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Status of Women Microbiologists

A study of microbiologists based on objective and subjective criteria is presented.

Eva Ruth Kashket, Mary Louise Robbins, Loretta Leive, and Alice S. Huang

The women's rights movement in American society has manifested itself in the raised aspirations of women in most academic and professional fields. For this reason, a study of women microbiologists was made by some members of the American Society for Microbiology (ASM) under the auspices of that society's Committee on the Status of Women Microbiologists. A questionnaire was designed in order, first, to determine the present status of women in the profession and, second, to inquire into the possible reasons for that status. Reported here are some of the most interesting results obtained from that questionnaire, which was distributed to the registrants at the 1971 annual meeting of the ASM (*1*). Also included are data on salaries obtained from the total membership of the society (*2*).

The ASM is a suitable organization for such an inquiry because it is a large professional society encompassing academic, governmental, clinical, and industrial employees. The ASM has an open membership and requires of its members a bachelor's degree in microbiology or a related field or equivalent training and experience. The proportion of women in the society is relatively high, and, therefore, a valid comparison can be made between women microbiologists and their male counterparts.

In this article, we present evidence that the status of women microbiologists is lower than that of men and that the lower status of the women results, to a large degree, from inequality of opportunity throughout their careers. We believe that these findings would also apply to women in other professions (*3*).

Composition of the Sample

The overall educational profile of the respondents to the questionnaire was fairly representative of the ASM membership (Table 1). Women accounted for 29 percent of the respondents, compared to 23 percent of the total membership. In the society, proportionately fewer women than men hold doctoral degrees; women account for 16 percent of the persons with doctorates. Among the respondents, there was a slight overrepresentation of Ph.D.'s, which probably indicates that persons with the higher degree were more likely to attend meetings.

Because marriage and children are considered dominant factors in the career patterns of women, the answers given by the respondents were analyzed not only by sex, but also by marital status (*1*). Women differed significantly from men in marital status: only 44 percent of the women were married, while 90 percent of the men were married. Abut half of the women with doctorates were married, and the same was true for those without the advanced degree. Of the women who were married or who had been married prior to the study, 54 percent had no children, while only 12 percent of the men in a comparable group had no children.

Job Performance

Because there was such a difference between the family responsibilities of the sexes, it was interesting to determine the amount of time that each group spent at work. The respondents were asked to give the total number of hours they work each week, including work at home or in the library and time spent at meetings. Among the full-time employees (more than 95 percent of the respondents in any group, excluding students), there was no differ-

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ence between women and men at the nondoctoral level (Fig. 1). Among persons with a doctorate, women worked a median of 50 to 59 hours per week, whereas the median for men was between 50 to 59 and 60 to 69 hours per week. This difference is only marginally significant ($P = .056$).

When the number of years that respondents in each group have held their present positions is examined, it is clear that there is no difference between the sexes. Women stayed at their jobs as long as men did, and there was no significant difference between the sexes in the number of years at the present position (Fig. 2). The median time at the present job was 2 to 3 years.

Subjective evaluation of job performance was measured by asking the respondents to compare themselves and the frequency with which their work is published to other workers in their area of specialization. Women and men rated themselves equally in the performance of their jobs (Fig. 3) and, likewise, considered themselves to have an equal degree of independence in their professional work (Fig. 4). In comparing their own publication frequency to that of others, men and women rated themselves equally (Fig. 5). To determine whether or not these subjective responses were biased, we compared the answers of those who hold doctorates and those who do not. The latter rated themselves lower than persons with doctorates did (Fig. 5). When asked their motivation for working, both women and men gave multiple and similar reasons, rating economic necessity, self-fulfillment, and professional competence very highly.

From these responses, it can be generally concluded that women work as hard as men, remain at their jobs as long as men do, feel that they publish as much as their male counterparts, and have basically the same motivations for working outside the home as men.

Table 1. Comparison of respondents to the total ASM membership, by highest academic degree.

Degree	Respondents (%)		Total ASM membership (%)*	
	Women ($N = 237$)	Men ($N = 578$)	Women ($N = 3,275$)	Men ($N = 10,858$)
B.A. or B.S.	24	13	30	13
M.A. or M.S.	26	17	29	18
Ph.D. or D.Sc.	46	63	36	55
M.D. or D.V.M.	3	6	3	11
Other†	1	1	2	3
Total	100	100	100	100
Percent of total	29	71	23	77

* Drawn from (2). † Includes persons with no degree.

Discontinuities in Professional Career

Interruption during the childbearing years is considered by many employers to be characteristic of women's professional careers. To assess the extent of interruptions in careers of women mi-

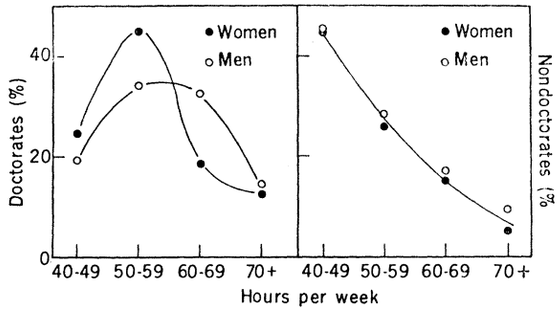
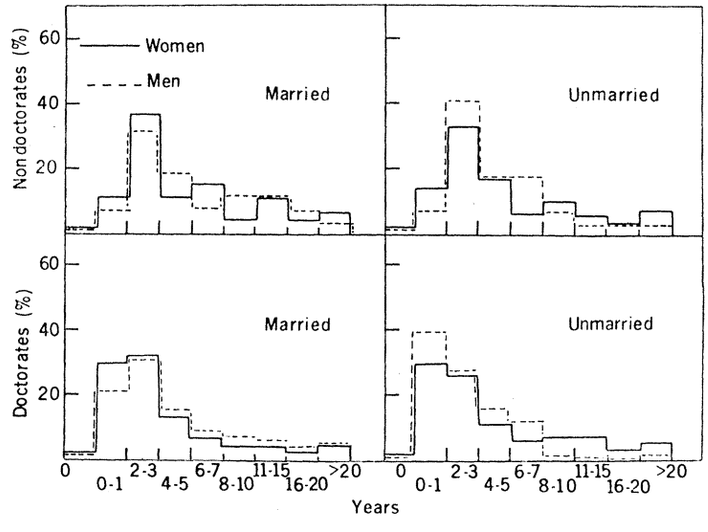


Fig. 1 (left). Working hours per week of full-time employees. Fig. 2 (right). Number of years at present position by sex, degree level, and marital status ("unmarried" includes single, widowed, and divorced).



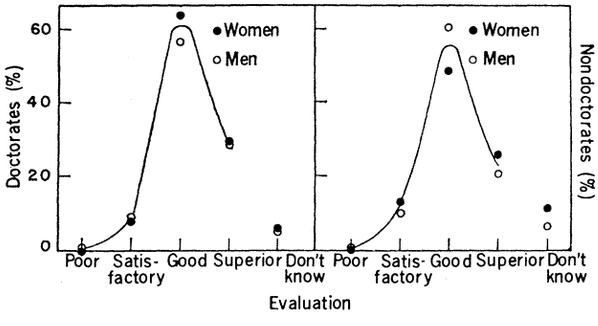


Fig. 3 (left). Self-evaluation of job performance.

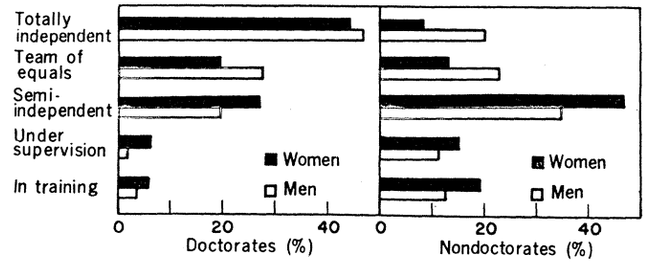


Fig. 4 (right). Degree of independence felt by respondents.

crobiologists, we asked the respondents the amount of time taken off from work, other than vacations. Discontinuities were reported by about 16 percent of each group (women and men), with the exception of married women, 38 percent of whom reported discontinuities. More than half of the discontinuities of married women lasted less than 2 years. These discontinuities occurred as frequently among married women with doctorates as among those without. Unmarried (single, widowed, or divorced) women had fewer discontinuities, equal in number to those of men.

Salary

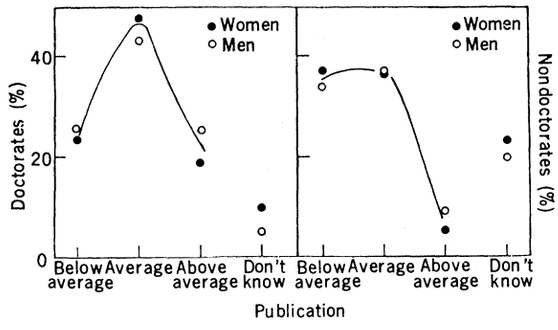
The status of an employee can be determined by many indices, of which salary is the most revealing. All of the following data on salaries are derived from the 1970 annual membership survey (*2*). The median annual salary of all women ($11,400) was lower than that earned by all men ($16,000) (Fig. 6). A salary difference would be expected, since fewer women than men hold the doctoral degree (Table 1); however, women earned less than men at every level (Fig. 6). The differences in salary were 10 percent more for men at the bachelor's level, 15 percent more at the master's level, and 32 percent more at the doctoral level. Additional income, such as consulting fees, was reported by 8 percent of the women and 21 percent of the men, with persons at the doctoral level earning additional money twice as frequently as those without the advanced degree. The median additional annual income of women was $1200, compared to $1900 for men.

A difference in salary between the sexes may be due to differences in rank. Indeed, as we show later, women tend to hold lower ranks than men. When the salaries for the sexes were compared by rank, however, women were seen to earn less than men at every level except the lowest, that of research assistant (Fig. 7). Moreover, the difference in salary increased with rank.

The discrepancy in salary between the sexes may be due to differences in seniority. However, women doctorates earned less than men at every period after graduation, and the difference in salary again increased with seniority (Fig. 8). The same pattern of a lower earning power for women in relation to seniority is observed with individuals at the master's and bachelor's levels (data not shown). Although it has been commonly argued by employers that salary levels are determined partially by need, no differences in salary were detected among the married male doctorates 10 years after receiving their doctorates, whether they had dependent children or not.

When salary levels were analyzed geographically, approximately the same differential between female and male doctorates was obtained in every region (*2*). This finding was also true at the master's and bachelor's levels except in New England, where men at the nondoctoral level earn less than women.

Salary comparisons based on the type of institution that employed microbiolo-



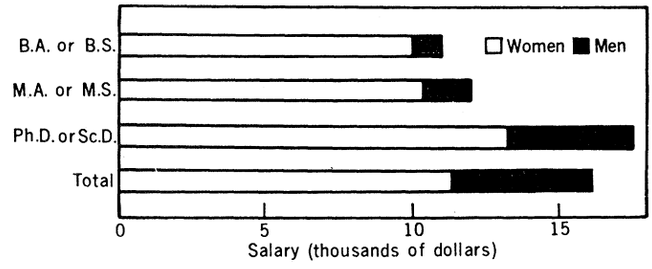
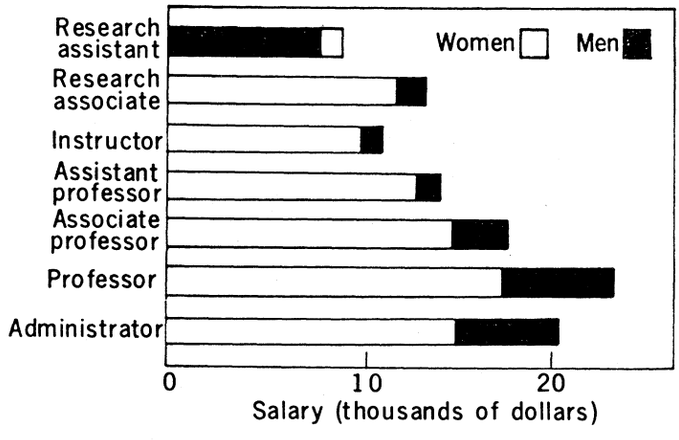


Fig. 5 (left). Frequency of publication, compared to others in the same position and field. Fig. 6 (right). Median annual salary, by sex and degree level.



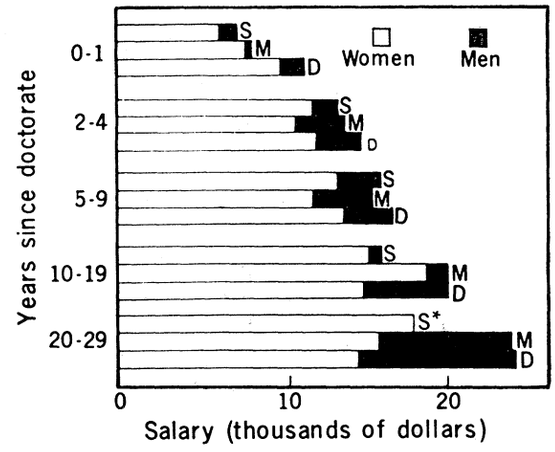


Fig. 7 (left). Median annual salary, by sex and academic rank. Fig. 8 (right). Median annual salary of doctorate holders, by sex and number of years since degree (*S*, single persons; *M*, married without dependents; *D*, married or formerly married with dependents; *, too few single men for analysis).

gists showed that, overall, women were paid 30 percent less than men by educational institutions, government, and private industry. In clinical laboratories the differential was 20 percent (*2*).

Although most of the respondents were paid directly by their institutions, proportionately fewer women (52 percent) than men doctorates (72 percent) were paid directly by their own institutions. There was no significant difference in the source of salaries between the sexes at the various academic ranks. Therefore, the greater reliance by women on "soft money," such as research grants to themselves or their immediate supervisors, probably reflected the greater proportion of women doctorates at the lower academic ranks, particularly that of research associate.

In summary, women microbiologists earn far less than men in every region of the country and at all institutions. The salary difference between the sexes increases with educational level, with rank, and with seniority. All women, married or not, with children or without, appear to be equally penalized. The salary patterns reported above for 1970 are the same for a similar survey conducted among the ASM membership for the year 1971 (*4*).

Employment Status

When the rank of the respondents was examined, women doctorates attained positions lower than those of men, but women without doctorates did not differ from men in their employment status (Table 2). In the academic hierarchy, women respondents were found predominately at the rank of associate professor, with research associates second in frequency. Men were found most frequently at the full professor level, with the associate professor rank next. Thus, women were three times as likely as men to be research associates, but one-third as likely to be full professors. There were no female department heads or academic administrators. In industry, women were one-quarter as likely as men to be found as research professionals. Analysis by marital status showed that single men with doctoral degrees, about 7 percent of male doctorates, held lower positions, along with all women (data not shown).

Another measure of employment status is the length of time it takes a person to reach a given academic rank after receiving the doctorate. Table 3 shows that professional rank was attained by a majority of those women who finally achieved it only 20 years after the doctoral degree, whereas a majority of men achieved this rank between 10 and 19 years after the higher degree.

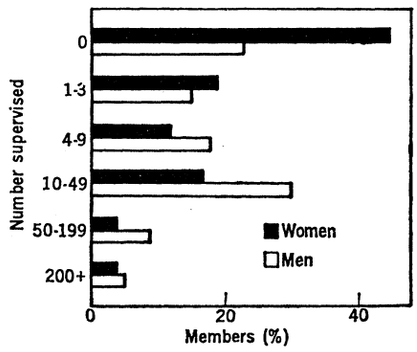


Fig. 9. Number of person-units supervised by doctorates (a person-unit is arbitrarily defined as one professional or three nonprofessional employees supervised).

Supervisory Responsibilities

Another indicator of status is the supervisory responsibility given an employee. From the membership survey it was found that women with doctoral degrees supervised significantly fewer persons than did men with doctorates ($P < .01$) (Fig. 9). At the master's and bachelor's levels, there was no significant difference between the sexes. When the data were analyzed by year since the doctoral degree (not shown), the median number of persons supervised by women was significantly lower than that of men, particularly beyond 20 years after graduation. Women with doctoral degrees did not supervise any more people than women who had stopped below that educational level. As was seen with salary levels, single women or women without dependents were not better off than married women with dependents and, again, single men with doctorates scored almost as low as women.

Extramural Recognition

Still another external standard for status is the frequency with which scientists are invited to participate in extramural events. The respondents were asked to give the number of times in the preceding 2 years they had been invited to lecture or consult outside their institutions, either within the United States or abroad; to write a review, chapter, or book; or to serve on a review panel or editoral board. As expected, persons at the bachelor's or master's levels were invited less frequently than those at the doctoral level. Women doctorates were invited less frequently than men doctorates (Fig. 10). The spread was wider in the least frequent categories (consulting outside the United States and serving on a review panel). These data were further

Table 2. Present position.

Position	Respondents (%)*			
	Doctorates		Nondoctorates	
	Women ($N = 106$)	Men ($N = 385$)	Women ($N = 116$)	Men ($N = 172$)
Student			21	25
Laboratory assistant	0	0	2	1
Laboratory technician	0	0	21	13
Laboratory supervisor	2	4	39	45
Postdoctoral fellow	11	5		
Research associate	19	6		
Instructor	6	2	7	2
Assistant professor	18	14	7	2
Associate professor	23	17	0	3
Professor	6	19	0	1
Department chairman	0	4	1	1
Administrator, academic	0	2	0	1
Research Ph.D. in government or nonprofit institution	5	6		
Research Ph.D. in industry	2	9		
Clinical or nonresearch Ph.D. in nonprofit institution or industry	5	6		
Administrator, nonacademic	2	3	2	4
Unit chief, government	1	3	0	1
Consultant-writer	0	0	0	1
Total	100	100	100	100

* Excluding persons not presently working (2 women, 1 man) and those not answering (13 women, 15 men).

analyzed as a "lectureship index" by arbitrarily assigning one point per event in the two categories that occur most frequently and two points per event in the rarer categories. The average score per individual was 2.7 for both women and men below the doctoral level, irrespective of marital status. At the doctoral level, however, women scored lower than men: single women doctorates, 3.6 points; single men doctorates, 4.1; married women doctorates, 3.5; and married men doctorates, 5.6. These results may well reflect the higher proportion of women in the lower ranks.

Career Guidance

In an effort to measure subtle forms of influence during the training period, we asked for the respondents' subjective responses. One facet of education is the influence of teachers and other successful scientists on the molding of careers. Because university faculties are overwhelmingly male, we were interested in determining whether respondents felt they had received adequate professional guidance during their training. Figure 11 shows that persons who went on for a doctorate perceived less discouragement than those who did not. Women doctorates perceived more discouraging advice than did men doctorates ($P < .01$). At the bachelor's and master's levels, however, the opposite occurred, as more men felt discouraging guidance than women ($P < .05$). When marital status was considered, the greatest difference was between married women and married men at the doctoral level ($P < .001$) (data not shown).

On the question of role models, about half of the respondents felt that they had had suitable models during their training period. Relatively fewer persons without doctorates (40 percent) indicated appropriate role models than did persons with doctorates (59 percent). There was no significant difference between women and men in any group except among the married doctorates, where fewer women had had appropriate role models than had men ($P < .05$). There was no significant difference between women with and women without doctorates. Men with doctorates, however, felt that they had significantly more ($P < .001$) appropriate role models than did men without doctorates. It may be concluded that men are urged to continue their studies, while women are more likely to be encouraged to stop at the lower levels and receive discouragement if they pursue an advanced degree.

Table 3. Time required to attain professional rank.

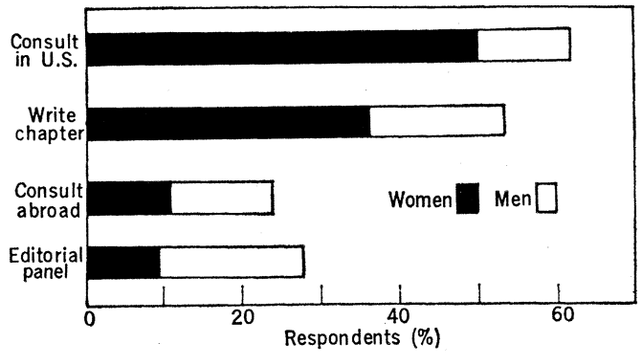
Years since degree	Professors (No.)	
	Women	Men
0–9	8	31
10–19	12	241
20+	18	182

Attitudes of Respondents

To determine whether the respondents themselves felt that they had experienced discrimination, we asked them whether their present positions had fulfilled their expectations at the end of their training period. The majority of each sex found their present positions as expected; persons without doctoral degrees, except single men, tended to be more satisfied than those with the higher degree. However, married women with doctoral degrees were much more dissatisfied than their male counterparts: 30 percent of them, as opposed to 15 percent of the married men, felt that their present position was worse than expected. Single men without doctoral degrees were also dissatisfied, since 35 percent of them, as opposed to 12 percent of the unmarried women without doctorates, felt that their present position was worse than expected.

The respondents were also asked if their present position were commensurate with their abilities and in line with their future expectations. Significantly fewer women (62 percent) than men (75 percent) at the doctoral level gave affirmative answers ($P < .05$). There was little difference between the sexes below the doctoral level (70 percent versus 72 percent). These feelings were also evident from comments added by the respondents (*5*).

When respondents were asked why they were in their present positions (Table 4), the majority (63 to 84 percent) gave a combination of "own choice" plus "no better position available." There was no significant difference by sex for any group other than married doctorates; in that group, the women mentioned bias ten times more frequently than men and limited mobility five times more frequently. Only 1 percent or fewer of the persons in any group said that the position itself was unimportant. Limitation by family responsibility accounted for only 9 percent of the married women without doctorates and 3 percent or fewer of persons in other categories, including all other women. It is possible to conclude from these data that women,



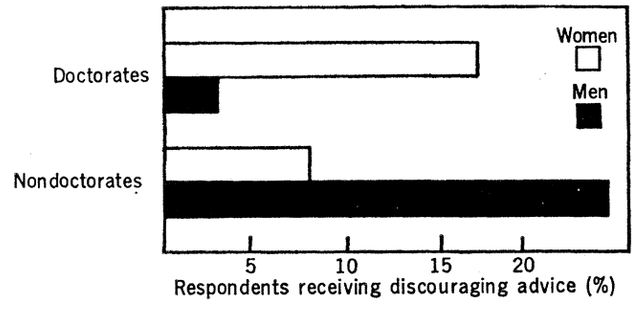


Fig. 10 (left). Extramural invitations to doctorates (women, $N = 104$; men, $N = 360$). *Write chapter* represents writing review chapter or book or refereeing the work of others. Fig. 11 (right). Professional guidance during training period: respondents receiving discouraging advice.

especially married women at the doctoral level, feel dissatisfied with the positions in which they find themselves. Their jobs are less likely than men's to fulfill their prior expectations or to be in accord with their view of their abilities.

Attitudes of Spouses

To ascertain some of the assumptions held by spouses of professional women, questions were asked of a select group of microbiologists who were married to professionals. The choice of spouse by women and men differed radically. Most women doctorates (96 percent) had married professionals, half of them in the same field. Women without doctorates showed roughly the same pattern. On the other hand, 42 percent of the men had married professional women, one-third of them in the same field. There was, again, no difference between men with and without doctorates.

Because of the widely held belief that the help and support of an understanding spouse is important for a successful career, persons married to professionals were asked to indicate the degree to which they felt their spouses had supported their professional aspirations. At the nondoctoral level, the responses fell into the various categories similarly for both sexes, with better than 78 percent of the spouses supporting the respondents with enthusiasm. More women doctorates (82 percent) than men doctorates (70 percent) felt that their spouses supported them enthusiastically ($P < .05$). As another test of support for each other, individuals married to professionals were questioned about their own mobility. Respondents were given a choice of several circumstances under which they might change geographic location with the opportunity for professional advancement. The response for women and for men was dramatically different (Fig. 12). Excluding those persons unwilling to move at all, 93 percent of the women doctorates answered that they would move only if their husbands obtained a statisfactory position before moving. In contrast, 83 percent of men doctorates indicated that they would move whether or not their professional wives had satisfactory prospects for employment. Persons without doctorates showed the same pattern.

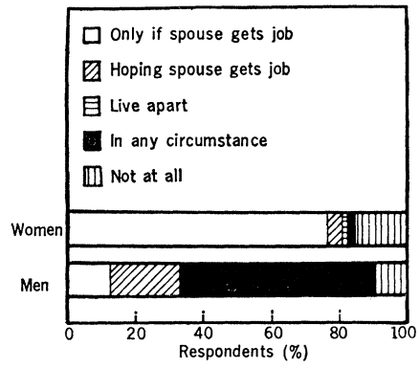


Fig. 12. Conditions for relocation.

An analysis was then made of only those persons who felt enthusiastically supported in their careers. Again, of those willing to move, 95 percent of women doctorates would move only if their husbands also had found satisfactory employment. Of the men doctorates willing to move, only 20 percent made satisfactory employment for their professional wives a prerequisite, while 80 percent were willing to move in any circumstances or in the hope that their professional wives would eventually find satisfactory employment.

Conclusion

The general picture that emerges from this study is that the woman microbiologist, upon entering the professional job market, faces (i) slower advancement; (ii) restricted extramural recognition; and (iii) fewer positions of a supervisory or administrative nature, when compared to men. Most striking is the salary differential, which increases with increasing educational level, with increasing rank, and with increasing seniority.

From the beginning of her professional training, the woman microbiologist feels handicapped by lack of encouragement and proper role models. She generally receives little advice regarding her professional future and rarely feels pushed to take the most challenging position. Should she be married, she feels that her mobility is severely restricted. Even though the subjective nature of these feelings may be interpreted as projections of failure, subtle inducements for women to stay at lower levels may well exist, in addition to more objective measurements, such as lower salary levels and slower professional advancement.

Despite these handicaps, professional women continue to work. As a group, they work for the same reasons that men do, they work as long and as hard as men do, and they remain at their positions as long as men do. Women and men rate themselves equally as to job performance, degree of independence, and publication rate.

On the basis of this study, it should not be surprising that women professionals are less visible than men and that only a small proportion of women become what is considered successful by the usual external criteria. If women were to receive continued encourage-

Table 4. Reasons for present position ($P < .001$ for married men and women with doctoral degrees; not significant for all other groups).

Position	Frequency with which a given reason was cited							
	Doctorates				Nondoctorates			
	Married		Single		Married		Single	
	Women ($N = 54$)	Men ($N = 365$)	Women ($N = 58$)	Men ($N = 29$)	Women ($N = 50$)	Men ($N = 139$)	Women ($N = 71$)	Men ($N = 31$)
No better position available	42	47	51	49	42	49	50	50
Own choice	35	47	42	47	46	46	42	44
Limited mobility	10	2	0	0	3	1	4	4
Was discriminated against	10	1	6	2	0	1	1	0
Family responsibility	3	2	0	2	9	2	2	2
Do not care about position	0	1	1	0	0	1	1	0
Total	100	100	100	100	100	100	100	100
Total number of reasons	105	697	107	51	91	263	129	54

ment, scientific contact, and professional recognition at each stage of their professional lives, they would undoubtedly become more visible.

The lack of encouragement and self-confidence leading to isolation, which then leads to lack of recognition, is a vicious circle that must be broken for the woman professional. This can be done most easily for the beginning student. For older women, there must be increased placement in positions of responsibility and visibility. Protective practices that discourage women from entering arenas of competition can only be viewed as discrimination on the basis of sex, since women professionals are rarely given the choice between being protected and being independent.

Unexpectedly, this study illustrates the lower status of another group of individuals who are considered deviants from the expected roles of the established society—single men with doctorates, who were found in the positions predominately filled by women.

In conclusion, this study of a select group of scientists probably has general applicability to all women professionals in their roles vis-à-vis men. Examination and documentation of discriminatory practices based on sex points to the areas in which women must direct their demands for equality.

References and Notes

1. Among the approximately 3500 registrants at the meeting in Minneapolis, about 900 answered the questionnaires, 815 of which were sufficiently complete for full analysis. The purpose of the survey was not indicated on the questionnaire. The questionnaire consisted of 40 questions with multiple choice answers. The questions were grouped under headings which related to (i) personal information, (ii) education, (iii) past professional experience, (iv) present professional experience, (v) self-evaluation, and (vi) career decisions of individuals with professional spouses. Answers were first encoded on standard coding sheets and then keypunched and verified on standard IBM cards. Analysis was done with the aid of an IBM computer, using the set of programs *Statistical Package for the Social Sciences* [N. H. Nie, D. H. Bent, C. H. Hull, (McGraw-Hill, New York, 1970)]. Using the determinants sex, marital status, and doctoral degree for categorizing the respondents into eight groups, the answers to the questionnaires were examined in relation to these groups. Chi-square values were derived to determine the significance (P) of the differences observed among these groups.
2. The data on salary levels and supervisory roles are derived from the 1970 annual membership survey conducted by the American Society for Microbiology [M. L. Robbins, *ASM News* **37**, 34 (1971); L. Leive, *ibid.*, p. 57].
3. See *Chem. Eng. News* **50**, 34 (1972); P. H. Abelson, *Science* **175**, 127 (1972); D. J. Glancy, *Harv. Law Sch. Bull.* **21**, 22 (1970); M. S. White, *Science* **170**, 413 (1970); A. S. Rossi, *Am. Sociol.* **5**, 1 (1970); H. S. Astin, *The Woman Doctorate in America: Origin, Career and Family* (Russell Sage Foundation, New York, 1969); A. Fischer and P. Gold, *Am. Anthropol.* **20**, 332 (1968); C. Lopak, *Women in Medicine* (Johns Hopkins Press, Baltimore, 19(→ A. E. Bayer and H. S. Astin, *J. Hum. Resour.* **3**, 191 (1968); R. J. Simon and E. Rosenthal, *J. AAUW* **60**, 127 (1967); A. S. Rossi, in *Women and the Scientific Profession: The M.I.T. Symposium on American Women in Science and Engineering*, J. A. Mattfeld and C. G. Van Aken, Eds. (MIT Press, Cambridge, Mass., 1965), pp. 51–127.
4. *ASM News* **38**, 173 (1972).
5. Additional comments were solicited from the respondents, and 62 persons wrote notes on various topics. Ten of the essays dealt with the employment situation in general, 8 contained criticisms of the questionnaire, 13 mentioned bias against applied microbiology in educational institutions and in the questionnaire, 2 had favorable comments on the ASM, and 19 mentioned miscellaneous topics. In addition, 13 essays dealt with discrimination against women in education and jobs: 7 were written by married women doctorates, 1 by a married man doctorate, and the others by single women and female students. The comments included personal testimony on, first, lack of encouragement of female graduate students and, second, the severe impediments to promotion at the higher faculty levels.

6. We wish to express our deep gratitude to Lotte Bailyn and Gertrude Baltimore for their helpful advice and criticisms of this study; to Asger F. Langlykke and the many ASM members for their interest and support; and to Richard Triplett for programming and computation.

An Invitation for Suggestions on Candidates

At the December meeting of the Board of Directors, William Bevan confirmed his decision to resign as Executive Officer of the Association effective 30 September. In response to the announcement of Dr. Bevan's decision, the Board of Directors appointed a committee of three persons to serve as a search committee, consisting of the Board chairman, Leonard Rieser, president Roger Revelle, and president-elect Margaret Mead.

The appointment of a new Executive Officer is of crucial importance to the Association; at the same time it is an extraordinary opportunity for an individual to exercise leadership in the scientific community. The committee invites suggestions of possible candidates and applications from individuals who wish to be considered for the position. Those submitting applications should include a résumé of their experience. Such communications should be addressed to Leonard M. Rieser, Chairman of the Board of Directors, American Association for the Advancement of Science, Dartmouth College, Hanover, New Hampshire 03755.—LEONARD M. RIESER

NEWS AND COMMENT

Eradicating the Boll Weevil: Would It Be a No-Win War?

The boll weevil, bane of the cotton belt for more than half a century, is reported to cause some $200 to $300 million in economic losses annually, making it the United States' most important farm pest. Great amounts of chemicals have been applied just to keep the weevil in check. Indeed, the U.S. Department of Agriculture says that one-third of all insecticides used in this country on farm crops are used for control of the boll weevil or for control of other pests that would not become problems if chemicals used against the weevil did not also destroy beneficial insects. Eradication of the boll weevil has long been the goal of the cotton industry; and now the industry, supported by some leading USDA entomologists, is pressing to have the government lead a 6- to 10-year campaign intended to rid the cotton belt of this pest for once and for all.

The cost of this campaign would be