depended completely on their parents for financial support in undergraduate school and still fewer in graduate school.

The majority of the married women were in fields either identical or similar to those of their husbands. Women scientists married somewhat later than the average girl. Bearing children did have an influence on the pattern of advancement of a woman's career, but with

time a woman with children could attain the high ranks in her field. Also, women without children did reach top positions in a reasonable time (not unlike the progress made by men). Of the children born to women in the sciences, it can be said that the sons seemed to follow the parent's professions, but the daughters (only 2 examples) did not. Most women hired housekeepers to help care for the children while they worked. The women scientists interviewed had a variety of outside interests, partook in nonscientific organizations, and enjoyed entertaining in the home.

Although science is a difficult field with some prejudices against women, women have found the scientific career to be a fruitful, satisfying way of life and, with careful planning, a career that can successfully include a family.

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