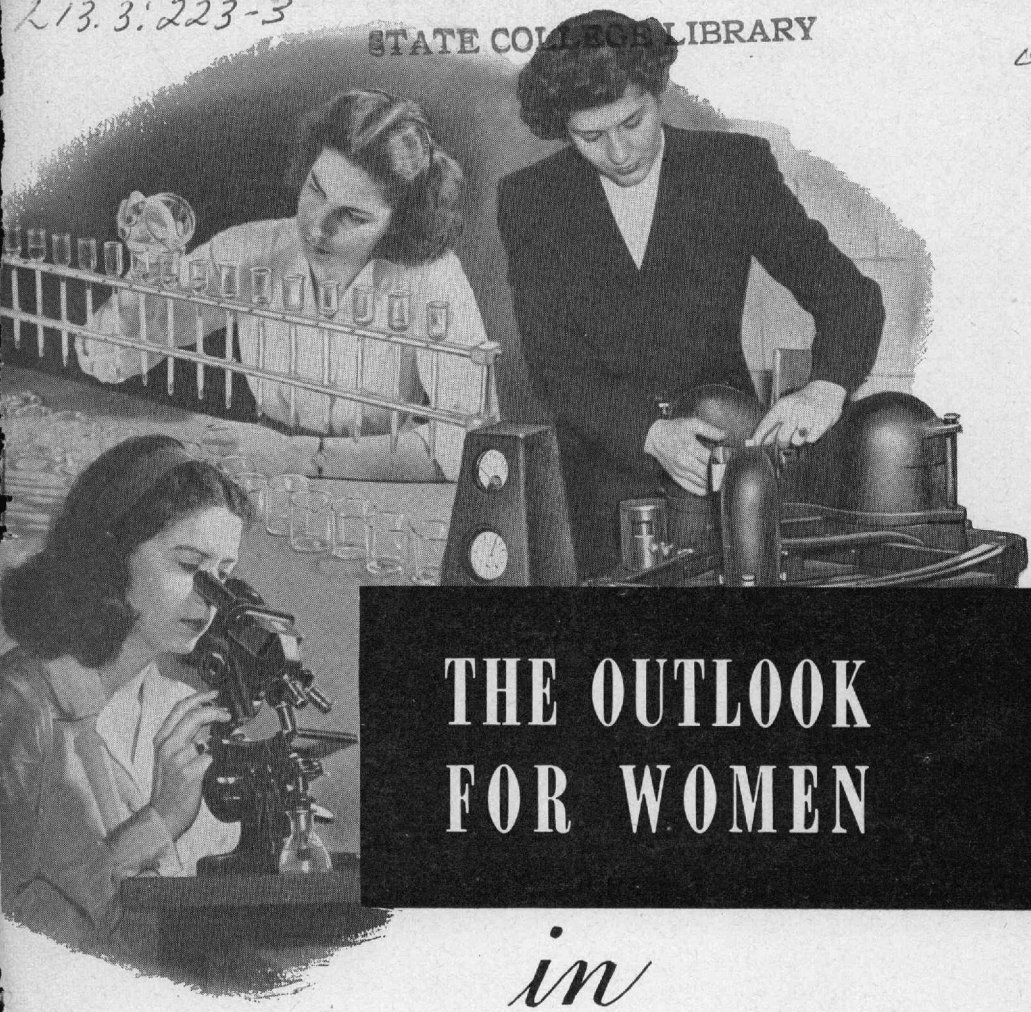

THE OUTLOOK FOR WOMEN

in

THE BIOLOGICAL SCIENCES

Bulletin No. 223–3

U. S. DEPARTMENT OF LABOR

WOMEN'S BUREAU

UNITED STATES DEPARTMENT OF LABOR
L. B. SCHWELLENBACH, SECRETARY
WOMEN'S BUREAU
FRIEDA S. MILLER, DIRECTOR

The Outlook for Women in the Biological Sciences

BOTANY
BACTERIOLOGY
ZOOLOGY
GENERAL BIOLOGY

Bulletin of the Women's Bureau No. 223–3

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No. 223–1 *The Outlook for Women in Science*
No. 223–2 *The Outlook for Women in Chemistry*
No. 223–3 *The Outlook for Women in the Biological Sciences*
No. 223–4 *The Outlook for Women in Mathematics and Statistics*
No. 223–5 *The Outlook for Women in Architecture and Engineering*
No. 223–6 *The Outlook for Women in Physics and Astronomy*
No. 223–7 *The Outlook for Women in Geology, Geography, and Meteorology*
No. 223–8 *The Outlook for Women in Occupations Related to Science*

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LETTER OF TRANSMITTAL

UNITED STATES DEPARTMENT OF LABOR,
WOMEN'S BUREAU,
Washington, December 22, 1947.

SIR: I have the honor of transmitting a description of the outlook for women in the biological sciences which has been prepared as a part of a study on the outlook for women in science. The extraordinary demand for women with scientific training during World War II and the resulting questions which came to the Women's Bureau prompted us to undertake this study. The paucity of published information on women in science and the encouragement of the scientists and educators who were consulted in the course of this study confirmed the need for the information here assembled and synthesized. The study was planned and directed by Marguerite Wykoff Zapoleon and completed with the assistance of Elsie Katcher Goodman and Mary H. Brilla of the Employment Opportunities Section of the Bureau's Research Division. Other members of the Bureau staff who helped to broaden the coverage of this study through interviews in the field were regional representatives Margaret Kay Anderson, Martha J. Ziegler, Rebecca G. Smaltz, and another member of the research staff, Jennie Mohr. Corinne LaBarre, Research Assistant, of the Western Personnel Institute, Pasadena, Calif., furnished the information obtained from western colleges.

In the part of the study here transmitted, the sections on botany and bacteriology were written by Mary H. Brilla and the remainder by Marguerite Wykoff Zapoleon.

Respectfully submitted.

FRIEDA S. MILLER, *Director.*

HON. L. B. SCHWELLENBACH,
Secretary of Labor.

FOREWORD

Much has been written about science and scientists, but little has been told about the work women trained in science have done and can do in the future.

Although these women are few in number when compared to men in science or to women in such occupations as teaching and nursing, their contribution to the national welfare, so strikingly demonstrated in World War II, goes forward daily in the laboratories, classrooms, offices, and plants in which they work.

The every-day story of where these women work, of what kind of work they are doing, and of what other young women who join their ranks in the future may do has been the subject of this report on the outlook for women in science. Unlike the usual monograph which describes an occupation in detail at a particular point in time, this study, like the Women's Bureau series on occupations in the medical and health services which preceded it, is concerned primarily with changes and trends.

Although more than 800 books, articles, or pamphlets were culled for background information, the principal raw material for the entire study of which this bulletin is a part came from such primary sources as scientific organizations, employers and trainers of women scientists, and men and women scientists themselves. Principal sources were as follows:

Scientific organizations: The National Research Council supplied useful directories of scientific laboratories and organizations. Helpful criticism and direction to other authorities were obtained from its Office of Scientific Personnel. Sixty separate organizations of scientists supplied information on their women members, by interview or correspondence.

Federal agencies: Unpublished information on personnel in scientific fields was supplied by:

The United States Bureau of Labor Statistics,
The National Roster of Scientific and Specialized Personnel,
The United States Office of Education,
The United States Civil Service Commission, and
The United States Public Health Service.

In addition, 52 separate bureaus, offices, or other operating units of the Federal Government known to employ scientists were solicited for information regarding the number of women

employed on jobs requiring scientific training and the type of work they were doing. Detailed statistics over a period of years were available from some agencies, while only fragmentary data were obtained from others. The women's military services likewise supplied information on the wartime use of women trained in science in the WAC, WAVES, and the Marine Corps.

Private industry: One hundred industrial firms were visited in 1945 and 1946 to obtain information, usually by interview with the director of research or the personnel director, on the women employed by any part of the organization in any capacity requiring scientific training of college level. Prewar, wartime, and postwar statistics were obtained where available, as well as suggestions and comments. In many instances, some of the women in scientific work were interviewed on the job. The firms visited included:

Seventy-eight firms listed in the National Research Council's 1946 directory of 2,443 firms having research laboratories. The firms visited are listed in the directory as employing 24,816 persons as scientific or technical personnel in their laboratories. This number represented 28 percent of the total personnel of this type estimated as employed in all the laboratories listed. In addition to this numerical coverage, an attempt was made to include among the 78 firms visited small as well as large firms, plants in all parts of the United States, and a variety of industries. However, the intricate industrial organization, inter-relationships, and variety of research revealed in the directory, added to the fact that some firms did not report personnel statistics and none reported women separately, made the selection of a true sample complicated beyond its value for this purpose. The firms visited were chosen rather as a clue to industrial firms most likely to be engaged in the type of work in which women trained in science are used. In all firms, information was requested for the entire organization rather than for the research laboratory only.

Eighteen commercial laboratories which offer testing services to industry and individuals and which employed women were also visited. Seven others contacted did not employ women. These 25 laboratories represented 10 percent of the 244 commercial testing laboratories listed in the National Bureau of Standard's 1942 Directory of Commercial Testing and College Research Laboratories. Since personnel

is not reported in the Directory, there is no clue to the coverage of workers.

Three large additional industrial firms which employed women in laboratory work but were not listed as having research laboratories were visited, as was one biological supply house.

Research institutions: Eight research institutions or centers, some of them identified with a particular college or university, also supplied information on women members of the scientific staff.

Colleges and universities: Statistical information on the number of women graduated with degrees in science, mathematics, and engineering over a period of years from 1939–40 to 1946 was obtained from 30 colleges and universities and from 9 engineering schools. Again an attempt was made to obtain wide geographical coverage and to cover different types of institutions, such as women's colleges, State universities, and small liberal arts colleges. The information available from these sources, too, varied. Placement bureaus and heads of science departments as well as deans of women at these institutions and at 6 other colleges contributed reports on the demand for women trained in the sciences. The Western Personnel Institute made possible the inclusion of data which it collected for the Bureau from its affiliated colleges and universities in the far West. Since no recent data were available on the number of women teaching science in the colleges, a count was made in 1947 of the women identifiable by name who were listed on science faculties in the catalogs of 330 institutions of higher learning which were then available in the United States Office of Education Library. These institutions were selected because they are believed by the United States Office of Education to be representative in their enrollments of the 1,749 institutions of higher education in the United States and, therefore, are likely to have faculties equally representative.

Other sources: In addition, 97 individuals not included in the afore-mentioned sources, most of them women scientists, contributed information, suggestions, or helpful criticisms of the preliminary manuscripts circulated before revision for publication.

While every effort has been made to obtain wide coverage, there remain some dark corners still unexplored because of the range and variety of these fields and the difficulty of obtaining information from widely scattered sources. Perhaps this beginning will result in further additions to our so-little knowledge.

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Courtesy Bryn Mawr College

Figure 1.—An advanced student working on a research problem in biology.

THE OUTLOOK FOR WOMEN IN THE BIOLOGICAL SCIENCES

INTRODUCTION

Since biology is the science of life, its principal subdivisions are the sciences of zoology which deals with animals, including man, and of botany which deals with plants. The term "biologist," used rather loosely by others, is by scientists usually applied to one who studies both animal and plant life. The limnologist, for example, is a biologist who has specialized in the study of animal and plant life in fresh water, as the oceanographer has concentrated on the study of oceans and living organisms in them.

In contrast, most biological scientists specialize in animal or plant life and are accordingly called zoologists or botanists rather than biologists. They in turn may become expert in one of many specializations which have evolved in these sciences over the years such as: physiology (concerned with life processes) and genetics (concerned with breeding and heredity). These are mentioned in more detail in the separate discussions of botany and zoology which follow, and which also refer to their application to agriculture, forestry, and animal husbandry.

Bacteriology has evolved more recently as a distinct biological science which, however, relates to chemistry as well. This, too, is discussed separately since it ranks relatively high among the sciences in its employment of women.

Any attempt to arrive at the number of men and women engaged in the biological sciences is subject not only to the difficulties of obtaining statistical information from widely scattered sources but also to those of classification in a group of sciences which are basic to so many fields. Table 1, therefore, which shows the numbers engaged in the biological sciences as taken from a voluntary registration in 1946, is presented merely to indicate the minimum number and proportion of women in the principal sciences in this group. Those who have taken degrees in medicine, dentistry, nursing, and human nutrition have not been included, except for unavoidable overlapping, because the outlook in most of those fields has been discussed in other bulletins of the Women's Bureau. Biochemistry has been included in the discussion on chemistry rather than under the biological sciences.

The figures presented may well underestimate the total number and particularly the number of newcomers in the sciences who are not likely to be on organization and other lists used in obtaining a regis-

tration by mail. However, the statistics do indicate that bacteriology, general biology, and general zoology rank highest in the number of women engaged in them, with general botany and physiology ranking next. The proportion of women is highest in general biology, bacteriology, and general botany, in all of which they form more than one-fifth. In such applied agricultural and animal sciences as forestry, agronomy, and poultry breeding, women are as negligible in number as they are in engineering, an applied science in the physical field.

Table 1. Distribution by Specialization and Sex of Persons Registered in Biological Science With the National Roster of Scientific and Specialized Personnel, Dec. 31, 1946 [1]

Specialization	Number registered			Percent women are of total
	Total	Men	Women	
Total in the biological sciences [2]	23,657	21,500	2,157	9.1
Botany and related plant sciences	9,964	9,634	330	3.3
General botany	1,063	831	232	21.8
Plant physiology and pathology	1,048	979	69	6.6
Agricultural sciences including forestry	7,853	7,824	29	.4
Zoology and related animal sciences	7,800	7,185	615	7.9
General zoology	3,901	3,469	432	11.1
Physiology and pathology	1,514	1,342	172	11.4
Dairy, poultry, and other animal sciences	2,385	2,374	11	.5
Bacteriology	2,643	2,051	592	22.4
General biology and natural history, including wildlife and fish	2,438	1,886	552	22.6
Genetics (not further identified)	375	337	38	10.1
Other biological sciences	437	407	30	6.9

[1] This is by no means a complete listing of all scientists, but is a report of voluntary registrations. Younger workers especially are likely to be represented inadequately in a roster of this type.

[2] Pharmacology and human nutrition have been omitted.

Source: National Roster of Scientific and Specialized Personnel (*30*).

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Botany as Defined by Webster's International Dictionary Second Edition, Unabridged, 1947

"*Botany*—the science of plants: the branch of biology dealing with plant life. Botany, in its broadest sense, comprises many subordinate sciences, each with a distinctive terminology. The most important of these are: *morphology*, treating of form and structure (often only the external form); *anatomy* or *histology*, of internal structure; *cytology*, of the cell; *physiology*, of life processes; *paleobotany*, of fossil plants; *ecology*, of the relationships of plants and their environment; *taxonomy* or *systematic botany*, of plant classification; *phytogeography*, of distribution; *pathology*, of plant diseases; *genetics*, of plant breeding and heredity. Applied or economic botany deals with the uses of plants to mankind, * * * thus *forestry*, *pharmacognosy*, *horticulture*, *agriculture*, etc., fall in greater or less degree within its province."

Courtesy American Association of University Women

Figure 2.—Contributions to cytogenetics through pioneer research with corn won for this botanist the 1947 American Association of University Women's Award for distinguished achievement by a woman scholar.

THE OUTLOOK FOR WOMEN IN BOTANY

Botanists are concerned with the science of plant life and have many possibilities of specialization within this science. Although they may be called by other names, such as taxonomist, cytologist, geneticist, they are basically botanists, and those who have not specialized so finely are usually known as botanists.

There are three main branches of botany, each of which is further broken down into finer areas of specialization. The three large divisions are:

1. Systematic botany, or taxonomy, which is concerned with the classification of plants including their identification, description, and nomenclature.

2. Plant morphology, the study of the form and structure of plants. Plant morphology is further subdivided into external morphology and histology, which includes anatomy, the study of internal structures; and cytology, the study of cell structure. Included too is morphogenesis, the study of the causes which determine form and structure.

3. Plant physiology, the study of the functions of plants.

Other phases of botanical study are plant ecology, the relation between plants and various factors of their environment; plant geography, the geographical distribution of plants; and paleobotany, which deals with the structure and relationships of fossil plants. Botanical science is applied to practical problems in such fields as agronomy, horticulture, soil science, plant pathology, and forestry, among others.

The various specializations within the botanical field are too numerous to be discussed in detail in this bulletin (*27*). However, the broad base of fundamental botanical knowledge common to them all makes possible a considerable amount of transfer within the field. It also facilitates the teamwork among specialists in this field who attack together a problem which may involve, for example, physiology, genetics, and cytology. The woman who has a degree in botany is not restricted to a narrow occupational area. Especially if she has some knowledge of the sciences of chemistry, physics, and bacteriology, she will find a variety of jobs in which she can apply her training in botany. In this discussion, the outlook for women in botanical work in general is discussed, with special mention of a few of the specialties in which women are employed, on which information was available to the Women's Bureau: plant physiology, plant pathology, horticulture,

agronomy, soil science, and forestry. Except in plant physiology, the number of women is relatively insignificant in these specializations. Except for forestry, however, there is nothing in the location or type of employment that need be considered an unusual deterrent to women. Among general botanists, women constitute about one-fifth of the total. (See table 2.)

Table 2. Distribution by Specialization and Sex of Plant Scientists Registered With the National Roster of Scientific and Specialized Personnel, Dec. 31, 1946 [1]

Specialization	Number of registrants			Percent women are of total
	Total	Men	Women	
Total	9,964	9,634	330	3.3
General botany	1,063	831	232	21.8
Plant physiology	330	292	38	11.5
Plant pathology	718	687	31	4.3
Horticulture	1,127	1,114	13	1.2
Agronomy, soil science	2,281	2,273	8	.4
Forestry	4,445	4,437	8	.2

[1] This is by no means a complete listing of all plant scientists, but is a report of voluntary registrations. Younger workers especially are likely to be represented inadequately in a roster of this type.

Source: National Roster of Scientific and Specialized Personnel (*30*).

GENERAL BOTANY

Prewar Distribution

In the last prewar year of 1941, there were 1,365 men and women members of the Botanical Society of America (*20*). Late in the following year, 1,188 men and 288 women were registered in botany with the National Roster of Scientific and Specialized Personnel, in addition to over 7,000 men and about 75 women registered in plant pathology, plant physiology, agronomy, horticulture, soil science, and forestry (*29*). Because the younger graduates are not likely to be fully represented in professional organizations and are less likely to be reached by a mailed questionnaire as used for the Roster registrations, these statistics are indicative only.

In the prewar period, opportunities for general botanists were limited and were mainly in teaching. Most women with bachelor's degrees in botany taught in high school; usually they had studied several sciences and taught high school biology. Positions in colleges and universities were open to only the most capable Ph. D.'s. Of the 873 employed persons who had received their Ph. D.'s in botany in the decade preceding 1940, about 40 percent were teaching, another 12 percent combined teaching with research, and about 40 percent were in research (*12*).

Only a very few botanists were absorbed by industry before the war, although there were some jobs for them as seed specialists. A

number, whose training included enough bacteriology, did bacteriological work, especially in medical laboratories. Because there were so few outlets in general botany, some women botany majors took enough bacteriology to qualify themselves for such positions.

The prewar demand for botanists in the Federal Civil Service was small and came principally from the United States Department of Agriculture. Although, in the year ended June 30, 1940, 22 women were among the 60 who were qualified through Civil Service examinations as botanists at the Junior Professional Assistant level, only 3 men and no women were appointed to such positions in the same period (*23*). Earlier, in 1938, the Federal Government employed 130 women as agronomists, horticulturists, botanists, and bacteriologists (*41*). Only a few of these 130 women were general botanists, since bacteriologists predominated in this group.

Annual Addition to the Supply

In the 40-year period before the war, about 2,000 Ph. D. degrees had been awarded in botany, an average of 50 a year (*21*). But the number of Ph. D.'s was increasing. From 1935 to 1940 there was only one year, 1937, in which the number of doctorates in botany was less than 100 (*11*). The largest number granted in any one year before the war was 112, in 1940.

There are no separate statistics on the prewar number of first degrees in botany, which are included in the 4,629 degrees in the biological sciences in 1941–42, along with bacteriology and zoology (*43*). Most of the 30 schools that reported statistics on women graduates in science to the Women's Bureau had fewer than a half dozen women botany graduates annually, and the largest number of women who received degrees in botany, both bachelors and advanced degrees combined, in a single year from any of these schools was 20.

Wartime Changes

For most botany graduates, the number and types of jobs available during the war continued to be much the same as they had been before the war, although there were some exceptions. Some botanists worked as medical adjuncts or as chemists or biologists. A few were on war research projects such as the study of methods of overcoming the destructive action of fungi on certain vital materials, such as fabrics, glass, and paints, which were exposed to the weather and subject to attack by fungi, especially in the tropics. Some botanists trained in bacteriology did research on penicillin and other antibiotics. For the most part, however, the volume of the wartime demand for botanists did not compare with the size of the expansion in such sciences as

physics and chemistry. However, many botanists contributed to the war effort by continuing to do much the same type of work that they had done in peacetime, applying it to special problems arising from wartime needs.

Although reports from colleges indicated that most of their wartime graduates who had majored in botany became high school teachers or graduate assistants in botany departments of universities, a variety of other jobs were reported. Among the jobs that these women took were those of: laboratory technician in cytology at a State agricultural experiment station; assistant in plant physiology at an institute for plant research; director of Oxford testing of penicillin for a commercial company; seed analysts in State seed laboratories; botanist in a State park; pathology assistant at a State agricultural experiment station; assistant gardener in a botanical garden; and research assistant on a Navy project, working on the effect of fungi on materials.

Women who had some training in chemistry, in addition to their botanical training, sometimes went into a somewhat different type of work. For example, one went into a flour mill laboratory, and another became a research chemist with a medical research institute.

Only a few of these graduates took jobs that they would possibly not have entered in a normal period. These included positions with a National Defense Research Committee, as technical assistant at an aircraft company, as an overseas hospital secretary with the Red Cross, and a WAC assignment as a physical therapist in an Army hospital.

The Botanical Society of America published a list of its members and their occupations shortly before the end of the war in 1945. By far the largest number of both men and women members were employed at that time in colleges and universities. Over three-fourths of the women were teachers, graduate students, research assistants, or technical assistants in institutions of higher learning. Although most of them were primarily botanists, a substantial number gave their teaching field as biology. Others reported zoology and physiology, paleobotany, general science, plant physiology, plant ecology, and bacteriology as the subjects that they taught. No other type of institution approached the colleges in importance as employers of these botanical specialists (*5*). If information on the employment of all persons with degrees in botany were available, the distribution might be different. For example, it is likely that a much higher proportion would be listed as high school teachers. (See table 3.)

The largest number of doctorates awarded in botany in any one year was 120, in the war year of 1942. But by 1944 the abnormal war situation had caused this number to drop to 52 (*11*). However, the number of graduates who received bachelor's degrees in the biological sciences was virtually the same in 1943–44 as it had been in 1941–42,

although the proportion of women increased substantially. Always a significantly large group in the biological sciences, women composed about two-fifths of the 4,629 graduates in 1941–42 and slightly more than half of the 4,622 graduates in 1943–44 (*43*) (*44*).

Table 3. Distribution by Type of Employer of Women Members of the Botanical Society of America, Inc., Reporting Employment, July 1945 [1]

Type of employer	Women members reporting employment	
	Number	Percent
Total	215	100.0
Educational institutions	177	82.3
College and university	165	76.7
High school	7	3.3
Unspecified	5	2.3
Government	[2] 17	7.9
Research foundations and museums	12	5.6
Industry	6	2.8
Other	3	1.4

[1] Excludes 54 women who did not report on employment.
[2] Includes 10 employed by the U. S. Department of Agriculture.

Source: Botanical Society of America, Inc. (*5*).

Earnings and Advancement

Earnings of botanists increased somewhat during the war period, although college placement bureaus in 1946 reported that the salaries offered beginners varied considerably. For example, in medical research, $1,500 per year was the salary offered for a botanist's assistant, a position for which only an undergraduate degree in botany was necessary. A seed company asked for a botany major to work as a seed analyst at $2,000 per year.

Earnings in 1946 reported by women botanists already employed also varied widely. One was employed as a research chemist by a medical research institute at $2,600 per year; a recent graduate of a woman's college was director of penicillin testing in a commercial firm at approximately $2,200 annually. The beginning salary in the Federal Civil Service for botanists and other plant scientists, at the junior professional assistant level in 1947, was $2,644 per year. In State colleges, women teachers with the Ph. D. were starting at about $3,000 per year. In research, starting salaries were from $3,000 to $4,000.

Before the war, in the 1930's, plant pathologists employed by colleges and State experiment stations earned from $1,500 to $6,000 per year. The average was probably about $2,700 (*45*). In the early postwar period pathologists with advanced degrees were starting at salaries of $2,320 to $2,980 a year (*37*). An average salary for workers with 10 to 20 years' experience was between $3,420 and $5,180 per year. Salaries in horticulture, agronomy, and soil science were com-

parable with those in botany and plant pathology, according to the National Roster of Scientific and Specialized Personnel.

According to a study published in the proceedings of the Association of Official Seed Analysts in 1946, permanent seed analysts employed in seed laboratories earned from $780 to $3,420 a year. For the heads of laboratories whose sole responsibility was the work of the seed laboratory, the range of salaries was from $2,000 to $3,700, and for those who had other responsibilities salaries ranged up to $6,500.

A graduate degree is almost essential for advancement in any of the sciences. Very few people with only a bachelor's degree attain positions in which they can do creative work.

Because of the limited number of opportunities to do distinguished work, advancement in botany is slow, especially for women. Nonetheless, women have done notable work in many phases of botanical science. A number of women botanists have been sent to other countries as consultants; many have contributed to the literature; and a few have attained full professorial rank on college and university faculties.

Organizations

In 1906 the Botanical Society of America was organized with 116 members (*21*). By 1945 there were nearly 1,400 members, and 19 percent of these were women (*5*). One woman has served as president of this organization. The Mycological Society of America also has a fairly high proportion of women, about 15 percent, among its more than 400 members. But in all of the other organizations of plant scientists, the percentage of women is much smaller. In 1946 less than 2 percent of the 1,260 members of the American Phytopathological Society and about 3 percent of the 675 in the American Society of Plant Physiologists were women. The Society of American Foresters had even fewer women members, only 13 in a total of approximately 5,500 members. Five qualified for active membership, which requires graduation from a professional school with at least a B. S. in forestry, and 8 were associate members trained in other phases of botany who were doing work that applied to forestry. The only requirement for membership in the other groups mentioned above is interest in the science.

There is some overlapping of membership among these various societies. This overlapping is evidence of the close relationship that exists among these fields. Women interested in a career in any of the plant sciences must have the basic botanical knowledge common to all of them and then must acquire the special skills and knowledge of their particular field of interest.

The Outlook

In the fall of 1946 a survey of the future personnel needs for botanists with advanced degrees and for graduate students in botany was made for the Botanical Society of America. The conclusion, admittedly conservative, was that approximately 1,900 would be needed in 1950, exclusive of the more than 1,000 plant pathologists of comparable training also needed in 1950. To meet the 1950 need would require 369 more plant pathologists and 828 more botanists than were estimated as being available in 1946. The percentage distribution of the additional botanists needed by 1950 (excluding plant pathologists) is given in table 4.

Teaching will be the principal outlet for two-thirds of the additional botanists (except plant pathologists, for whom the demand was greatest in research) needed according to this survey (7). The source of the estimated demand for additional botanists up to 1950 is shown in table 5.

Table 4. Percent Distribution by Field of Specialization of Additional Botanists (Except Plant Pathologists) Needed Between Fall 1946 and 1950

Botanical specialization	Percent	Botanical specialization	Percent
Total	100.0		
		Plant ecology	5.1
General botany; miscellaneous	28.5	Plant morphology	4.6
Plant physiology	21.8	Plant cytology	4.3
Taxonomy of higher plants	11.6	Plant anatomy	3.5
Plant breeding; genetics	8.3	Economic botany	2.8
Mycology	7.0	Taxonomy of lower plants	2.5

Source: 1946 survey, made for the Botanical Society of America, of personnel needs for botanists with advanced degrees and for graduate students in botany (7).

Table 5. Percent Distribution by Type of Employment of Additional Botanists (Except Plant Pathologists) Needed Between Fall 1946 and 1950

Type of employment	Percent	Type of employment	Percent
Total	100.0	Research	33.7
		Governmental	13.3
Teaching	65.0	Institutional	13.2
College	57.0	Industrial	2.8
High school	[1] 4.7	Other	4.4
Junior college	3.3	Miscellaneous	1.3

[1] The figure for the high school teaching group is believed to be disproportionately low due to the method of sampling.

Source: 1946 survey, made for the Botanical Society of America, of personnel needs for botanists with advanced degrees and for graduate students in botany (7).

There were many more opportunities in 1947 in college teaching for women who had the Ph. D. in botany than there were before the war. A 1947 count of teachers in 330 institutions of higher education, comprising a United States Office of Education enrollment sample

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of all the 1,749 such institutions in the United States, showed that there were 151 women listed as teaching botanical subjects in these schools. Thirty-five of them held the rank of assistant professor or above, and 25 of these were Ph. D.'s. With only a very few exceptions, the 151 women taught botanical subjects only. If this sample is as representative of faculty as it is of enrollment, there were slightly more than 650 women botany teachers in colleges and universities, most of them in universities, colleges of arts and sciences, and technical and professional schools. Only a few were in junior colleges or in Negro institutions.

Outstanding women botanists reported offers of good positions from colleges and universities, including some offers to head departments. As enrollments in institutions of higher learning have increased, some schools have expanded existing botany departments or organized new ones. As a result of such expansion, women are now on some faculties formerly composed only of men. For women who had a bachelor's degree in botany, and who had training in other sciences as well, high school teaching continued to be an important outlet. This group is obviously not included in the survey of botanists with graduate training, referred to in table 4.

Industry offers few opportunities to women botanists except in the field of mycology. (See p. 3–13.) There is far less demand in industry for botanists than for bacteriologists and chemists. Women botanists were found in only 1 of the 78 firms with research laboratories visited by a representative of the Women's Bureau in the course of this study. They worked directly on insecticides in a chemical company. However, women botanists are known to be employed in seed houses. They also work as plant pathologists or as technicians who culture fungi and bacteria, or are employed in slide making. Women also do experimental work in some of the 59 or more botanical gardens in the United States. Some are on research projects financed by private foundations or institutions. Museums also employ botanists, but the number of available jobs is small, since, although there is at least 1 botanical museum in every State, the entire country has less than 100. Women are also employed at herbaria and arboretums, among them the Gray Herbarium and the Arnold Arboretum at Harvard, the New York Botanical Garden, and the California Academy of Sciences. The National Herbarium of the Smithsonian Institution in 1947 employed some botanists, mostly taxonomists, but they included only one woman, noted for her work on grasses, who was formerly employed by the United States Department of Agriculture.

Government, never an employer of a large number of botanists, does not promise to become an important outlet for them in the future,

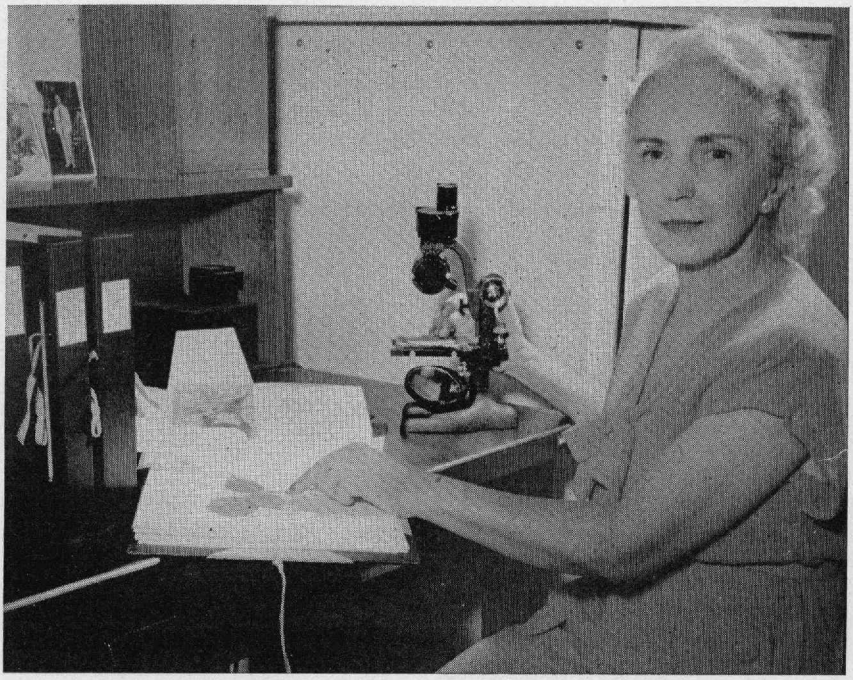
except in the specialized agricultural fields in which men predominate. Of the Federal agencies that reported on employment to the Women's Bureau, only the Department of Agriculture employed women under the title of botanists. There were relatively few jobs even with this agency, which employed only seven women as "botanists" and four as "seed technicians" in the Washington area in 1946. Reports from a few field offices further bear out the conclusion that Government botanical jobs for women, in general botany, were scarce. At one regional laboratory, openings for botanists were rare. However, one woman xylotomist, who had a bachelor's degree in botany and had specialized in the study of woody plants in her undergraduate training, was doing microscopic work identifying wood cuttings at this laboratory. A woman with a Ph. D. was in charge of the pathology branch of a technical laboratory of the Department of Agriculture, and another outstanding woman botanist, whose major fields are plant physiology, anatomy, and the study of foreign woods, was also employed. (See p. 3–73 for minimum requirements for Federal Civil Service positions as botanists.)

College placement officers verified the evidence from industry and Government that there was little demand, except in teaching, for women with general botanical training. However, women interested in botany can expand their employment opportunities in industry and Government by taking a substantial number of courses in one or more related scientific fields, such as bacteriology, chemistry, physics, or zoology, or perhaps by combining botany with mathematics, statistics, or economics.

A recently expanded branch of botany is mycology, the science of fungi. Mycology is concerned with structure, affinities, classification, physiology, and growth of fungi, and with all applications of these aspects of the subject in industry, agriculture, and medicine. It has come into greater prominence recently because of the extensive use of fungi in the manufacture of drugs. In this work, a knowledge of bacteriology and chemistry is essential. Employment opportunities in mycology are greatest for those who have a background in plant pathology, biochemistry, and bacteriology.

As the whole field of antibiotics has grown, opportunities for mycologists have developed. A few years ago women were discouraged from specializing in mycology because of the lack of jobs in this field. Openings were rare and chiefly in teaching or research. Many mycologists found that their best opportunities were not in their own specialized field but in teaching or research in some other biological science. Consequently, there were few trained mycologists, and the sudden demand created by the expanding use of penicillin and other

antibiotic drugs far exceeded the supply. The penicillin industry has hired most of those who were available. Only three women mycologists were located in the course of this study: one worked for a drug company, and two were employed by the United States Department of Agriculture in the Washington area in 1946.



Courtesy U. S. Department of Agriculture

Figure 3.—A mycologist at work in the Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture.

Most of the members of the Mycological Society of America, which includes most of the men and women in this country who are concerned with mycology, teach in colleges and universities, although there are a very few in industrial research. Many of the college and university teachers give courses in biological specializations other than mycology.

There is an urgent demand for mycologists by the approximately 14 or 15 basic manufacturers of penicillin and other antibiotics, by the universities where antibiotic research is done, and by Government agencies that are doing work in this field. The antibiotic industry has opened many new opportunities to scientists in various fields, and the mycologist who has a good background in chemistry is especially well favored.

There are also a number of jobs in related fields that might attract women trained in botany (*13*) (*17*). For the woman who knows botany and who has some artistic ability, there is botanical illustration or work in the floral industry. Some botany graduates have become successful operators of their own businesses, as florists. There are also possible careers in botanical editing and writing, for the woman who combines writing ability with a knowledge of botany. Several women trained in botany have succeeded to positions as editor or chief editor of technical journals and periodicals in this field. Botanical librarianship is another type of work available to women with adequate training. Although botanical librarians are sometimes women trained primarily in library work, with only a working knowledge of botanical subjects, some positions require a high degree of specialization in botany. In the Department of Agriculture library, for example, a woman with a Ph. D. in botany has compiled an outstanding new type of bibliography. Publishers of scientific books and magazines, educational and research institutions, museums, and botanical gardens are among those who employ botanical illustrators, writers and editors, and librarians.

There is nothing in the nature of most botanical work that makes it an unsuitable field of work for women, and many women botanists in the United States and other countries have done distinguished work. One authority says that, "This is definitely a field in which women may make contributions and achieve distinctions fully equal to those of men * * * women are adapted to successful work in the botanical field. In America they must overcome a certain amount of hide-bound prejudice * * *, but they are steadily doing that and demonstrating a welcome talent in this field."

Plant Pathologist as Defined by the National Roster of Scientific and Specialized Personnel (*37*)

"Plant pathologists deal with the nature, cause, and control of diseases of plants and of the decay of plant products, and seek to protect field crops, vegetables, fruits, ornamental plants, and plant products from damage or destruction by infectious fungi (molds, mildews, smuts), bacteria, viruses, or by physiological disorders."

Plant Physiologist as Defined by the National Roster of Scientific and Specialized Personnel (*37*)

"The plant physiologist studies the mechanics and the chemistry of growth, maturity, and reproduction in plants. He studies these functions of the plant in relation to structure and development and to the influence of elements in the plant's environment such as soil, temperature, moisture, and light."

PLANT PATHOLOGY AND PLANT PHYSIOLOGY

Plant pathologists study plant diseases and methods of prevention and control. Because their work may involve the study of bacteria, fungi, or other agents that may cause plant disease, plant pathologists must also be competent in bacteriology and mycology. It is not uncommon for them to be members not only of the American Phytopathological Society, but also the Mycological Society of America, the Society of American Bacteriologists, or the American Society of Plant Physiologists (*33*). Although women are more prominent in these other phases of botany, they comprised only 4 percent of plant pathologists in 1946.

Plant pathologists teach in colleges and universities; they do research with the Federal Government, educational institutions, State experiment stations, private and commercial agencies; or they may be engaged in plant quarantine work (Federal or State), or in field control. They are employed in all land grant colleges and State experiment stations, by the United States Department of Agriculture, and by commercial firms engaged in manufacturing disinfectants and spray materials. Opportunities are scattered throughout the country, since each State has a definite program of plant disease control, usually directed by the State experiment station (*45*). Some plant pathologists operate a consulting business of their own as "plant doctors." In 1937 there were 265 plant pathologists in the United States in State colleges and experiment stations, according to a study of the Georgia National Youth Administration.

The United States Department of Agriculture also has stations in the Washington area and throughout the country. Before the war, in 1940, there were 52 qualified applicants, 6 of them women, for Federal Civil Service positions as junior professional assistants in plant pathology. Three men were appointed that year (*23*). (See p. 3–73 for minimum requirements for Federal Civil Service positions as plant pathologists.)

The Ph. D. is essential for advancement to top posts in this field. Evidence of its importance is the fact that almost two-thirds of the 265 pathologists in State colleges and experiment stations in 1937 had their Ph. D.'s. Seventy-five had a master's degree, and 20 had a bachelor's degree (*45*). The count of women teaching botanical subjects showed that there were 8 women teaching plant pathology in the 330 schools in the sample, or about 33 in all institutions of higher education.

In a survey in the fall of 1946 of the need for botanists, the supply of plant pathologists was short of estimated needs in 1950 by 233 professional plant pathologists and 136 graduate students in this specialty. More than half of those needed would be required in research (*7*).

It is unlikely that the number of women will increase proportionately in this field in which men have been preferred because of the extension and field work involved.

Plant physiologists study the physiology of plants and the effects of various environmental conditions upon them. Although plant physiologists are fewer in number than plant pathologists, women form a higher proportion of the plant physiologists, between 11 and 12 percent in 1946. Plant physiologists are employed principally by colleges and universities, Federal and State agencies, other research agencies, and industrial firms manufacturing food products and agricultural fungicides (*39*). The majority of the members of the American Society of Plant Physiologists, according to that organization, work in institutions of higher learning; some are employed by the Federal Government in various capacities.

In 1940, 83 persons, including 16 women, passed the Federal Civil Service examination for positions in plant physiology at the junior professional assistant level. Only two appointments, both of men, were made to such positions in the same year (*23*). (See p. 3–74 for minimum requirements for Federal Civil Service positions as plant physiologists.) However, persons trained in plant physiology are sometimes employed by the Federal Government under other titles, such as that of horticulturist or seed technologist.

According to figures published in the Newsletter of the Association of Official Seed Analysts, there were 30 seed technologists employed in Federal laboratories in 1946, of whom 14 were women. In addition, State laboratories employed approximately 232 seed technologists or seed analysts, of whom 155 were women. Other openings for women trained in this field may be found in commercial seed laboratories, for according to recent information there were 29 women among the 50 members of the Society of Commercial Seed Technologists, who probably represented about half the number of commercial seed technologists in the United States.

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Horticulturist as Defined by the National Roster of Scientific and Specialized Personnel (*25*)

"A horticulturist applies scientific methods to the production and breeding of all types of plants except field crops. These include flowers, greenhouse plants, ornamental shrubs, trees, vegetables, fruits, berries, and nuts."

Agronomist as Defined by the National Roster of Scientific and Specialized Personnel (*25*)

"The agronomist is concerned with the technical aspects of plant, soil, and related sciences, and their application to the production, improvement, and utilization of field crops, and to the management and improvement of soil.

* * * * * * *

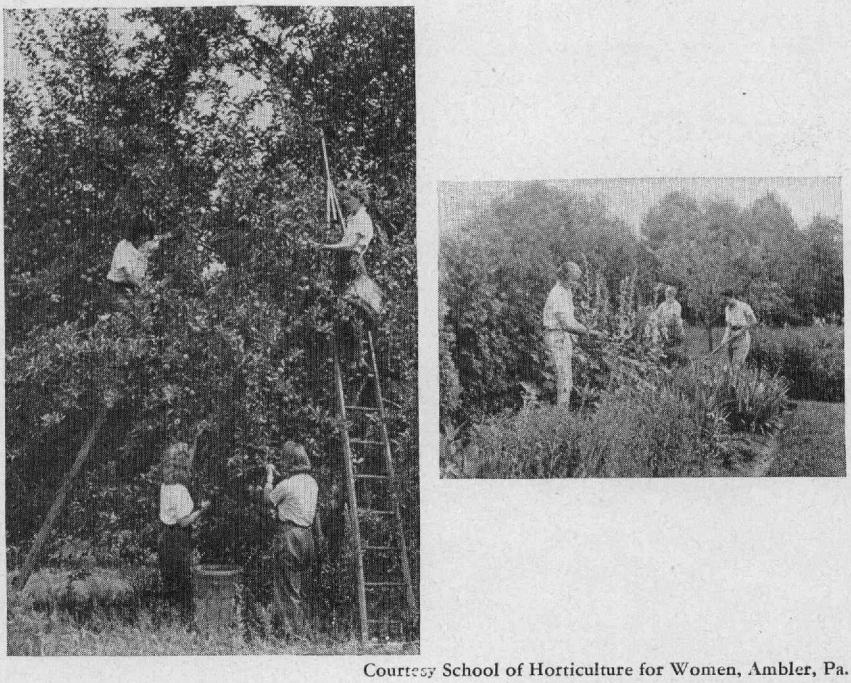
"In all his studies, the purpose of the agronomist is to develop methods for the most efficient production, management, and utilization of field crops as well as to improve existing varieties with reference to soil and climatic adaptation, disease and insect pests, and other characteristics leading toward sustained or increased production of high quality products."

Soil Scientist as Defined by the National Roster of Scientific and Specialized Personnel (*38*)

"The soil scientist primarily * * * carries out research work to learn the basic principles of soil origin, distribution, and composition; its chemical and physical properties; and the application of such knowledge to soil management practice, crop production, and farming systems. Some of the specific applications relate to irrigation and drainage practice, land tillage, and runoff and erosion control."

HORTICULTURE, AGRONOMY, SOIL SCIENCE

Horticulturists and agronomists both do research in the breeding, production, use, processing, storage, and shipment of crops. Horticulturists work on fruits and nuts, garden vegetable crops, flowers and ornamental plants, and nursery stock; agronomists, on field crops. Although agronomists are concerned with variety testing, crop rotation, and many other problems, their chief techniques are largely those of plant breeders. Agronomists are primarily plant geneticists, devoting themselves to the application of genetical principles and procedures to practical ends. Soil scientists concentrate on problems of soil and their relation to crop production (*38*)



Courtesy School of Horticulture for Women, Ambler, Pa.

Figure 4.—Students in training at a school of horticulture.

Although, with forestry, these specialties include almost 80 percent of all the plant scientists, as already noted (see table 2) women are very rare in these fields. The actual farm work involved may be a deterring factor to some women, although United States census figures, which for 1940 show over 300,000 women as farm laborers, seem to contradict this impression.

Teaching and research are the chief occupations of Ph. D.'s in horticulture. In 1940 almost half of the 119 employed persons who had received doctorates in this field in the preceding decade were doing research. About one-sixth were teachers, and over one-fourth combined teaching and research (*12*). In the 330 institutions of higher education referred to earlier, there were 7 women teaching horticulture, 1 of them teaching horticulture and forestry. This indicates that there were about 23 women teachers of horticulture in all colleges and universities.

Courtesy U. S. Department of Agriculture
Bureau of Plant Industry, Soils, and
Agricultural Engineering

Figure 5.—A pomologist examining potted seedlings in connection with a peach tree breeding program.

Training in horticulture can be obtained at agricultural colleges, which are usually connected with State universities. Some botanical gardens, including the New York Botanical Garden, offer 2-year courses in horticulture. In addition, there is a school of horticulture,

at the junior college level, established especially for women, the School of Horticulture for Women in Ambler, Pennsylvania. Established in 1910, this school offers 2-year courses in agriculture, horticulture, and landscape design (*22*). Alumnae are employed in a variety of jobs that include, among others, library work, teaching, writing for trade publications, landscape designing, and farm and garden work. One graduate is employed as a garden consultant by a seed company; another is a research assistant at a State agricultural experiment station; and one is a horticultural therapist at the United States Naval Hospital (*19*).

Outlets for women trained in horticulture, however, are limited. In the Federal Civil Service there are not many appointments in this field, nor are there many applicants. In 1940 only one man qualified as a horticulturist; in this same year, only one assistant horticulturist was appointed (*23*). In 1946 only one woman horticulturist, with the title of pomologist (specialist in fruit crops), was employed by the United States Department of Agriculture in the Washington area. (See p. 3–75 for minimum requirements for Federal Civil Service positions as horticulturists.)

A survey of industrial laboratories, made by the Women's Bureau, shows that, as in Government, there are few women doing horticultural work in industry. Women horticulturists were employed in only 2 of the 78 industrial research laboratories visited in connection with this study. Both of these were chemical companies; one employed two women horticulturists, and the other employed one; all were permanent employees.

There are relatively few openings in the Federal Government for women agronomists. In 1940, 89 people, only 1 of them a woman, qualified as agronomists; 31 men were appointed that year. At the junior professional assistant level in agronomy, there were 228 qualified applicants, including 1 woman. Only 55 were appointed, all of them men (*23*). (See p. 3–76 for minimum requirements for Federal Civil Service positions as agronomists.) Only 1 woman agronomy teacher, a woman Ph. D. with the rank of associate professor, was listed on the faculties of the 330 institutions of higher education mentioned earlier.

Like horticulturists and agronomists, soil scientists are employed primarily by State agricultural experiment stations, the United States Department of Agriculture, colleges and universities, and manufacturers of various agricultural products (*38*). However, no women soil scientists were employed by any of the Government agencies or by any of the industrial research laboratories surveyed by the Women's Bureau. (See p. 3-76 for minimum requirements for Federal Civil Service positions as soil scientists.)

Forester as Defined by the National Roster of Scientific and Specialized Personnel (*25*)

"The forester is concerned with the operation, management, protection, utilization (recreational and economic), mensuration, logging, and reforestation of public and privately owned forest lands. The profession of forestry usually includes the subordinate or related areas of silviculture, range management (or science), and wood technology (the properties, anatomy, identification, preservation, and industrial utilization of wood)."

Forester as Defined by the United States Forest Service

"The forester is concerned with the operation and management of wild land, commonly called forest areas.

"The profession of forestry includes a knowledge of the underlying natural sciences basic to an understanding of problems involved in correlating the uses of the five principal resources, namely, timber, water, forage, wildlife, and recreation."

FORESTRY

Forestry, like geology, is usually thought of as a man's province, largely because of the attendant field work, much of it in isolated places. One government official estimated the amount of such work as 90 percent of the job of the average forester, during the first 10 years of his professional life. The few women in forestry are employed by forestry organizations, although most of the men are engaged in jobs that include field work with Federal, State, or local forestry departments. The Federal Government is a major employer of foresters. Others are employed by lumber companies, manufacturers of wood products, and other timberland owners. However, almost half of the 61 persons who received doctorates in forestry in the decade preceding 1940 were teachers, and more than a third were doing research (*12*). Only 5 of the 151 women botany teachers on the faculties of the 330 schools in the Office of Education sample were teaching forestry, and 4 of these taught forestry and wood technology. If this sample is representative of all college and university faculties, then there are fewer than 25 women forestry teachers on all faculties.

Courtesy U. S. Forest Products Laboratory

Figure 6.—Employed in the U. S. Forest Products Laboratory, this scientist, called a xylotomist, identifies wood specimens by their microscopic structure.

There are about 9,000 people in forestry and related fields, including soil conservation, range management, and similar work, according to the Society of American Foresters. Of the approximately 5,500 members of the Society in 1947, only 13 were women, 5 of them active and 8 associate members.

Twenty-six men and no women were appointed to forestry jobs in the Federal Civil Service at the junior professional assistant level in 1940 (*23*). (See p. 3–77 for minimum requirements for Federal Civil Service positions as foresters.)

Courtesy Purdue News Service

Figure 7.—One of the few women freshmen receiving instruction in forestry at a school of agriculture in 1947.

Even before the war, there were women in forestry. In 1938 the Federal Government employed 30 women in forestry and range science occupations (*41*). The United States Forest Service, in the depression years 1933-36, employed a few professional women foresters who were assigned to emergency work relief projects. During World War II a woman forestry aid was employed by the Tennessee Valley Authority. In 1946, however, there were only 5 women with forestry or other botanical training doing professional work in the United States Forest Service. Two were botanists classified as forest ecologists, 2 were wood technologists, and 1 was a forest pathologist. Two women also occupied subprofessional positions requiring botanical training—a botanical artist and a herbarium clerk. The present sup-

ply of foresters, including those released from the armed forces, plus the additional graduates each year, about 500 annually before the war, is believed to be adequate to meet normal postwar needs. (*36*).

The United States Forest Service does not as a rule employ women in the field, because conditions are such that it is impractical to do so. Field work is an important part of a forester's training, and, as already noted, the largest part of his work for about 10 years consists of field work. This field experience is essential for advancement to most desk jobs, and women, who do not usually have the opportunity to obtain such experience, find advancement difficult.

There are, however, certain types of forestry jobs in which women are not so handicapped. In the future, there may be a few additional jobs for women in wood technology and wood chemistry in laboratory and research programs. These would not necessarily involve the type of preparation that now makes forestry training especially difficult for women. Other sources of employment for women trained in forestry are club, radio, and education work.

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Bacteriology as Defined in a Revision of the Occupational Summary Prepared by the National Roster of Scientific and Specialized Personnel (*26*)

Bacteriology is concerned with the classification, identification, propagation, sterilization, isolation, and physiology of the various types of bacteria and other micro-organisms; their effects upon cells, tissues, organs, food products; their use in industrial fermentation and related processes; the preparation of immune serums, vaccines, and other "biologicals." In a broad sense, the field deals with pathogenic or disease-causing bacteria, and the saprophytic bacteria, which live upon dead organic matter.

Courtesy U. S. Food and Drug Administration

Figure 8.—A bacteriologist testing penicillin for pyrogens.

Some Typical Jobs in Bacteriology

A bacteriologist in a university hospital might describe her duties as follows:

I am responsible for all the routine diagnostic bacteriology including: nose and throat cultures, blood cultures, spinal fluid examinations, stool cultures for the isolation of enteric pathogens, studies on sputa from cases of acute and chronic respiratory infections, etc. I prepare and standardize autogenous vaccines. I test the sensitivity of recently isolated strains of bacteria to the various sulfonamides, to penicillin and to streptomycin as well, determine the blood levels of the specific one with which a patient is being treated.

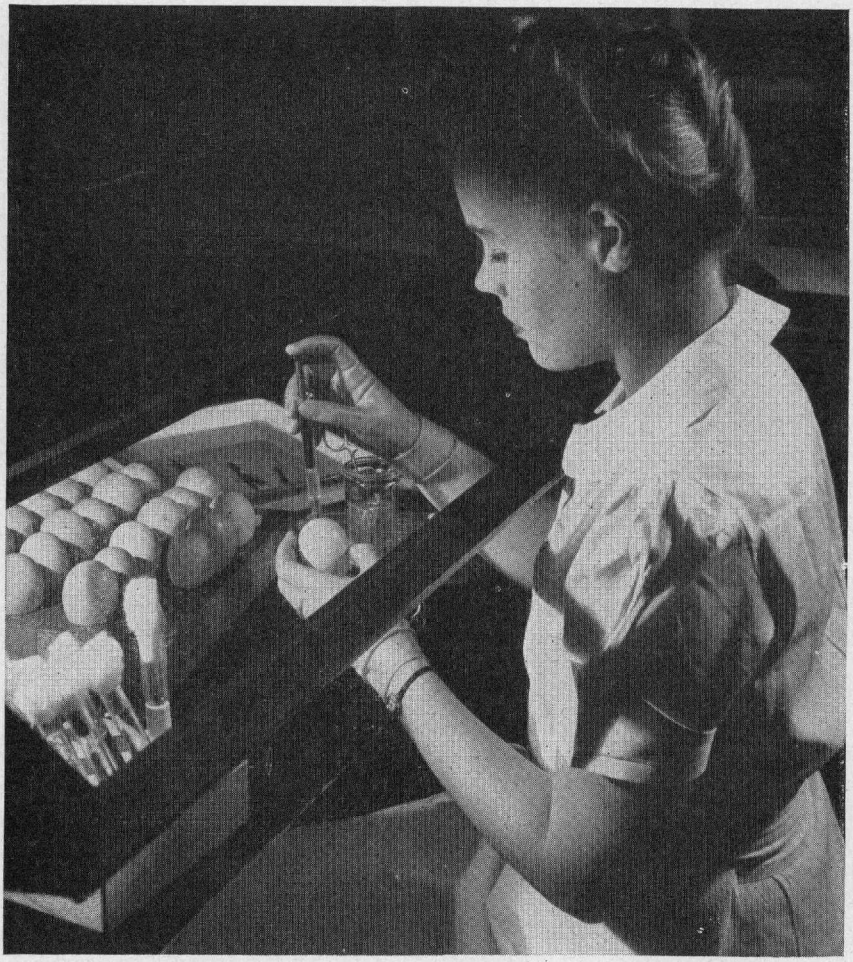
A junior or assistant bacteriologist in a research laboratory, carrying on studies with viruses involved in acute respiratory infections, might be quoted as saying:

My duties as a member of the research team are to attempt to establish and then maintain growth of viruses in chick embryo. Isolations of various viruses are attempted directly from the blood, nasal washings, and the sputum of patients and indirectly from the tissues of animals previously inoculated with them.

A research bacteriologist engaged by a group of food manufacturers might investigate (*a*) the possible sources of contamination of a food with enterotoxigenic staphylococci, (*b*) the conditions under which the growth of these bacteria might be kept at a minimum, and (*c*) the conditions that might contribute to the development of especially potent toxins.

Courtesy University of Cincinnati

Figure 9.—Conducting bacteriological research in a children's hospital.



Courtesy U. S. Public Health Service

Figure 10.—Injecting a chicken egg with typhus rickettsia for the preparation of typhus vaccine.

THE OUTLOOK FOR WOMEN IN BACTERIOLOGY

Bacteriology, a specialty which has developed in the field of biology within the past 60 years, has attracted a large number of women. The 592 women bacteriologists registered with the National Roster of Scientific and Specialized Personnel at the end of 1946 were 22 percent of the total group (*30*).

Those who specialize in bacteriology usually approach it from one of the following avenues: basic courses in chemistry or such biological sciences as botany or zoology; agricultural science; home economics and nutrition; or premedical or medical training. A Ph. D. in bacteriology is sometimes combined with an M. D., and it is not unusual to find physicians working in the bacteriological field. The fact that the biological sciences have attracted relatively more women than have the physical sciences, plus the kinship of bacteriology with home economics, especially nutrition, may explain the unusually high proportion of women.

Prewar Distribution

In 1939 there were about 4,000 bacteriologists in the United States, according to the National Roster of Scientific and Specialized Personnel. They worked in a variety of places: State, local, and Federal public health laboratories; hospitals, clinics, dispensaries, and medical research laboratories; colleges and universities; agricultural research and experiment stations; plants manufacturing drugs, serums, antiseptics, disinfectants, and fungicides; dairies and other food products plants; and distilleries, breweries, and other fermentation industries (*35*). For the most part, however, they were concentrated in the larger metropolitan areas throughout the country, primarily where medical centers and factories are located (*16*).

The bacteriologist may specialize in a particular field, such as agricultural, industrial, veterinary, medical, or public health bacteriology; or in a particular type of research or analysis, such as immunology (concerned with responses in man or animals to specific infections or biological agents), serology (the study of body fluids especially in relation to immunity), virology (deals with ultramicroscopic organisms known as viruses, which often cause disease), or medical mycology (the science of pathogenic fungi) (*26*). Mycology, which is also considered a branch of botany, is discussed on pages 3–13 and 3–14.

Women bacteriologists, even before the war, were employed in a variety of jobs in many types of establishments, although medical laboratories were by far the most common outlet. Many of these

women did routine laboratory work, preparing cultures and making analyses. The Ph. D.'s among them were engaged chiefly in research or teaching, and a few were in charge of research projects and production units, usually in industries manufacturing biological and chemical products or preparing food products.

In 1940 almost 45 percent of the 325 employed men and women who had been granted a Ph. D. in bacteriology in the preceding decade were engaged in research; nearly 29 percent were teaching; and about 18 percent combined teaching and research (*12*).

Although some of the women Ph. D.'s in bacteriology obtained good positions in bacteriological work before the war because of the demand for trained persons, one university in the Midwest reported that it was difficult to place all of those with undergraduate degrees in jobs requiring bacteriological specialization. Usually, however, they found laboratory jobs of some sort, frequently in chemical analysis, if they had had enough chemistry.

In industry, women bacteriologists were found primarily in the laboratories of plants manufacturing foods, food products, or biological products. Comparatively few were in the dairy industry, where heavy work is sometimes involved. Nine of the 78 industrial firms visited by the Women's Bureau in 1945–46 that had research laboratories in which technically trained women were employed in some capacity, had employed women bacteriologists before the war either on control or research work. In the additional 18 commercial testing laboratories visited, none of the women employed were bacteriologists.

Approximately 100 women bacteriologists were employed in the Federal Government just before the war. This is an estimate based on the fact that only 130 women were employed in the Federal Government as agronomists, horticulturists, botanists, and bacteriologists, at the end of 1938, according to a Women's Bureau study (*41*), and later statistics indicate that women agronomists, horticulturists, and botanists were relatively few. Apparently the supply was greater than the demand before the war. Although 220 women and 301 men passed the 1940 Federal Civil Service examination for Junior Professional Assistant with option in bacteriology, only one woman and three men were appointed to probationary or permanent positions from this list in the year ending June 30, 1940 (*23*). There were almost no calls for bacteriologists, according to the Medical Division of the United States Civil Service Commission, except from the Food and Drug Administration, which then employed men, principally because they were used not only in the laboratory but also on field inspection and surveys which sometimes may involve difficult physical conditions. A few calls a year were received from the United States Public Health Service, where women as well as men were placed.

Annual Addition to the Supply

There are no available statistics on the number of persons who received first degrees in bacteriology before the war, although, according to the United States Office of Education, 2,632 men and 1,997 women received bachelor's degrees in all the biological sciences, including bacteriology, in the academic year 1941–42 (*43*). Very few doctorates have ever been awarded in bacteriology to men or to women. The largest number granted was 71 in 1941 (*11*). In the entire prewar decade they totaled only 355 (*12*).

Only 10 of the 30 colleges and universities from which the Women's Bureau obtained statistics on women majors in science granted degrees in bacteriology, and the number of men and women graduates who had majored in bacteriology in any 1 of them was small. Thirty-one was the largest number of men and women graduated by any 1 of these schools in any 1 year. Most of them graduated less than 10.

Wartime Changes

There was no marked change in the type of work done by women bacteriologists during the war, and although there was an increase in demand, it was not comparable in volume to that which took place in such fields as chemistry, mathematics, and physics. However, there was a substantial increase in the demand of State health departments for bacteriologists, and opportunities for employment in industry were increased by the development of new drugs like penicillin and streptomycin and by the vacancies created by the loss of men bacteriologists to the armed services.

Seventeen of the firms visited by the Bureau in connection with this study had women bacteriologists in their laboratories during the war, 8 more than the 9 that had employed them previously. Two of the 17 were commercial testing laboratories. The others, all manufacturing firms, represented the same industries—foods and chemicals, especially pharmaceuticals—that had employed women bacteriologists before the war, with the exception of 1 that manufactured paper products. The number of women bacteriologists in a single firm was small; the range was from 1 to 12. Often, there was only 1, and in only 1 firm were there more than 10.

In these industrial laboratories women were employed at all levels of responsibility and skill. They were laboratory technicians, developmental bacteriologists, assistant and associate research bacteriologists, and heads of laboratories. The technicians' work involved standard laboratory analyses and sometimes the use of animals in testing; a knowledge of routine production methods was also required. At a higher level of skill and responsibility, the develop-

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mental bacteriologists were concerned with the improvement of methods of processing, and the research bacteriologists, with new products and new uses of old ones. Heads of laboratories supervised routine testing or such projects as virus research or virus production.

In Government, except in military service, job opportunities did not expand to the same extent that they did in industry. The Federal Civil Service Commission reported no marked change in the demand for bacteriologists in Government until late in the war, when they were needed in greater numbers to test new drugs. Women bacteriologists were employed only in small numbers in a few Government agencies. Among these were the Chemical Corps and the Office of the Quartermaster General of the War Department, the Fish and Wildlife Service in the Department of the Interior, the Department of Agriculture, the United States Public Health Service, which also sent bacteriologists to State and territorial laboratories, and the Food and Drug Administration. Only in the last mentioned was there any appreciable expansion caused by the new antibiotic drugs (substances produced from cultures of micro-organisms and used in the treatment of bacterial diseases). For example, the wartime controls which required that all penicillin must meet the Food and Drug Administration's tests and the law, effective in 1945, bringing penicillin under the inspection and regulation of the Administration increased the need for bacteriologists in the laboratory.

In fact, most of the women bacteriologists taken on during the war by the Food and Drug Administration were testing penicillin, streptomycin, and other new antibiotic drugs. However, a few tested foods suspected in connection with food poisoning cases or the sterility of surgical dressings, ampoule drugs, and other products, the safe use of which depends on freedom from bacterial contamination.

Both the Women's Army Corps and the WAVES used the services of bacteriologists during the war. Thirty women bacteriologists commissioned as WAC officers and 84 as WAVES officers were assigned to active duty as bacteriologists. More than 1,500 enlisted women were trained in these services to work as medical laboratory technicians who assisted physicians, bacteriologists, and other scientists in the laboratory by performing routine duties. A report on the outlook for medical laboratory technicians has already been published by the Women's Bureau (*42*).

Research foundations and university research projects were another source of employment for bacteriologists during the war. Women bacteriologists worked at the Rockefeller Institute, for example, on special war research and at various universities on projects subsidized since 1944 by the United States Public Health Service through grants-in-aid.

Courtesy Miner Teachers College

Figure 11.—A class in bacteriology at Miner Teachers College.

In January 1944, nearly three-fifths of the 220 graduate students in bacteriology and more than four-fifths of the undergraduates in the United States were women (*40*). There was almost no change in the total number of undergraduate degrees in all the biological sciences, including bacteriology, between 1941–42 and 1943–44. In both academic years there were about 4,600. But the percentage awarded to women increased slightly from 43 percent to a little more than half (*43*) (*44*).

At the doctorate level, however, losses were suffered during the war. The total number of doctor's degrees awarded in bacteriology and microbiology fell from a high of 71 in 1941 to 49 in 1944 (*11*). No figures are available on the proportion of women among those receiving Ph. D.'s. Fragmentary statistics from a few schools show no discernible increase in the number of women who took graduate work during the war, although more assistantships were available to women because of the scarcity of men.

Earnings and Advancement

Before the war, bacteriologists with a bachelor's degree usually started at a salary of $1,200–$2,000 per year; the latter was the beginning rate in the Federal service (*35*). The 1947 starting rate as a bacteriologist at the beginning professional grade in the Federal Civil Service was $2,644 per year. In the Middle Atlantic States, the starting rate in 1947 in industry for bacteriologists with a bachelor's degree

was reported by an industry spokesman to be about $2,700, for those with a master's, $3,000, and for Ph. D.'s, $4,200. As late as 1945 college placement bureaus reported that starting salaries in public health laboratories were usually under $2,000 a year and that most beginning medical laboratory jobs paid about $1,500–$1,600 annually.

In 1947 the annual salaries of 148 women employed in bacteriology were reported in a questionnaire study, the results of which have been made available by the Society of American Bacteriologists. Twenty-eight of the women were technicians or combined study with their work. Two had no degree. But 118 were employed entirely in professional work. The range of their salaries and the median salaries by type of employment and academic degree are shown in table 6. The median salary for the entire group was $3,400, although salaries ranged from $1,800 to $6,000. Both median and top salaries were higher for the 75 percent having graduate degrees.

Table 6. Annual Salaries of 118 Women Bacteriologists in Professional Positions, by Type of Employment and Highest Academic Degree Held, 1947

Type of employment	Highest academic degree held			
	Total	Bachelor's	Master's	M.D., D.Sc., or Ph. D.
Total:				
Number of women	118	29	46	43
Range of salaries	$1,800–$6,000	$2,000–$4,620	$1,800–$5,820	$2,400–$6,000
Median salary	$3,400	$3,000	$3,360	$3,720
Teaching and research:[1]				
Number of women	47	4	13	30
Range of salaries	$2,000–$5,500	$2,000–$3,000	$2,500–$5,450	$2,400–$5,500
Median salary	$3,200	$2,500	$3,000	$3,550
Government and hospital laboratories:				
Number of women	42	12	21	9
Range of salaries	$1,800–$6,000	$2,760–$4,620	$1,800–$5,820	$3,000–$6,000
Median salary	$3,624	$3,334	$3,600	$4,152
Industry:				
Number of women	29	13	12	4
Range of salaries	$2,400–$5,800	$2,691–$4,290	$2,700–$4,056	$2,400–$5,800
Median salary	$3,360	$3,000	$3,450	$3,960

[1] Exclusive of research in industry or in government and hospital laboratories.

Source: Earnings data from a 1947 questionnaire study made available by the Society of American Bacteriologists. In this study, the proportion of women with higher degrees is considerably higher than that among all women trained in bacteriology.

There were substantial differences in the average salaries received by women in different types of work. Although the teaching and research group contained by far the largest proportion of the women with doctorates, this group was the lowest paid. Higher salaries were paid in industry, in which only a few persons held the doctorate. Highest salaries were reported by women employed in government and hospital laboratories.

These 118 women bacteriologists averaged between $3,000 and about $4,100 per year, except for those few within the teaching and research group who had no more than the bachelor's degree, who averaged

only $2,500, usually for an academic year of 9 months. These figures substantiate the Ohio State Employment Service report that a reasonable expectation of earnings for an average experienced bacteriologist is $3,000–$4,000 a year (*16*).

In spite of the relatively large number of women in bacteriology, most of the higher positions are held by men (*46*). Although a number of women are engaged in research jobs and become group leaders, only a few are heads of laboratories. Those who serve in this capacity are more likely to be found in industry than in a medical laboratory, where a male physician is often in charge, although some State departments of health are headed by women. There are many women instructors of bacteriology, but few women head bacteriology departments in colleges and universities. Evidently advancement is slow for women scientists, even in those sciences in which they form a significantly large proportion. However, the 1947 meeting of the Society of American Bacteriologists, at which 68 women were among the 430 who presented papers, afforded ample evidence of the professional achievements or contributions of women bacteriologists.

Organizations

The chief professional organization is the Society of American Bacteriologists, organized in 1899 with 57 members (*47*). In 1947 there were over 3,000 members, of whom about one-fourth were women. There are no special requirements for membership except interest in bacteriology, although most of the members are engaged in bacteriological or related work. Two women have served as presidents. One, who held office in 1928, worked at the National Institute of Health and is noted for her work in brucellosis (an animal disease that occurs in cattle, hogs, and goats and, when transmitted to humans, is commonly known as undulant fever). The other, who served as president in 1943, carried on studies that have led to an orderly grouping of streptococci, so that potentially pathogenic strains may be readily recognized and their significance in causing epidemics may be investigated; her immuno-chemical studies have been far reaching. She is now a member of the staff of the Rockefeller Institute for Medical Research. There are several other professional societies, in which women form varying proportions of the total membership, such as the Laboratory Section of the American Public Health Association.

The Outlook

In 1947 there were at least 1,000 women bacteriologists in the United States, if we assume that the membership of the Society of American Bacteriologists with about 800 women members represents about four-fifths of all professional bacteriologists.

Almost 600 women bacteriologists were registered with the National Roster of Scientific and Specialized Personnel at the end of 1946. Although incomplete in coverage, Roster figures give some indication of the proportion of women in bacteriology in the early postwar period and of the extent of their training. Although women constituted about 22 percent of the Roster's bacteriologists, they were only 13 percent of the Ph. D.'s but nearly 30 percent of those with bachelor's degrees in bacteriology, as listed at the end of 1946 (*30*).

It is perhaps because the Ph. D. is so important and because so few women have it that, according to one prominent bacteriologist, probably no more than 5 percent of those in research and teaching are women. Here, too, the turn-over is lower and openings fewer than in more routine work. The same authority estimates that in work done primarily by women with the bachelor's degree—such as control work or testing in biological supply houses and other industries and in hospital, public health, and other medical laboratories—40 to 50 percent of the personnel are women. This estimate is verified in part by a recent survey of employment in State and local health departments undertaken by the United States Public Health Service. In 1945, 57 percent of the bacteriologists and serologists employed in State and local health departments were women. Altogether, 525 women classified as bacteriologists or serologists were employed in the 38 State health departments or in the 80 percent of the full-time local health departments reporting in the survey. Because turn-over is rapid in the bachelor's degree group, there will be continued opportunity for new graduates, certainly in hospital and other medical laboratories.

For women with undergraduate training only, hospital, public health, and other laboratories will continue to be the largest source of employment. Research in medical schools and other medical research centers, as well as in hospitals and public health research laboratories, was retarded during the war, which diverted to the armed forces those who normally supervise such work. Furthermore, the volume of routine work was too great during the war to permit research. Research work, therefore, may be expected to offer some expansion in opportunity to women bacteriologists, especially to those with graduate training, as long as the shortage of physicians and of men scientists continues. There are limiting features however. Few hospitals have special divisions of bacteriological work for which advanced training in bacteriology is necessary. Expansion of services results primarily in a greater increase in the use of the less highly trained medical technicians rather than in the employment of bacteriologists with graduate training.

Other employment outlets for bacteriologists are such research projects as those financed by the United States Public Health Service.

Although grants may be made to assist various types of research groups, or even individuals, in practice they have almost invariably been given to universities. Somewhat more than four million dollars has already been distributed under this plan. Much of the postwar expansion in job opportunities for bacteriologists, according to one authority, will result from such subsidized medical research. Since the war period, there has been a renewed interest in research and an increased number of positions in research projects, subsidized or undertaken by the government.

The Women's Bureau found 45 women bacteriologists employed in 16 establishments among the 78 industrial firms having research laboratories and the 18 commercial laboratories which were visited after the war in the course of this study. Although exact statistics were not available from one of these companies, this indicates that there are probably about 400 women bacteriologists in industry. There may be considerably more. Individual scientists may become specialized in several fields, so that their classification under a single science is difficult. For example, in some fields, including the expanding one of microbiological assays, there are many who are in part bacteriologists, in part chemists, and are likely to be classified as chemists. For this reason, and because the sample is also subject to considerable error because the bacteriological group is so small and concentrated industrially, the estimate must be taken only as a provisional one until better statistics are available.

The women in the laboratories visited were doing all types of bacteriological work, with varying degrees of responsibility. Some were technicians, doing routine work; but it was not unusual for women bacteriologists with advanced degrees to be engaged in developmental work or research. Some were research assistants and associates in bacteriology; others were working on independent projects. A few were in charge of research projects or of production units in pharmaceutical companies.

One woman was supervising work on bacteriological cultures; another was a department manager, supervising a virus research laboratory; another headed the virus production laboratories. These three women had doctor's degrees in bacteriology.

All the 16 employers, except one, intended to retain the women bacteriologists they were employing at the time of the Women's Bureau study, including those hired during the war. Only one employer said that he employed women only because he could not afford to pay the salaries necessary to obtain men for laboratory work. Sometimes, because of the nature of the industry, men are preferred. For instance, in the dairy business, the ability to do heavier work than that normally required of a bacteriologist is often necessary in small plants.

Most of the wartime expansion in industrial bacteriology is permanent, since it was not associated with war production alone but stemmed from the development of such new products as antibiotic drugs and such new processes as the dehydrating and freezing of foods. Microbiological assay of vitamins is another recently developed field that will continue to require the services of bacteriologists. In addition to opportunities in these newer fields, more jobs are likely to become available in established industries where normal expansion was prevented by the war. The routine nature of many of the positions in industry has discouraged men from entering the field, and there are, consequently, more jobs for women. However, many of these are so routine that the simple techniques necessary can be taught on the job and do not require college training. As a result, wages remain low.

Courtesy U. S. Food and Drug Administration

Figure 12.—Bacteriologists testing the potency of streptomycin.

In 6 Federal agencies reporting the employment of women bacteriologists, there were 46 women doing bacteriological work a year after the war's end. There are probably some additional bacteriologists in the Federal service, because all agencies employing bacteriologists were not covered, and statistics were not available on the field offices of one department where a number of such workers are known to be employed. Since returning servicemen will be available, opportunities for women in the Federal services will be quite limited for a few years.

The Food and Drug Administration may continue to hire a few women bacteriologists from time to time. Since 1947, the law has required that streptomycin, like penicillin, be certified by the Administration, and other new antibiotic drugs requiring such testing may reach commercial production soon. There also may be occasional openings for women in the U. S. Public Health Service, which in 1947 employed 17 women bacteriologists, most of whom were with the National Institute of Health in Washington. (See p. 3–78 for minimum requirements for Federal Civil Service positions as bacteriologists.) So important have these new antibiotic drugs become that in the Federal Security Agency's Division of Penicillin Control and Immunology, the new employment classification "Antibiotics Analyst" has been substituted for that of "Bacteriologist."

Women bacteriologists are less handicapped in competition with men than are women in most other scientific fields. Some employers say they prefer women for certain types of bacteriological work, because they believe women have special talents useful in this field. Very few men have the patience required for tedious repetition in culture studies, and most of the tiresome, painstaking bacteriological procedures are carried on by women. Women, as compared with men, are reported to give closer attention to detail, to be better at repetitious work, and more painstaking on projects requiring extensive data-keeping.

Although women trained at the Ph. D. level in bacteriology can obtain research and college teaching positions, their advancement is likely to be less rapid than that of similarly qualified men. But because fewer people took advanced training in bacteriology during the war years, women with Ph. D.'s found their opportunities better in the early postwar period than before the war. Nevertheless, many colleges specify that they want men for teaching openings. Some college departments of bacteriology have never hired women and refuse to do so, and in any one department or research institute there are usually only one or two women bacteriologists.

In 1947, 127 women bacteriologists were listed as faculty members in the catalogues of 330 institutions of higher education (comprising a United States Office of Education enrollment sample of the 1,749 institutions of this type in the United States). If this sample of schools is as representative of the employment of women bacteriologists in all institutions of higher education in the United States as it is of enrollment, there were about 315 women on bacteriology faculties alone and about 110 additional women who combined academic employment in bacteriology with that in such other fields as botany or a medical science. Over four-fifths of the faculty women covered in the count were in publicly or privately controlled universities. A little more than one-tenth were on the staffs of medical or other tech-

nical and professional schools. The numbers in separate colleges of arts and science, junior colleges, and other institutions were negligible. Obviously, therefore, the woman who wishes a faculty position in bacteriology will find her opportunities greatest in universities or professional schools.

Although none of the 127 women was listed as a full professor of bacteriology in the catalogues examined, 12 women had the title of assistant or associate professor. Of these, 9 had the doctorate. An additional 22 women were listed as instructors. The remaining 93 held various titles such as those of research associate, teaching fellow, or graduate assistant, indicating they were probably combining research or study with teaching or might be engaged primarily in research. It appears likely that many women bacteriologists on college faculties, if not most, were combining research with teaching.

The present demand for all types of bacteriologists exceeds the number of those qualified for the available positions. There is a need for those able to do diagnostic work in medical bacteriology, as well as for research associates. State and larger city laboratories need competent personnel in this field.

In 1947 there were many evidences of the continuing demand for bacteriologists. The bacteriology department of one university was receiving at least one request a week for a well-trained bacteriologist. Advertisements for bacteriologists appeared constantly in issues of professional journals in this field. The Placement Bureau of the Society of American Bacteriologists also reported more requests for both men and women bacteriologists than it could fill. The director of laboratories for a State health department needed competent workers so desperately that he said his problem of obtaining staff was more difficult than it had been during the war.

The use of newer and more powerful drugs, requiring laboratory tests to check their effects on patients, has also created an additional demand by physicians for laboratory service. Many of the physicians who served with the Army and Navy became used to laboratory assistance, which increased the accuracy of their diagnoses; and on their return to civilian practice, they have sought service from public and private laboratories.

The expansion of bacteriological work in the medical and industrial fields indicates a continuing demand for women with the bachelor's degree in bacteriology. But training or experience in related scientific fields, in addition to that in bacteriology, is often helpful. For example, a combination of enzymology and bacteriology is good in the research field. For medical bacteriologists, practical experience in serology and in the handling of sanitary problems increases the probability of getting a position as head of a section in a hospital. The student interested in medical research, in which an M. D. degree is

reported to provide a distinct advantage in obtaining appointment or advancement, might well consider combining this degree with a Ph. D. in bacteriology.

Prewar experience and the comments of employers interviewed shortly after the war strongly suggest that training in chemistry improves a woman's chances for employment. Some employers considered a background in chemistry the best foundation for work in their laboratories. Actually, reports from colleges show that many of the master's and doctor's degrees in bacteriology are awarded to women whose first degree was in chemistry and who became interested in bacteriology through work in a medical laboratory. The woman who is interested in bacteriology can increase her employability by securing thorough training in both bacteriology and chemistry, as well as in the medical sciences.

The young woman who is interested in bacteriology will find that many colleges have only very limited curricula in this subject. A study made by a group of bacteriologists at Purdue University in 1941 revealed that 132 of 168 colleges and universities surveyed offered only one bacteriology course. On the other hand, as many as 29 bacteriology courses were given at one school (*10*). Of the 30 colleges and universities offering degrees in the sciences, among the institutions that supplied the Women's Bureau with statistics for this study, only 10 granted degrees in bacteriology. The difference in the amount of training available at various schools suggests the importance, to women interested in becoming bacteriologists, of selecting the proper college or university. A student whose undergraduate training has been inadequate may be delayed in obtaining an advanced degree because of the time lost in making up this deficiency. Thorough undergraduate training in all of the sciences, including mathematics, is desirable for the student who plans to do graduate work.

Of 188 institutions of higher learning surveyed by the National Roster of Scientific and Specialized Personnel shortly after the war, only 19 offered the Ph. D. in this field (*28*). Postgraduate training is more likely to be available in State universities, medical schools, and agricultural colleges than in other types of colleges and universities.

Bacteriology is a field that women have already entered in large numbers and one in which they have made substantial progress. They are less likely to encounter discrimination because of their sex than are women in many other professions and are, on the contrary, preferred by many employers who believe that this is work for which women are particularly well adapted. The well-trained woman bacteriologist, especially if she has a good background in related sciences, will find that there is a continuing demand for her services.

The Zoologist as Described by the National Roster of Scientific and Specialized Personnel (*34*)

"The zoologist works in the basic biological science which deals with animals, especially with their origins, interrelationships, classification, life histories, habits, behavior, life processes, diseases, relations to environment, growth and development, genetics, and distribution."

Zoology as Defined in Webster's New International Dictionary, Second Edition, Unabridged, 1946

"Zoology—The science which treats of animals; the branch of biology dealing with the animal kingdom and its members (as individuals and classes) and with animal life. Zoology, in its broadest sense, includes animal morphology (together with anatomy, histology, and cytology), physiology, embryology, genetics, taxonomy, paleontology, ecology (bionomics, ethology) and various other sciences in whole or in part. There are also numerous divisions named according to the particular groups of animals with which they deal, as, entomology, treating of insects; ichthyology, of fishes; ornithology, of birds; protozoology, of protozoans, including their economic and pathological relation to man; * * *."

Courtesy Bryn Mawr College

Figure 13.—Students in zoology laboratory examining material under a binocular microscope and dissecting a rat.

THE OUTLOOK FOR WOMEN IN ZOOLOGY

Zoology in its broadest sense includes such applied fields as dairy and poultry science and the physiology and pathology of human beings as well as of lower forms of animal life. In its narrowest sense zoology is confined to the study of the form and structure of animals (morphology), their classification (taxonomy), their development (embryology), and their functioning (physiology).

In 1946, 7,800 persons were registered by the National Roster of Scientific and Specialized Personnel as trained or employed in one of the zoological sciences, used in the broader interpretation and including general zoology itself, which employed less than one-fifth of the total. (See table 7.) Of the 615 women registered, however, the majority were general zoologists, and physiologists ranked second. On the other hand, there were almost twice as many men in the applied animal and poultry sciences as there were in general zoology. The mother science was also outranked by entomology in the volume of its employment of men.

In the discussion that follows, the outlook for women in general zoology is presented, followed by special mention of physiology because of the increasing interest in and emphasis on this field. The applied sciences of animal husbandry are also discussed separately, but anatomy, entomology, and parasitology are included with general zoology.

Table 7. Distribution by Specialization and Sex of Persons Registered in Zoology and Related Sciences With the National Roster of Scientific and Specialized Personnel, Dec. 31, 1946 [1]

Specialization	Number registered			Percent women are of total
	Total	Men	Women	
Total	7,800	7,185	615	7.9
Zoology	1,545	1,215	330	21.4
Physiology	863	754	109	12.6
Pathology	651	588	63	9.7
Anatomy	474	432	42	8.9
Entomology	1,555	1,524	31	2.0
Parasitology	327	298	29	8.9
Dairy, poultry, and other animal sciences	2,385	2,374	11	.5

[1] This is by no means a complete listing of all zoologists, but is a report of voluntary registrations. Younger workers especially are likely to be represented inadequately in a roster of this type.

Source: National Roster of Scientific and Specialized Personnel (*30*).

GENERAL ZOOLOGY

Prewar Distribution

As in many of the other sciences, the type of employment in zoology often varies with the amount of training and degree of specialization. For zoologists with the Ph. D., college teaching was the most common type of employment before the war, as it was after, except for the entomologists.

In 1940, 255 entomologists, 122 anatomists, and 976 other zoologists who had received their doctorates during the preceding decade reported their type of work to the American Council on Education (*12*). Almost one-half of the entomologists were engaged in research work exclusive of teaching, compared with only one-fifth of the zoologists and one-third of the anatomists. More than three-fourths of the anatomists and almost two-thirds of the zoologists were teaching full-time or combined teaching with research or administrative work. But less than half of the entomologists were instructing at all, and only one-third were engaged primarily in teaching. Separate statistics on women were not given, but all available evidence indicates that women who received the doctorate usually became college teachers, while a few were engaged in research in a medical school or in a research institution.

Young women graduated with master's degrees in zoology before the war usually continued their graduate work toward the doctorate and became teachers of science in colleges or took research assistant jobs in medical or other research institutions. A few became secondary school teachers.

Medical laboratory work, other medical or health work (usually involving additional training), and high school teaching were the principal occupations of women graduating with bachelor's degrees in zoology before the war. For work in many hospital laboratories, a learning period of 6 months without pay or a special training course in medical laboratory technology was required for employment (*42*). However, for work in medical school laboratories, training was usually given on the job. A laboratory technician in neurology, for example, was taught on the job to prepare and embed tissues by the frozen paraffin and celloidin methods, to section tissues, stain sections, and make permanent slides of various types of nervous tissues. She also was trained to assist in operations on monkeys and dogs. A wide variety of activities is represented in the prewar employment of 110 women with undergraduate degrees in zoology, as reported to the Women's Bureau from a number of colleges. (See table 8.) Among the miscellaneous activities were chicken raising, scientific illustrat-

ing, editorial work and statistical work in a laboratory as well as such nonscientific work as employment in a real estate office.

Very few were employed in industry, and they worked either in biological laboratories in companies manufacturing food products, pharmaceuticals, or other chemicals, or in chemistry laboratories in various industries where they were applying techniques learned more often in chemistry than in zoology.

Table 8. Prewar Employment of 110 Women Graduated With Bachelor's Degree in Zoology 1928–41, Compared with Wartime Employment of 120 Women Graduated With Bachelor's Degree in Zoology 1942–45

Type of employment	Women graduated with bachelor's degree in zoology in—			
	1928–41 and employed 1940–41	1942–45 and employed wartime	1928–41 and employed 1940–41	1942–45 and employed wartime
	Number	*Number*	*Percent*	*Percent*
Total	110	120	100.0	100.0
Medical laboratory work	30	27	27.3	22.5
Other medical or health work (including medicine, nursing, physical therapy, X-ray work, and health education or preparation for such work)	17	20	15.4	16.7
Teaching, high school	13	4	11.8	3.3
Research work in institutions or universities (except medical schools)	8	8	7.3	6.7
Industrial laboratory work	8	9	7.3	7.5
Secretarial, clerical or business work	8	10	7.3	8.3
Graduate study (sometimes with teaching duties)	7	18	6.4	15.0
Museum work	3		2.7	
Military service		11		9.2
Government employment		4		3.3
Social science or personnel work	2	6	1.8	5.0
Nutrition work	2		1.8	
Engineering aid		2		1.7
Miscellaneous	12	1	10.9	.8

Fifty women were employed in the Federal Government in 1938 as zoologists or naturalists, 7.7 percent of all the Federal employees in this occupational group (*41*). In the year ended June 30, 1940, however, only one woman received a probationary or permanent Civil Service appointment to a zoological job, that of junior aquatic biologist. But, 13 men were appointed that year to professional field jobs and 6 others as aids or assistants in entomology; another 13 men were appointed as biological aids for injurious mammal control, one was appointed in a junior professional job in animal nutrition, and 8 in professional jobs as wildlife specialists (*23*).

Annual Addition to the Supply

The number of Ph. D. degrees awarded annually in general zoology in the years from 1935 through 1940 averaged 169, nearly one-fourth of them in entomology, and about one-tenth of them in anatomy (*11*).

There is no estimate of the proportion women comprised of this group.

The number of men and women receiving bachelor's degrees in zoology before the war is not known. However, scattered reports from a variety of colleges to the Women's Bureau indicate that few schools graduated more than 10 women a year with a major in zoology. The maximum reported by any one school for a single year was 36.

Wartime Changes

Although World War II affected higher education in obvious ways, the evidence from 14 representative colleges points to no significant change in the number of undergraduate degrees in zoology awarded to women either during the war or in the early postwar year of 1946, as compared with 1939 or 1940. Only 3 colleges, all on the west coast, showed a decline in the number of women graduated in zoology during the war. This decline continued into 1946. Eleven other colleges showed no change or small increases.

At the graduate level, however, a noticeable drop took place. The number of doctorates in zoology, entomology, or anatomy awarded to men and women in 1944 totaled 84, compared with more than twice that number, 181, in 1940 (*11*). The demand for highly trained scientists in this as in other fields caused many to leave college work temporarily for research connected with war problems; potential male graduate students were likewise diverted to military service. However, indications are that the number of women graduate students did not decline. They were sought for the more desirable graduate assistantships which prior to the war had more often gone to men than to women. This induced many women to continue graduate work.

Many experienced zoologists meanwhile worked on wartime projects, often at their usual posts. In the Fish and Wildlife Service, for example, a woman zoologist with a Ph. D. who had become a specialist on furs advised the Army on the best type of shoes and sleeping bags to use in frigid climates. Others, with sufficient training in related fields, were diverted to physiological or bacteriological work. Still others worked on projects financed by the Federal Office of Scientific Research and Development. One young woman, for example, who graduated with a bachelor's degree in zoology in 1944, worked as a research assistant to a parasitologist attempting to ascertain whether snails native to the United States could enable tropical blood diseases afflicting our servicemen to invade the United States.

In a wartime statement to her students on the lines of work for zoology majors in which there was a special demand because of the war, a leading zoologist listed: technician work in medical laboratories; technician and research assistant work in research institutions and on

research projects; parasitology; medicine, nursing, and public health; teaching; and scientific library or secretarial work (*14*). Because of the tremendous need in medical laboratories, women were hired for hospital laboratory work without the customary learning period or the special course in medical technology usually required.

Courtesy U. S. Department of Agriculture

Figure 14.—Entomologist testing repellency of cloth against mosquitoes.

The wartime occupations of young women who graduated with the bachelor's degree in zoology during the war years 1942 to 1945 proved to be quite similar to those of prewar graduates, except for the additional outlets of military service and government research projects. (See table 8.) Relatively more women, as scholarships and fellowships were more easily available, undertook graduate work, sometimes combined with college teaching assistantships; this may in part explain the drop in the proportion taking teaching positions in high schools.

Earnings and Advancement

The only recent comprehensive report on earnings of zoologists and others trained in zoology is that of the American Physiological Society, which studied the earnings of physiologists in its 1945 survey. But fragmentary reports on other fields indicate wide variations. In 1946 the salary offered young women with the bachelor's degree in zoology to teach high school science varied from $1,400 to $2,100 for the academic year of 9½ months. In laboratories in medical schools and hospitals, beginning salaries for those with undergraduate degrees varied from $1,300 to $2,250 a year, with lunches often included on hospital jobs. Although most young women took salaried jobs, one recent graduate after taking training became a partner in a medical laboratory, on the basis of receiving one-third of the profits. In 1946 she averaged from $300 to $500 a month. In industry, laboratory jobs paid beginners from $1,800 to $2,000 a year. Those with a master's degree usually started at a salary of $1,800 to $2,500 a year in research laboratories or in biological supply houses. But wide variations in salaries were evident at all levels. A zoologist who had just received her Ph. D. was hired in 1946 by a research foundation at a salary of $2,000 a year as an industrial research chemist. These represent beginning salaries. In the Federal Government the entering salary in 1947 was $2,644. Before the war, 90 percent of the women zoologists employed by the Federal Government earned more than the beginning salary (which at that time was $2,000) (*41*).

More comprehensive information is available on physiologists. In 1945 the median professional income for women physiologists was $3,200 a year; the median for the entire group, $5,050 (*2*). Part of this more than 50-percent difference may be due to the fact that 17 percent of the women lacked the doctorate, while only 2 percent of the men were without it.

Advancement in zoology, as in some of the other sciences, has come to women in the form of recognition as scientists but seldom in terms of economic rewards or promotion in title or position. In college teaching, however, a number of women have attained recognition. In 1946, 111 women zoologists were teaching zoology or entomology on the faculties of 330 institutions of higher education that were representative of enrollment in the 1,749 institutions of this type in the United States. Eleven of these women had become full professors, and 17 others had reached a rank above that of instructor. Two of the full professors were in universities. Some of these educators have attained distinction in research as well. For example, 1 woman professor of zoology at a woman's college is well known for her research contributions in endocrinology. One anatomist, who added an M. D.

degree to her degree in science, has won national renown for her work on the pathology of tuberculosis and on the origin, nature, and activities of the white blood cells. Other women in zoology have made contributions to cancer research; a few have become recognized as authors.

During the period 1919–38, 14 of the 134 national research fellowships awarded in zoology by the National Research Council went to women. All had their doctorates, 6 of them in zoology, 3 in physiology, 1 in entomology, 1 in herpetology, 1 in genetics, 1 in morphology, and 1 in biochemistry (*15*).

Organizations

In 1946 the American Society of Zoologists had more than 1,080 members, of whom about 100 were women (*3*). This Society, which requires the Ph. D. for membership, is composed mainly of those who are in academic rather than in industrial work. The American Physiological Society, which requires the doctorate and additional original contributions to the literature, in 1945 had 905 members, of whom 59 were women.

In the American Society of Parasitologists women formed 13 percent of the membership, which in 1947 numbered 521. A college degree with some work in zoology is required for membership, and most of the members have had training in parasitology or in tropical medicine. In 1947 the American Association of Anatomists had 864 members, of whom 91 were women (*1*).

The Entomological Society of America, open to anyone interested in the scientific study of insects, in 1946 had 943 members, of whom 42 were women. In 1934 a woman was for the first time elected to the presidency of this organization. The American Association of Economic Entomologists had approximately 2,000 members at the end of 1946. Only a few were women, however, since economic entomology involves field work in which heavy manual labor is sometimes necessary.

There are numbers of other societies such as the American Ornithologists Union, interested in bird life; the American Society of Ichthyologists and Herpetologists, interested in fish and reptiles; and the American Society of Mammalogists, interested in man and other animals that nourish their young with milk.

The Outlook

Less affected by World War II than such sciences as chemistry and physics, zoology appears likely to offer to women in the future opportunities similar in quantity and in nature to those available just before the war. The principal possibilities of expanding demand lie: in the

increasing need for teachers, but primarily for those who can teach not only zoology but biology and other sciences as well; in research or laboratory work which is likely to require training in physiology or chemistry as well as in general zoology.

The postwar occupations of women members of the American Society of Zoologists supply the best indication of work available to women with the doctor's degree and experience in zoological work. In August 1946, the type of employment of 90 percent of the women members of the Association was indicated in a membership list (*3*). Seventy-eight, or 85 percent, were working in colleges or universities, a few in research but most of them in teaching. Eleven of the women members, or roughly 12 percent, were employed in separate research institutions or laboratories. Only one was employed in the Federal Government. Of the remaining two, one worked in a museum, the other in a petroleum company.

The women members of the American Association of Anatomists, which also requires a doctor's degree for membership, were very similar in their distribution by type of employer. Eighty-one women anatomists in 1947 indicated their employment on the Association's membership list (*1*). Sixty-seven, or 83 percent of them, were working in colleges or universities either in teaching or research. Eleven, or 14 percent, were employed in such research institutions as the Wistar Institute of Anatomy and Biology in Philadelphia, the Carnegie Institution of Washington, and the Roscoe B. Jackson Memorial Laboratory at Bar Harbor, Maine.

In 1946, 146 women were found listed in the catalogues of 330 institutions of higher education, comprising a United States Office of Education enrollment sample of all such institutions, as teaching zoology, anatomy, entomology, or parasitology. An additional 9 women were teaching one of these subjects in combination with other sciences or subjects. If these institutions are a true sample of college faculties, as they are of enrollments, there were in all institutions of higher education 585 women teaching one of these zoological sciences exclusively and an additional 130 teaching them in combination with other subjects. Not all of these women, however, had their doctorates. One half of them had either a master's or a doctor's degree. Most of the others, however, were graduate or teaching assistants, probably engaged in work leading to a higher degree. In addition to their teaching duties, a few of these faculty women also served on the staff of an experiment station. In 1945–46, two women, one a professor of zoology and one an associate professor of entomology, also were on the research staff of the experiment station. Some women were engaged in full-time research at these stations. In 1945–46, two women

in animal genetics were on station staffs in addition to a much larger number in animal husbandry and animal pathology as noted later.

At the bachelor's degree level, one of the characteristic paths followed by many young women graduated in zoology will continue to be training and practice in one of the professions in the medical and other health services. Of 23 young women graduated in zoology in 1945 or 1946, on whom follow-up reports were available, only 1 was going on with graduate work in zoology, while 7 were taking training for work as a physician, nurse, occupational therapist, medical laboratory technologist, or health educator. One writer, in calling attention to the fact that "medicine is the destination of the majority of students who take zoology," expressed the opinion that this has been a handicap to the development of zoology (*9*). One prominent woman zoologist believes that this is due to the failure to make known to college students interested in zoology the variety of other work available. For women, the difference in opportunity between medicine and zoology is less marked than it has been for men. The deciding factor is more likely to be the preference for an occupation involving constant practice of procedures and techniques as compared with one in which teaching is the principal outlet for those who become expert. Except in certain universities and in a few of the women's colleges, preparation for medicine is uppermost, and the curriculum is designed to meet the requirements of the medical schools.

For those trained at the bachelor's level, teaching in secondary schools will continue to provide opportunity, especially for those who can teach biology, other sciences, or mathematics, besides zoology. Three of the 23 graduates in 1945–46 mentioned above became teachers. A large demand for the bachelor group, however, will continue to come from medical laboratories of all types. Of the 23 graduates mentioned before, 6 were employed in medical laboratories. One, after completing a special training course for medical technologists, was doing routine laboratory tests in a hospital. Two others were working in pathology laboratories in hospitals. [See Women's Bureau bulletin on medical laboratory technicians (*42*).] The other three were research assistants, one in a hospital, one in a medical school, one in a public health laboratory. Only two of the graduates were working in industrial laboratories: one as an assistant in a biological laboratory, the other as an assistant in the chemical laboratory of a pharmaceutical company.

Women trained primarily in zoology are rarely found in industry. In the 100 industrial firms visited by a representative of the Women's Bureau in the course of this study, the only woman with a bachelor's degree in zoology found employed in scientific work was one working

Courtesy Ward's Natural Science Establishment, Inc.

Figure 15.—Training in zoology prepared this micro-slide technician for her work in a biological supply house.

in the entomology department of a biological supply house. To open the way to employment in industry, courses in general zoology must be combined with physiology or chemistry.

Although very few women are employed in general zoological work in the Federal Government, there will be an occasional opening from time to time in research work. At the end of 1946 the United States Department of Agriculture employed in the Washington, D. C., area two women as zoologists, two as parasitologists, one as a bibliographical entomologist, and one as a nematologist (concerned with nematodes such as pinworms and trichina).

Early in 1947 a woman entomologist was employed by the Tennessee Valley Authority. Most of the seven women biologists employed by the United States Fish and Wildlife Service in 1947, including three aquatic biologists, were zoologists. One, for example, was employed in a laboratory, where she was studying shad with a view to restoring the depleted shad fisheries of the Atlantic coast. Since a new scar is added to each scale every time a roe shad spawns, she could tell how many times a shad had spawned by studying its scales. She kept thousands of shad-scale impressions on plates for microscopic study. Another, classified as an assistant biologist, was working in ornithology. She maintained 2 million file cards of information on migratory birds obtained through the Service's program of banding birds and of recording reports received from those who return the bands.

Zoological gardens would appear to offer some opportunity, but openings for women are rare indeed. In the first place, employment is limited by the number of such parks. In 1946 there were about 40 zoological gardens in the United States (*4*). Their number increases very slowly because, although their educational and recreational function is recognized increasingly, they are costly to maintain. At least 1 large zoological garden has employed women trained in zoology in its information service, its children's zoo, and in 1 of its laboratories. Museums of natural history and children's museums, which are growing in number, offer more possibility in the future for young women than do zoological gardens.

These and other occupations followed by zoology majors have been outlined in detail for students by some colleges and universities (*13*) (*17*). The following list is based chiefly on Dr. Ann Haven Morgan's outline prepared for women students, with some additions from other lists (*14*):

Graduate students, including opportunities for fellowships and graduate assistantships.

Technicians and research assistants in universities and research institutes and projects. This includes usually preparation of materials for histological (tissue) and cytological (cell) study; it often involves doing experiments with and the care of animals and drawing or photography. Subjects of research may be in the fields of endocrinology (internal secretions), genetics (breeding or heredity), or embryology (early stages of development).

Technicians in hospitals, medical institutions, physicians' and public health laboratories. This involves such duties as gross and microscopic preparation and examination of tissues and blood.

Staff members of State experiment stations and Federal and State government research projects. This involves study of animals and plants, identification of life history, study of insects, pamphlet writing about animals and insects. Specialists in entomology (insects), ichthyology (fish), parasitology (human parasites and parasites of other animals), ornithology (birds), herpetology (reptiles).

Teachers of zoology or biology in colleges, universities, private schools, secondary schools.

Nature leaders, natural history park and museum guides and teachers, camp directors, and conservation educators.

Museum workers in medical museums and anatomy laboratories, including the preparation and demonstration of exhibits, art work, and guiding.

Librarians in medical, biological, and agricultural libraries.

Secretaries for scientists or for scientific organizations.

Scientific illustration, writing, or editing might be added to this list. Of them all, the medical outlets are those in which expansion is most likely because of the increasing emphasis on medical care, involving laboratory check-ups, and on research. Additional training is required for most of such work. Although calls for young women with majors in zoology alone may continue to be few at college placement bureaus, calls will continue to come in to the heads of zoology departments. There will be few trained who do not find an outlet in teaching or laboratory work. The demand for teachers has outstripped the supply of qualified persons in this field ever since World War II.

PHYSIOLOGY AND PATHOLOGY

The physiology of human beings is sometimes distinguished from the physiology of lower animals as well as from plant physiology by calling it medical physiology. Being concerned with the functioning

of the body in relation to its structure, development, and environment, the physiologist may specialize in the functioning of various parts of the body such as the brain (neurophysiologist) or the glands (endocrinologist). Closely related is the work of the pathologist, concerned with the nature, cause, and control of diseases affecting body functions (*25*).

Many physiologists, especially those employed in medical schools, hospitals, and medical research centers, have taken their principal training in medical schools and have M. D. degrees. In 1945, according to a survey by the American Physiological Society, 36 percent of the physiologists had an M. D., and 77 percent had a Ph. D. or Sc. D., with 19 percent holding both an M. D. and a Ph. D. (*2*). More than half of those with the Ph. D. had done their doctoral work in physiology.

This survey covered 955 physiologists in North America, 116 or 12 percent of whom were women. This proportion corresponds closely to the 13 percent women comprised of the 863 registrants in physiology in the United States reported by the National Roster of Scientific and Specialized Personnel (*30*). Women were relatively fewer, however, in the American Physiological Society, which requires the doctorate and additional evidence of original contributions to the literature on physiology. Among its 905 members in 1945, women numbered only 59 or 6 percent.

Most physiologists work in universities, according to the Association, which found two-thirds of the physiologists in North America covered in its 1945 survey so employed. The remaining group were about evenly distributed among the following: Other teaching institutions, research institutes, commercial laboratories, government service, and hospitals. Most of those who taught were instructing medical, dental, or graduate students. Only 10 percent taught undergraduate students primarily (*2*).

An average of 76 men and women were awarded a doctor's degree in physiology each year in the prewar years of 1935–40 (*11*). During the war, however, the number declined, so that in 1945 only 25 such degrees were awarded. If this lag were to continue there would be an estimated shortage of 600 physiologists by 1955 according to the American Physiological Society's 1945 study (*2*). In 1944 the withdrawal of men students for military service resulted in women undergraduate students in physiology outnumbering the men enrolled. More than 200 women and only 38 men were enrolled in such courses in the majority of institutions of higher education that reported data to the National Roster of Scientific and Specialized Personnel (*40*).

Scattered reports from colleges that offer an undergraduate degree with a major in physiology, however, showed no noticeable increase

Courtesy Science Service, Inc.

Figure 16.—A research assistant, who plans to specialize ultimately in neurophysiology, working on the physiological effects of DDT on nervous systems of insects at the Harvard Biological Laboratories.

3-60

or decrease in the number of enrollments of women majors in these fields during the war. In the related applied field of hygiene and public health, the number of women expecting to receive undergraduate degrees had been steadily increasing and approached 500 a year (*31*). In some schools a major in physiology and hygiene combined was offered. Except for those who went on to graduate work or to study medicine or nursing, most of those who had majored in physiology and hygiene entered teaching or medical laboratory work.

Half of the 10 graduates with a major in physiology and hygiene of the 1945 and 1946 classes in one eastern school, for example, became medical laboratory technicians. Two became teachers, and one entered graduate school. Another took a department store advertising job, and another married and was not seeking outside work. Of 45 girls graduated with the same major from another eastern women's college during 1939–43, 37 engaged in work definitely related to their major following graduation. Of these, 13 became associated with the Johns Hopkins University, either in the Hospital, the Medical School, or the School of Hygiene and Public Health. Two studied for the doctorate and one for the M. D. degree.

Very few women physiologists are employed under that designation in government or industry. During the war, the Army Air Forces commissioned approximately 200 physiologists and general biologists with the Ph. D. who were used in training, research, and testing programs in aviation physiology (*6*). But none of them were women. In 1947, however, 2 women were employed as physiologists by the Quartermaster Corps, which had employed 3 during the war. Two women physiologists were also employed in the Washington, D. C., metropolitan area by the United States Department of Agriculture. The demand is not great however. Only 4 men and no women were appointed to probational or permanent positions in physiology by the United States Civil Service Commission in the year ended June 30, 1940 (*23*). In industry, physiologists, although found more often than general zoologists, were likewise scarce. Only one woman with a bachelor's degree in physiology was found in 78 firms having industrial research laboratories visited in 1945–46. She was working in the bacteriology department of a dairy products laboratory. A woman with a Ph. D. in physiology was employed in an industrial research laboratory in a chemical company, where there was also an opening for a girl with a bachelor's degree in physiology and biochemistry. Animal and human nutrition research in universities, health departments, and food manufacturing companies also absorbed some physiologists. In 1945–46, four women were working as research assistants or technicians in animal nutrition in State experiment stations, in addition to one woman who held the rank of associate professor of poultry physiology.

Teaching will probably continue to offer the greatest opportunity for the employment of women physiologists. In 1946, 45 women were listed as members of physiology faculties in a study which covered 330 catalogues of institutions of higher learning included in an enrollment sample selected by the United States Office of Education. An additional 29 women taught physiology in combination with other subjects, and 25 taught hygiene, almost invariably in combination with another subject. If these institutions are representative of the 1,749 institutions of higher learning in the United States, there were, in 1946, 286 women college teachers of physiology, of whom 156 taught that subject exclusively. An additional 100 women were instructing in hygiene.

High school teachers of physiology almost invariably teach other sciences as well, and, in many schools, instruction in hygiene is given by physical education teachers rather than by the science faculty. It is possible for this reason that some young women who major in physiology take further training in physical education rather than in science.

For young women who are interested in college teaching, research, or laboratory work, however, study in other sciences such as chemistry and physics or in medical subjects is desirable.

Women in pathology are fewer than those in physiology, and there is less information about them. In 1946, 63 women were registered in pathology with the National Roster of Scientific and Specialized Personnel, 10 percent of the 651 registrants in that field (*30*). Unlike the women in physiology, only 14 percent of the women in pathology had the doctor's degree.

Most pathologists are employed in medical schools or laboratories. In 1946, 15 women were listed on college faculties as teaching or assisting in pathology alone or in combination with another subject, in the 330 institutions included in a United States Office of Education enrollment sample. None had reached a rank above that of assistant professor. If these institutions are typical of all such institutions in the United States, there were, in 1946, 47 women employed on pathology faculties in colleges and universities in the United States. Some of them were undoubtedly engaged in research as well as in instruction.

In 1945–46, three women were on State experiment station staffs, engaged in work in animal pathology, and two additional women were instructing in animal diseases as well as serving on station staffs.

The few remaining women in this field in 1947 were divided among industry, government, and research institutions not connected with colleges and universities. In 1 of the 78 industrial laboratories visited by a representative of the Women's Bureau in 1945 and 1946, 2 women trained in pathology were employed in the research laboratory of a chemical company. In 1947, 7 women pathologists were

employed in the United States Department of Agriculture in the Washington area.

Medical training appears to be even more essential for attaining rank in this field than in physiology. And women will find relatively more opportunity in the related field of bacteriology.

DAIRY, POULTRY, AND OTHER ANIMAL HUSBANDRY SCIENCE

As in other sciences, a large proportion of those trained in zoology apply their scientific knowledge to production, in this case, of animal life, including dairy cattle, fish, poultry, and bees. At least 2,400 men were engaged in such activities according to the National Roster of Scientific and Specialized Personnel in 1946. (See table 7.) Only 11 women, however, were registered in these applied sciences. Their proportion of the total was almost as low as their proportion in engineering and forestry.

Only occasionally is a woman found registered in courses in animal husbandry in schools of agriculture. But the variety of work possible in this field, as described in detail by the National Roster of Scientific and Specialized Personnel, indicates many opportunities in which heavy work with large animals (considered prohibitive for most women without help) is never involved (*32*). A University of Wisconsin bulletin points out that, "Women always have done a good share of the work involved in producing and processing poultry products. Women are also doing very important work in operating hatcheries. This includes culling the hatchery flocks, blood testing work, and learning to sex baby chicks. In fact, as time goes on, it looks as if women will be doing all the work in many hatcheries"(*46*).

Bee raising is another activity in which women have successfully engaged. In these applied fields, the marketing or business end must also be considered. One woman trained in poultry science, for example, has teamed up with a woman expert in business administration in the operation of a successful chicken farm.

At least seven women were college teachers in poultry or animal husbandry in 1946. A few more were instructing in schools of veterinary science. On State experiment station staffs in 1945–46, there were 14 women assisting in animal husbandry, of whom 2 were in poultry and 6 in dairy specializations.

In spite of the negligible number of women in these fields at present, there will always be opportunity in these animal sciences for women with scientific interest and with the initiative, confidence, and persistent effort required to leave the beaten path.

THE OUTLOOK FOR WOMEN IN GENERAL BIOLOGY

Most biological scientists are zoologists, botanists, or bacteriologists, and wherever possible the distinction between these fields has been retained. But it was obvious from a study of both the preparation and employment of biological scientists that the term biologist itself is in general use. Some colleges offer bachelor of science or arts degrees with specialization in biology or "life science" as it is sometimes called rather than in botany or zoology. The pages which follow supply information on the trends in the supply of and demand for women whose principal training or work experience is in biological science but who cannot be classified readily as zoologists or as botanists. Most of them are: outstanding scientists who have made contributions involving a high degree of specialization in more than one biological science; beginners who have taken undergraduate training in biology or in both botany and zoology without specialization.

Courtesy Bryn Mawr College

Figure 17.—An associate professor of biology instructing college students.

Prewar Distribution

There are no comprehensive prewar statistics on general biologists, but their number is estimated at between 1,500 and 2,000, of whom about 20 percent were women. High school biology teaching was the largest single area of demand, according to a prewar study of openings for biologists, as indicated by 200 professors of biology who cooperated in a questionnaire study (*18*). State and Federal agencies were mentioned as other outlets. Varying opinions were given on young graduates' chances for placement, ranging from "poor" to "good."

The employment reported for 47 young women graduated with bachelor's degrees during the period 1938 to 1941 with majors in biology rather than specifically in either botany or zoology indicates that the majority ultimately became medical laboratory workers or physicians or nurses, following training, of course. (See table 9.) The next largest number continued to study science in graduate schools, while some went at once into teaching, usually at the high school level. Only 3 of the 47 were employed in industry, and they were in chemical laboratory work.

Of the 78 firms with industrial research laboratories visited in the course of this study, only 4 employed women biologists before the war. These 4 were all chemical manufacturing companies, 1 of which was engaged in pharmaceutical work only. Only a few women were employed by each of these companies, most of them as technicians. One was a research associate in microbiology. Two of the 18 commercial testing laboratories visited employed women biologists on biological testing.

Table 9. Prewar, Wartime, and Postwar Employment of Some Women Graduated With Bachelor's Degree in Biology

Type of employment	Women graduated with bachelor's degree in biology in—					
	1938–41 and employed 1940–41	1942–45 and employed 1944–45	1941–46 and employed 1946	1938–41 and employed 1940–41	1942–45 and employed 1944–45	1941–46 and employed 1946
	Number	*Number*	*Number*	*Percent*	*Percent*	*Percent*
Total	47	94	95	100.0	100.0	100.0
Medical laboratory work	17	20	28	36.2	21.3	29.5
Laboratory or research work not further identified	----	27	26	----	28.7	27.3
Graduate study in science (sometimes with teaching or research duties)	14	4	15	29.8	4.3	15.8
Medicine or nursing (including preparation for)	7	9	2	14.9	9.6	2.1
Teaching	5	7	10	10.6	7.4	10.5
Industrial laboratory work	3	12	4	6.4	12.7	4.2
Research institution	1	----	----	2.1	----	----
Government employment	----	1	1	----	1.1	1.1
Zoological garden	----	----	1	----	----	1.1
Farming	----	----	1	----	----	1.1
Secretarial or other clerical	----	4	4	----	4.3	4.2
Military service	----	5	----	----	5.3	----
Miscellaneous	----	5	3	----	5.3	3.1

Source: Women's Bureau, 1945–46.

In the Federal Government, general biologists were also rare compared, for example, with bacteriologists and chemists. An oversupply at the beginning professional level in biology was indicated by the fact that almost 3,800 persons applied in 1940 for the junior professional assistant examination in biology, while only 117 persons passed the examination, and only 1 man was appointed that year. Only 5 of the 726 women who took the examination passed it. Biological statisticians, being fewer, fared better. Of the 167 who applied, 26 passed the examination for biometricians, and 7 of them were women. One man and one woman were appointed that year to beginning positions (*23*).

Annual Addition to the Supply

The annual number of men and women graduated with bachelor's degrees before the war with a major in general biology as distinct from botany or zoology or even for all these biological sciences together is not known. In 1941–42, the first war year, 4,629 bachelor degrees were awarded in all the biological sciences taken together, according to the United States Office of Education. Almost 2,000 of them, 43 percent, were awarded to women (*43*).

At the doctoral level, where more specialization takes place, degrees in the biological sciences were most often awarded in botany and zoology, with physiology, bacteriology, and entomology ranking next. Some 20 to 25 degrees were usually awarded each year in genetics (*11*). But only occasionally were Ph. D. degrees awarded in general biology itself. These were usually in microbiology, the study of the life of microscopic organisms.

Wartime Changes

Although some writers, in 1944, reported a decline in enrollments in the biological sciences, the 4,622 graduating in 1943–44 with bachelor's degrees in all the biological sciences combined was almost identical with the 1941–42 total. For the first time, however, more than half of those graduating were women (*43*) (*44*). The contradiction was probably due to wide variations in the trend in particular schools. In general biology alone, the effect of declining enrollments in 1 school was apparently offset by increasing enrollments in another. Of 15 colleges which reported bachelor's degrees granted over a period of years to women with a major in "biology" (rather than in a particular biological science such as botany or zoology), 7 reported no appreciable change in the number granted in the war years as compared with the years just before World War II. Four, however, reported an increase. A west-coast school, for example, granted women 47 bachelor's degrees with a major in biology during 1943–45, compared

with 18 during 1939–41. An east-coast school granted 137 in 1945 as compared with 65 in 1939. Two of the 15 schools initiated undergraduate majors in biology during the war. Only two schools showed a definite decline during this period in the number of first degrees awarded to women with a major in biology. Fewer women in this field, however, went on to graduate work in science. (See table 9.)

Although the war did not result in an immediate and overwhelming demand for general biologists, as it did for chemists, physicists, and engineers, certain wartime research jobs required the particular expertness of biologists. Two women were employed directly by the Quartermaster Corps, for example, as biothermologists. A number of others worked on research projects financed by the Federal Government at various universities. In the WAC and WAVES a few women were classified and assigned as biologists. At least two WAVES who had majored in biology in college were assigned as instructors, one as an aviation physiologist, and another as biological instructor in connection with the low pressure and chill chamber. One also served both as an assistant bacteriology laboratory officer and as an instructor of corpsmen. Others, with sufficient bacteriological training although they had majored in general biology, were used as serologists or bacteriologists in penicillin and other laboratories.

Biologists also felt the repercussions of the tremendous wartime demand for scientists in other fields, particularly in medicine and chemistry. As one authority put it, "The colleges and universities have been stripped of many of their physicists, chemists, engineers, even mathematicians, but the biologists have been left to teach medical students or have been used in scientific studies of agriculture, health, and nutrition. Biology is in time of war less applied than these other subjects, but it is no less important" (*8*).

As men biologists were drawn into military service, the opportunities for women increased. The number of professional women, most of them trained in biology, employed by the United States Fish and Wildlife Service, for example, increased from 10 in 1940 to 35 during the war. One junior biologist there worked on the effect of DDT, the new insecticide, on wildlife. More biological aids were also employed, like the three women hired by the Tennessee Valley Authority.

In industry, 2 additional firms of the 78 with industrial research laboratories visited by a representative of the Women's Bureau were added to the 4 which had employed women biologists before the war. One was a food company which hired a biologist as a technician; the other a manufacturer of containers which employed one in its central research laboratory. Meanwhile, the number of women trained in biology employed in the other 4 firms had increased, although exact figures for the two periods were not available.

The wartime demand at the laboratory technician and aid levels increased so much that some universities offered special 2-year programs to train women as biological aids or as medical laboratory aids. The programs included inorganic and organic chemistry, quantitative analysis, animal biology, English, mathematics, and biological techniques.

The wartime occupations of 94 young women who graduated with bachelor's degrees in biology during the war from 5 schools in the East, Middle West, and South indicate a decline in graduate study and an increase in industrial laboratory work, as compared with the prewar activities of a similar group. (See table 9.)

However, a considerable number of women who major in biology never enter scientific work, even under the pressures of wartime. A follow-up study in 1944, by a large eastern college, of 48 girls it had graduated 5 years earlier with a major in biology showed that almost one-third of them were married and not employed. One-fourth were engaged in business or clerical activities, including secretarial work, accounting, advertising, and retailing. Only one-fifth were using their scientific training directly in their work. Another one-sixth, however, were in occupations in which biology is useful as background, such as nursing, psychology, personnel, and social work.

Earnings and Advancement

The earnings of those trained in biology are similar to those described under zoology. (See p. 3–52.) Advancement depends largely upon graduate work which, in turn, means specialization in botany, zoology, or bacteriology. Occupations in the health services, which also require further training, offer alternative avenues for development.

Organizations

In 1946 the recently organized American Biological Society had 420 members of whom 47, or 11 percent, were women. Any professional biologist sponsored by two members may join this association.

There are a number of organizations which include zoologists, botanists, as well as general biologists among their members, like the Ecological Society of America and the American Society of Naturalists. The former, in 1947, had 51 women members out of a total of 700. Thirty-five of these women ecolcgists were employed in colleges and universities, 17 of them specializing in plants, 17 in animals, and 1 in both. Four were teaching both plant and animal science in high school. Twelve others were plant ecologists engaged in government or industrial research, or other activities. In 1946, the American Society of Naturalists, which elects to membership only

those who have made a research contribution in natural science, had 38 women members. Most of them had a doctor's degree in a field such as: embryology, histology, anatomy, botany, or zoology. The membership of the Genetics Society of America brings together plant geneticists as well as those who are interested in the breeding of animals and the heredity of human beings. Among its 604 members in 1946 were 69 women, divided about evenly between plant and animal genetics.

A number of societies which together include some 3,000 nutritionists, physiologists, endocrinologists, pathologists, immunologists, pharmacologists, and biochemists, constitute the Federation of American Societies for Experimental Biology. Further evidence of the efforts toward co-ordination in a rapidly developing field is the Union of Biological Societies, created to facilitate co-operation among more than 80 organizations in the biological sciences, among which there is, of course, much overlapping of membership as well as mutuality of interest.

The Outlook

The demand for college women who have majored in biology, as shown by placements in the early postwar period and scattered reports from college placement bureaus, will continue to be large from laboratories in medical schools, public health departments, hospitals, and medical research centers. One bureau reported that those trained in biology were difficult to place except in medical school or hospital laboratories or on occasional orders received from research foundations.

As competition from industry for science graduates decreased at the end of the war, the hospitals and medical centers again became more exacting in their requirements for research laboratory jobs, preferring those with training in physics or chemistry as well as in biology. On high school teaching jobs, for which occasional requests were received, mathematics was the combination subject most frequently required. In some city school systems, a master's degree in education was required for a high school teaching position. A variety of science and training in mathematics and related subjects were usually preferred to pronounced specialization.

Although most of the girls preferred industrial laboratory jobs, there were only occasional orders of this type, usually from companies manufacturing biological products, including pharmaceuticals and foods. There was a continuing demand, however, for technical librarians and literature searchers.

The kinds of jobs held in 1946 by 95 young women who were graduated with a bachelor's degree with a major in biology during the war years reflected the decline in the demand for them in industrial labora-

tory work. (See table 9.) The other noticeable difference was the apparent continued trend away from the study of medicine or nursing and a resumption of graduate study in science. But the numbers were too few to assume that these trends were general.

Courtesy Ralston Purina Co.

Figure 18.—A technician with a bachelor's degree in science using microbiological procedure in an industrial laboratory to measure pantothenic acid in feedstuffs.

Some of the women trained in biology who worked in industry were in chemistry rather than biological laboratories. This was especially the case during the war. However, biological techniques are required in some chemical companies, particularly in those manufacturing pharmaceuticals and in some engaged in food processing. In 1946, 39 women were found doing professional work under the title of biologist in the 78 firms having industrial research laboratories visited by a representative of the Women's Bureau. Three of these women were in microbiology. There was an even larger number, 57, employed as technicians or assistants on work for which a college degree was not required, but for which 2 or 3 years of college science including both biology and chemistry were preferred. Two women with bachelor's degrees in biology were employed in 2 of the 18 commercial

laboratories visited. In a biological supply house, two girls with high school training in biology were mounting specimens for museums. Biological illustration, writing, editing, and library work in medical and other scientific libraries in which publications in the field of biology are important represent related areas of work. (See Women's Bureau Bulletin 223–8.)

Aside from State and local public health departments, where medical laboratory work is available, there will probably continue to be very little government employment of women trained in biology. In the Federal Government, the Department of Agriculture is the largest employer of those trained in all the biological sciences taken together. However, most of those employed are highly specialized in a particular botanical or zoological science. In 1946, this Department employed in the Washington area only one woman as a biologist and another as a biological aid. However, some of the 81 women employed there as scientific aids undoubtedly had their principal scientific training in the biological sciences, although some may have been trained primarily in the physical sciences.

Two women were employed in 1947 by the Tennessee Valley Authority as biologists in addition to two as biological aids. The Fish and Wildlife Service employed seven women as biologists in addition to two biological editors and several librarians and information specialists. Because most of the professional positions in this Service involve strenuous outdoor duties regularly or seasonally, frequently in remote areas, the employment opportunities for women will probably continue to be restricted to laboratory or desk rather than field jobs (*24*). Most of the biologists employed by the National Park Service as park naturalists or park historians likewise work almost entirely in the field, and men will continue to be preferred for this work. Two women scientists, however, were employed in 1947 by this Service as aerobiologists in the far West.

More women in the future will probably be employed in nature education in local communities, since there is growing interest in this type of local instruction. This requires broad biological knowledge, as both animal and plant identification are necessary. Courses in the applied fields of forestry and agriculture as well as training in zoology and botany are helpful in this field as in wildlife management and conservation in which almost no women are employed. The schools which offer specialized courses in wildlife management and conservation have been listed by the Fish and Wildlife Service (*24*). A few schools also offer degrees in nature education. During the war, at least two women obtained such degrees at a State college.

In college teaching, the number of women biologists will continue to grow. Although most of the higher degrees in the biological sci-

ences were granted in botany or zoology, rather than in general biology, more women were teaching general biology in colleges and universities than were teaching zoology or botany alone. In 1946, 212 women were listed on the faculties of 330 institutions of higher learning, included in a United States Office of Education enrollment sample of such institutions, as teachers of biology, only a few of whom also taught in another subject field. If these schools are truly representative of the total, more than 1,000 women were on biology faculties in 1946. Of course, some of these may be primarily zoologists or botanists by virtue of their research work or training, although they are teaching in general biology. A distinguished woman biologist listed as outstanding in American Men of Science, after 50 years of teaching experience in the East, South, and far West, says that graduate students in recent years seem to be more interested in "life sciences" as related to problems of living than in pure science and research. She, herself, after her teaching and laboratory research principally in experimental morphology and embryology is devoting her energies to gerontology, the study of the phenomena of old age, serving as a lecturer and counselor for the American Institute of Family Relations on work with people over 65 years of age.

The emphasis on biology in college instruction combined with the recent information of organizations of biologists appears to indicate a trend toward growing opportunity for persons trained in general biology, especially in teaching. Like the biological aid positions in government, there are corresponding positions as research assistants in biological research laboratories such as the Department of Genetics of Carnegie Institution. Although only two women were employed on the full professional staff there early in 1947, one a cytogeneticist, the other a chemist, there were 10 working as research assistants and 3 as technical assistants. One woman was employed in a State experiment station in 1945–46 as a research assistant in microbiology.

Even in such positions, however, as in most others, young women will find their chances for entrance and for advancement greatly improved if they also have training in chemistry, or in bacteriology or physiology. Such courses in some schools are required for the degree in biology.

APPENDIX

Minimum Education and Experience Requirements for Application for Beginning Federal Civil Service Position as Junior Agricultural Assistant With Option as Botanist ($2,644 a Year)

(As taken from Civil Service Announcement No. 76, issued October 14, 1947, closed November 4, 1947)[1]

Applicants must have successfully completed one of the following:

A. A full 4-year course, in a college or university of recognized standing, leading to a bachelor's degree in botany; or

B. Courses in botany, in a college or university of recognized standing, consisting of lectures, recitations, and laboratory work totaling at least 20 semester hours; plus additional appropriate experience which, when combined with the 20 semester hours in botany, will total 4 years of education and experience and give the applicant the substantial equivalent of a 4-year college course. The following are types of experience which will be accepted in combination with education to complete the 4-year requirement:

Subprofessional or professional laboratory work which has provided a working knowledge of the theory and application of the basic principles of a botanical science.

Experience in abstracting, editing, or translating reports or scientific literature in botany or closely related fields.

Research experience in botany or related fields.

Professional work in botany, such as that described above as typical duties of the positions to be filled from this examination.

Teaching botany.

Minimum Education and Experience Requirements for Application for Beginning Federal Civil Service Position as Junior Agricultural Assistant With Option as Plant Pathologist ($2,644 a Year)

(As taken from Civil Service Announcement No. 76, issued October 14, 1947, closed November 4, 1947)[1]

Applicants must have successfully completed one of the following:

A. A full 4-year course, in a college or university of recognized standing, leading to a bachelor's degree in botany or plant science, including at least 10 semester hours in plant pathology; or

[1] For more complete and later information, consult latest announcements of the Civil Service Commission posted in first- and second-class post offices.

B. Courses in botany or plant science, in a college or university of recognized standing, consisting of lectures, recitations, and laboratory work totaling at least 20 semester hours, at least 10 of which are in plant pathology; plus additional appropriate experience or education which, when combined with the 20 semester hours in botany or plant science, will total 4 years of education and experience and give the applicant the substantial equivalent of a 4-year college course. The following are types of experience which will be accepted in combination with education to complete the 4-year requirement;

Subprofessional or professional laboratory work which provided a means of obtaining a working knowledge of the theory and application of the basic principles of a natural science.

Experience in abstracting, editing, or translating reports or scientific literature in plant pathology or closely related fields.

Research experience in plant pathology or related fields.

Other professional work in plant pathology, such as that described above as the duties of the positions to be filled from this examination.

Minimum Education and Experience Requirements for Application for Beginning Federal Civil Service Position as Junior Agricultural Assistant With Option as Plant Physiologist ($2,644 a Year)

(As taken from Civil Service Announcement No. 76, issued October 14, 1947, closed November 4, 1947)[1]

Applicants must have successfully completed one of the following:

A. A full 4-year course, in a college or university of recognized standing, leading to a bachelor's degree in botany or plant science, with a minimum of 10 semester hours of plant physiology; or

B. Courses in plant science, in a college or university of recognized standing, consisting of lectures, recitations, and laboratory work totaling at least 20 semester hours, at least 10 of which are in plant physiology; plus additional appropriate education or experience which, when combined with the 20 semester hours in plant science, will total 4 years of education or experience and give the applicant the substantial equivalent of a 4-year college course. The following are types of experience which will be accepted in combination with education to complete the 4-year requirement:

[1] For more complete and later information, consult latest announcements of the Civil Service Commission posted in first- and second-class post offices.

Subprofessional or professional laboratory work which provided a means of obtaining a working knowledge of the theory and application of the basic principles of a natural science.

Experience in abstracting, editing, or translating reports or scientific literature in plant physiology or closely related fields.

Research experience in plant physiology or related fields.

Other professional work in plant physiology, such as that described above as the duties of the positions to be filled from this examination.

Minimum Education and Experience Requirements for Application for Beginning Federal Civil Service Position as Junior Agricultural Assistant With Option as Horticulturist ($2,644 a Year)

(As taken from Civil Service Announcement No. 76, issued October 14, 1947, closed November 4, 1947)[1]

Applicants must have successfully completed one of the following:

A. A full 4-year course, in a college or university of recognized standing, leading to a bachelor's degree in horticulture (clericulture, pomology, or floriculture); or

B. Courses in horticulture, in a college or university of recognized standing, consisting of lectures, recitations, and laboratory work totaling at least 10 semester hours, and study in plant sciences (including plant physiology) totaling at least 10 semester hours; plus additional appropriate education or experience which, when combined with the 20 semester hours in horticulture and plant science, will total 4 years of education and experience and give the applicant the substantial equivalent of a 4-year college course. The following are types of experience which will be accepted in combination with education to complete the 4-year requirement:

Subprofessional or professional laboratory or field work which provided a means of obtaining a working knowledge of the theory and application of the basic principles of a natural science.

Experience in abstracting, editing, or translating reports or scientific literature in horticulture or closely related fields.

Research experience in horticulture or related fields.

Other professional work in horticulture.

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[1] For more complete and later information, consult latest announcements of the Civil Service Commission posted in first- and second-class post offices.

Minimum Education and Experience Requirements for Application for Beginning Federal Civil Service Position as Junior Agricultural Assistant With Option as Agronomist ($2,644 a Year)

(As taken from Civil Service Announcement No. 76, issued October 14, 1947, closed November 4, 1947)[1]

Applicants must have successfully completed one of the following:

A. A full 4-year course, in a college or university of recognized standing, leading to a bachelor's degree in agronomy; or

B. Courses in plant science and agronomy, in a college or university of recognized standing, consisting of lectures, recitations, and laboratory work totaling at least 30 semester hours (10 semester hours must have been in farm crops, 6 in soils, and 4 in animal husbandry); plus additional appropriate experience or education which, when combined with the 30 semester hours, will total 4 years of education and experience and give the applicant the substantial equivalent of a 4-year college course. The following are types of experience which will be accepted in combination with education to complete the 4-year requirement:

Responsible technical experience on a farm which grows hybrid corn or a similar class of seed for commercial purposes.

Responsible agronomic experience at a college or other experiment station.

Minimum Education and Experience Requirements for Application for Beginning Federal Civil Service Position as Junior Agricultural Assistant With Option as Soil Scientist ($2,644 a Year)

(As taken from Civil Service Announcement No. 76, issued October 14, 1947, closed November 4, 1947)[1]

Applicants must have successfully completed one of the following:

A. A full 4-year course, in a college or university of recognized standing, leading to a bachelor's degree in soils or closely related subjects: Agronomy, physical geography, geology (not economic); or

B. Courses in soils or closely related subjects: Agronomy, physical geography, geology (not economic), in a college or university of recognized standing, consisting of lectures, recitations, and laboratory work totaling at least 20 semester hours; plus additional appropriate experience or education which, when combined with the 20 semester hours, will total 4 years of education and experience and give the applicant the substantial equivalent of a 4-year college course. The following

[1] For more complete and later information, consult latest announcements of the Civil Service Commission posted in first- and second-class post offices.

are types of qualifying experience which will be acceptable in combination with education to complete the 4-year requirement.

Responsible experience with a soil survey crew.

Responsible experience in a soils laboratory.

Teaching experience in the field of soil science.

Minimum Education and Experience Requirements for Application for Beginning Federal Civil Service Position as Junior Agricultural Assistant With Option as Forester ($2,644 a Year): Options (1) Forest; (2) Range

(As taken from Civil Service Announcement No. 76, issued October 14, 1947, closed November 4, 1947)[1]

(1) FOREST OPTION

Applicants for the Forest option must have successfully completed one of the following:

A. A full 4-year course, in a college or university of recognized standing, leading to a bachelor's degree with major work in forestry, science, wildlife management, or range management which has included the following courses:

One course in each of the following groups:

(1) Dendrology or taxonomic botany.

(2) Forest ecology, silvics, or plant physiology.

(3) Range management or wildlife management.

(4) Soil science, forest soils, or geology.

Two courses in each of the following groups:

(1) Forest economics, forest finance, forest valuation, forest history, policy, or law.

(2) Plane surveying and mapping, topographic surveying and mapping, or forest improvements.

Three courses in each of the following groups:

(1) Forest entomology, forest pathology, or forest fire protection.

(2) Wood technology and forest utilization. (Courses such as logging, forest products, pulp and paper, milling, and wood preservation will also be accepted as courses in wood technology and forest utilization. However, not more than one course in chemical wood utilization or wood preservation will be accepted.)

Five courses in any combination of the following: forest mensuration, silviculture, forest planting, or forest management.

[1] For more complete and later information, consult latest announcements of the Civil Service Commission posted in first- and second-class post offices.

A bachelor's degree in forestry from a college or university of recognized standing will be accepted as meeting the educational requirements for this position; or

B. Courses in forestry, as listed in (A) above, in a college or university of recognized standing, consisting of lectures, recitations, and laboratory work; plus additional appropriate experience and education which, when combined with the courses in forestry, as listed in (A) above, will total 4 years of education and experience and give the applicant the substantial equivalent of a 4-year college course.

(2) RANGE OPTION

Applicants for the Range option must have successfully completed one of the following:

A. A full 4-year course, in a college or university of recognized standing, leading to a bachelor's degree with major work in forestry, including 15 semester hours of study in range management, or plant ecology, or a combination of these two subjects; or

B. Courses in a college or university of recognized standing consisting of lectures, recitations, and laboratory work totaling 30 semester hours in basic forestry subjects and 15 semester hours in range management or plant ecology or a combination of these two subjects; plus additional appropriate experience or education which, when combined with these courses will total 4 years of education and experience and give the applicant the substantial equivalent of a 4-year college course.

Minimum Education and Experience Requirements for Application for Beginning Federal Civil Service Position as Junior Professional Assistant With Option as Bacteriologist (Medical) ($2,644 a Year)

(As taken from Civil Service Announcement No. 75, issued October 14, 1947, closed November 4, 1947)[1]

Applicants must have successfully completed 4 years of study leading to a bachelor's degree, in a college or university of recognized standing, with at least 20 semester hours' credit in either general or medical bacteriology.

There is no experience requirement for this grade.

Minimum Education and Experience Requirements for Application for Beginning Federal Civil Service Position as Serologist ($2,644 a Year)

(As taken from Civil Service Probational Examination Specification No. 842, issued June 24, 1947)[1]

Applicants for all grades must have successfully completed four years of study leading to a bachelor's degree in a recognized college or uni-

[1] For more complete and later information, consult latest announcements of the Civil Service Commission posted in first- and second-class post offices.

versity with at least 20 semester hours of credit in serology or in general or medical bacteriology.

There is no additional experience requirement for this grade.

Minimum Education and Experience Requirements for Application for Beginning Federal Civil Service Position as Junior Agricultural Assistant With Option as Agricultural Bacteriologist ($2,644 a Year)

(As taken from Civil Service Announcement No. 76, issued October 14, 1947, closed November 4, 1947)[1]

Applicants must have successfully completed one of the following:

A. A full 4-year course, in a college or university of recognized standing, leading to a bachelor's degree in biological science, including at least six semester hours in bacteriology; or

B. Courses in biological science, in a college or university of recognized standing, consisting of lectures, recitations, and laboratory work totaling 20 semester hours, at least 6 of which are in bacteriology; plus additional appropriate experience or education which, when combined with the 20 semester hours, will total 4 years of education and experience and give the applicant the substantial equivalent of a 4-year college course. The following are types of experience which will be accepted in combination with education to complete the 4-year requirement:

Technical experience in a biological science laboratory.
Teaching bacteriology courses.

Minimum Education and Experience Requirements for Application for Beginning Federal Civil Service Position as Junior Agricultural Assistant With Options as: Zoologist (Parasitology), Entomologist, Biologist (Wildlife), Aquatic Biologist ($2,644 a Year)

(As taken from Civil Service Announcement No. 76, issued October 14, 1947, closed November 4, 1947)[1]

For option as Zoologist (Parasitology) applicants must have successfully completed one of the following:

A. A full 4-year course, in a college or university of recognized standing, leading to a bachelor's degree in zoology including at least one course in parasitology; or

B. Courses in zoology and parasitology, in a college or university of recognized standing, consisting of lectures, recitations, and laboratory work totaling at least 20 semester hours; plus additional appropriate experience or education which, when combined with the 20 semester hours, will total 4 years of education and experience and

[1] For more complete and later information, consult latest announcements of the Civil Service Commission posted in first- and second-class post offices.

give the applicant the substantial equivalent of a 4-year college course. Applicants must show at least one course in parasitology or 6 months of technical experience working with animal parasites.

The following are types of experience which will be accepted in combination with education to complete the 4-year requirement:

Subprofessional or professional laboratory work which provided a means of obtaining a working knowledge of the theory and application of the scientific principles involved in operations of a zoological laboratory.

Research or technical experience in parasitology or closely related fields.

For option as Entomologist applicants must have successfully completed one of the following:

A. A full 4-year course, in a college or university of recognized standing, leading to a bachelor's degree in entomology or in zoology, including at least one course in entomology; or

B. Courses in entomology or in entomology and zoology combined, in a college or university of recognized standing, consisting of lectures, recitations, and laboratory work totaling at least 20 semester hours; plus additional appropriate education or experience which, when combined with the 20 semester hours in entomology or entomology and zoology, will total 4 years of education and experience and give the applicant the substantial equivalent of a 4-year college course. The following are types of experience which will be accepted in combination with education to complete the 4-year requirement:

Subprofessional or professional laboratory work which provided a means of obtaining a working knowledge of the theory and application of the basic principles of a biological science.

Experience in abstracting, editing, or translating reports or scientific literature in entomology and closely related fields.

Research experience in entomology or related fields.

Other professional work in entomology.

For option as Biologist (Wildlife) applicants must have successfully completed one of the following:

A. A full 4-year course, in a college or university of recognized standing, leading to a bachelor's degree in biology, including at least 10 semester hours in zoology; or

B. Courses in biology, in a college or university of recognized standing, consisting of lectures, recitations, and laboratory work, totaling 30 semester hours, at least 10 of which are in zoology and 10 in botany; plus additional appropriate experience or education which, when combined with the 30 semester hours in biology, will total 4 years of education and experience and give the applicant the sub-

stantial equivalent of a 4-year college course. The following are types of experience which will be accepted in combination with education to complete the 4-year requirement:

Technical laboratory work in biology dealing with some phase of wildlife.

Responsible experience in making surveys of wildlife habits and foods.

For option as Aquatic Biologist applicants must have successfully completed one of the following:

A. A full 4-year course, in a college or university of recognized standing, leading to a bachelor's degree in biological science, including at least 6 semester hours in the biology of aquatic organisms; or

B. Courses in biology, in a college or university of recognized standing, consisting of lectures and recitations totaling 30 semester hours in biology, at least 6 of which are in the biology of aquatic organisms; plus additional appropriate experience or education which, when combined with the 30 semester hours in biology, will total 4 years of education and experience and give the applicant the substantial equivalent of a 4-year college course. The following are types of experience which will be accepted in combination with education to complete the 4-year requirement:

Subprofessional or professional laboratory work which provided a means of obtaining a working knowledge of the theory and application of the basic principles of a biological science.

Experience in abstracting, editing, or translating reports or scientific literature in aquatic biology or closely related fields.

Research experience in aquatic biology or related fields.

Other professional work in aquatic biology.

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