Name: Terry Warren Jones Date of Degree: May 26, 1963

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: CAREER OPPORTUNITIES IN THE BASIC BIOLOGICAL SCIENCES

Pages in Study: 48 Candidate for Degree of Master of Science

Major Field: Natural Science

Scope of Study: This report has been prepared to help the student, teacher, counselor, or anyone who may be concerned with career guidance in biology to become better informed about the career opportunities which are available in the basic biological sciences of zoology, botany, physiology, entomology, and microbiology. The information presented concerning these areas includes: (1) the career opportunities which are available, (2) what biologists in each field do, (3) where these opportunities are, (4) the educational requirements which are necessary, (5) the rewards which may be expected, and (6) other pertinent information concerning careers in these fields. There is also one chapter devoted to the opportunities for women in biology.

Findings and Conclusions: All the opportunities indicated in this report may, perhaps, be summarized into one statement. Biology is a fairly conservative field, seldom subject to wholesale demand, yet almost always with positions open for young men and women who are qualified to fill them. Most important of all is the fact that there are shortages in the present supply of biological scientists. As far as can be determined, these shortages will continue unless some success is realized in attracting young people to careers in the biological sciences. Today, there is not a single branch of biology that doesn't have space for a good new applicant.

In the future, there must be enough young biologists to fill the gaps opened by the retirement of older men and women. More than that, a continuing supply of additional workers will be needed to meet a dual challenge: (1) the growing demands in established branches of biology, and (2) the new fields of biology which will be opening in the future. The United States and the world are growing ever more populus and more demanding of the goods and services which biology helps make possible.

Biology is one of the oldest fields of human knowledge. It has now become one of the newest and most dynamic. For young men and women with an urge to build a career in the basic biological sciences, there will be numerous career opportunities in this new dynamic biology.

ADVISER'S APPROVAL James H. Zant

CAREER OPPORTUNITIES IN THE BASIC BIOLOGICAL SCIENCES

By

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Bachelor of Science

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Weatherford, Oklahoma

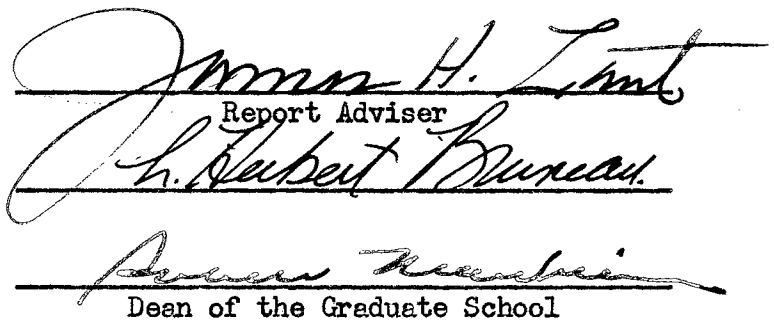
1962

Submitted to the faculty of the Graduate School of
the Oklahoma State University
in partial fulfillment of the requirements
for the degree of
MASTER OF SCIENCE
May, 1963

CAREER OPPORTUNITIES IN THE BASIC

BIOLOGICAL SCIENCES

Report Approved:



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PREFACE

In today's highly technical society, the field of biology has attained a very important position. Biologists are now on the threshold of unraveling the secrets of life. They are also performing a very valuable service in our attempts to reach into space. The result of these and other present-day activities has been an increased demand for biologists at all levels of training.

I am of the opinion that the student, teacher, and counselor are often unaware of the vast number of opportunities for a career in the biological sciences.

Consequently, this report has been prepared to help the student, teacher, counselor, or anyone who may be concerned with career guidance in biology to become better informed about the career opportunities which are available. An attempt has been made to present: (1) the career opportunities which are available, (2) what biologists in each field do, (3) where these opportunities are, (4) the educational requirements which are necessary, (5) the rewards which may be expected, and (6) other pertinent information concerning careers in these fields.

This report has been limited to the opportunities which are available in the basic biological sciences of zoology, botany, physiology, entomology, and microbiology since these are the fields which are a part of the curriculum at the Oklahoma State University.

I wish to express my appreciation to Dr. James H. Zant, Director of Supplementary Training Program for High School Mathematics and Biology

Teachers of the National Science Foundation, for his invaluable guidance, suggestions, and criticisms in the preparation of this report.

Appreciation is also extended to Dr. L. Herbert Bruneau, Associate Professor of Zoology, for his assistance in the preparation of this report.

This report is dedicated to my wife, Nancy Alice Jones. Without her encouragement and her patience in the typing of this report, it would not have been possible.

TABLE OF CONTENTS

CHAPTER I

INTRODUCTION

"Biology is very interesting, but are there any opportunities for a career in biology?" "If there are opportunities, where do they exist?" "What are the educational requirements for a career in biology?" "What kind of work are biologists engaged in?" These are questions which often arise in the minds of many high school students who are taking a course in high school biology. In his brief experience with high school biology students, the author has found that many students, and even teachers and counselors, are unaware of the numerous opportunities for careers in the biological sciences.

Many intelligent people have the misconception that biologists are queer little men who spend their time chasing butterflies with a net or dissecting pickled frogs in a dark laboratory. Biology does include these things, but it means a very great deal more.

Biology may mean, for example, the bombardment of bread mold with neutrons in a nuclear reactor at Oak Ridge to see something of how characteristics are passed on from one generation to the next, or the use of radioactive phosphorus as a way of tracing the path by which minerals move into a plant and become a part of its life and structure. It may mean the exploration of volcanic Alaskan valleys to see which plants survive best in so strange an environment. It may involve many careful biochemical experiments in an effort to determine the pathways by which

a vegetable oil is formed, or critical thinking and evaluation leading to a theory of the origin of life. Biology can be the development of a better method for the preparation of tissue sections for study under the microscope, or it can be a regional land-use analysis designed to insure success of a new agricultural venture. A biologist may spend many hours with pen and ink, camera, or water color in illustrating a book so accurately, so strikingly, that readers for years to come can turn to it for information, pleasure, and inspiration. He may work in foreign lands to help rebuild desolated farming areas or assist in freeing the inhabitants from the major threats of disease. It may mean spending many fulfilling years teaching or training future biologists. A biologist may spend a lifetime collecting grasshoppers, tiger beetles, snakes, or ferns. Biology means every aspect of the study of living organisms.

As the reader may see from these examples, there are many areas in which career opportunities exist for the biological scientist. The field of biology may be roughly divided according to the following major fields of interest of students in the field: (1) the basic biological sciences, (2) the applications of biological science in agriculture, and (3) the applications of biological science in the medical and healing arts.[1] Biologists engaged in the basic biological sciences are primarily concerned with searching for knowledge about the fundamental laws of biology and with the collection of basic information about plants and animals. However, there are functions performed by many biologists which may be of an applied nature. Agricultural biologists specialize in the problem

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[1]Educational Requirements for Employment of Biological Scientists, U.S. Department of Labor, Bureau of Labor Statistics Pamphlet No. 7-8.2 (Washington, 1955), p. 4.

of increasing and improving agricultural production, developing new varieties and strains of plants and animals, and in the conservation of renewable natural resources such as forests, ranges, and soils. The medical and healing arts, another large field of applied biology, includes those whose principal interest is in healing the sick and in preventing disease in man or in domestic animals.

The purpose of this report is to inform the reader of the career opportunities available in the basic biological sciences of zoology, botany, microbiology, physiology, and entomology. Where it has been desirable in isolated circumstances, information concerning applied biology in the agricultural biological sciences has been provided. Although the medical and healing arts are certainly a part of applied biology, it is considered that these fields should not be a significant part of a report of this scope.

An attempt has been made to present just what opportunities for careers are available in each of these fields, where the opportunities are, the educational requirements necessary or desirable for a career in these fields, what biologists engaged in these fields do, the rewards which can be expected, and other pertinent information concerning careers in these fields.

There are many opportunities available in these fields for a career in teaching, both at the high school and college or university level. Being aware of these opportunities, a portion of each chapter has been devoted to the career of teaching the basic biological sciences.

Many opportunities exist today for women to find employment in the biological sciences. It is a recognized fact that many young women may find enjoyable and profitable work in biology. For this reason, a

chapter on the opportunities available for women has been included. This is done with the hope that they may gain an insight into these opportunities and be stimulated to seek a career in biology.

The bibliography at the end of this report lists material found helpful in writing the report. This might also be of aid to the reader who wishes to obtain further information on any of these careers.

CHAPTER II

EDUCATING THE BIOLOGIST

Although the educational requirements for a career in each of the basic biological sciences will be included in the chapters devoted to each of these areas, it will be helpful to summarize this information in one place and to add a few points.

Preparatory Courses in High School

Biological science is too comprehensive and too complex to be well understood without some formal training. This means that, with only occasional exceptions, the student will have to complete a full high school or college education to enjoy any likelihood of successfully pursuing a career in biology.

The course of study in high school will be much the same whether a young person plans to go on to college and major in the biological sciences or plans to seek a job in this field immediately upon graduating from high school. He will want to take as much general science, biology, chemistry, and physics as his schedule will permit. If advanced courses in the latter three subjects are offered, they should be scheduled if at all possible. A thorough grounding in English, particularly grammer, and in mathematics is essential, and two years of a foreign language are extremely helpful.

There are several avenues open for extracurricular activities in the biological sciences for interested high school students. A number of study

programs for high school science students are offered by universities and other organizations during the summer months. For example, one university schedules a summer session of two weeks for eighty high school pupils from the ninth to the twelth grades. These students take part in laboratory and field activities in the natural sciences. Another program provides for a ten-weeks' summer session limited to twenty-five promising students who have had at least one course in biology. The techniques and methods of research are taught. Some local communities provide cooperative work-training and apprentice activities for students during the summer months.[1]

Among other activities of interest to science students are science clubs, bird or wildlife study, scientific journals and books, visits with scientists, and science fairs. In addition, prospective scientists often visit laboratories, State extension stations, biology departments at the university, and museums of natural history and technology.

Preparation in College

If a student's plans and hopes carry him on to college, he will for the first time be free to make a choice among biological fields, to specialize on some things and to leave out others. The point that a student should not specialize too early should be stressed. He should wait until he has sampled the different kinds of biology before making a choice. Several specialties will probably be encountered that never occurred to him before. One of these specialties may be the very one for him. The

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[1]Mary C. Murphy and Evelyn S. Spiro, Careers for Women in the Biological Sciences, Women's Labor Bureau Bulletin No. 278 (Washington, 1961), p. 49.

student should take courses in both the zoology and botany departments if the college has separate departments. Some time should be devoted to outdoor study and to laboratory experimentation. If this is not done, the student runs the unhappy risk of being a zoologist who should have been in bacteriology, or a collector of ferns who should be studying the nerve responses of birds. Most such misfits never took the time early in their careers to try several kinds of biology before they settled on one. The alert and curious student may very likely come upon approaches and areas which no one has thought of or begun to explore.

The required course of study for obtaining the bachelor of science degree with a major in biology varies greatly from college to college. Some colleges offer a wide range of electives in biology, while others have a high percentage of required courses.

Colleges which offer a major in biology most frequently require courses in botany, genetics and heredity, anatomy, and physiology, in addition to general biology. Among colleges which offer a botany major, the courses most frequently required, other than botany, include anatomy, morphology, physiology, ecology, genetics and heredity, and general biology. A senior seminar is also required by many colleges. Fewer colleges offer a major in microbiology or bacteriology, but among those which do, the courses required most often outside the immediate major field are immunology, physiology, and genetics and heredity. Other courses which are required or deemed highly desirable for majors in biology or its specialties are taxonomy, histology, entomology, mycology, virology, parasitology, pathology, evolution, and cytology.[2]

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[2]Ibid., p. 45.

As for courses outside the biological sciences, the number that the student includes in his college program depends somewhat upon his chosen biological specialty. At least two years each of college mathematics, chemistry, and physics are desirable for most biologists. For almost any specialty the student chooses, he will be much better off with intermediate mathematics.

A foreign language should be taken by students working for a degree in the biological sciences. German or French are the foreign languages which are of the most help to biologists. Much of the world's scientific literature is published in either German or French. Although there is an increasing tendency toward the use of trained persons to translate and abstract this material, many biologists find it a great advantage to be able to read papers in the original language. With the Russian nation widening its activity in the scientific fields, the study of their language is becoming increasingly popular among scientific students.

The biologist should also be a master of the English language, both in writing and in speaking. There are too many brilliant biologists who have trouble in communicating their ideas and findings to others. When this happens, the progress of the biologist and of the biological world are stunted. For this reason, many biologists find it advantageous to take undergraduate courses in explanatory writing, report writing, and public speaking. Learn how to speak and write effectively! The students efforts in this direction will some day be repaid many times.

Advanced or Graduate Degrees

Graduate training is necessary for employment in most professional positions in the biological sciences. Persons who want to become top-

flight scientists in the biological field should, if at all possible, work toward gaining a doctor's degree. Those with less than a doctor's degree seldom have sufficient knowledge or experience in the field to start plans for a research project, develop techniques for conducting a study, analyze the results, or prepare a report of the findings. The doctor's degree or its equivalent is also a prerequisite for top-level teaching and administrative posts. A medical degree, with specialization in one of the biological sciences, is necessary for some positions. Although a number of people with less than a doctor's degree have made names for themselves in biological research in the past, today's trend in biology is toward raising the academic requirements for its workers.

Even though the doctor's degree is desirable, the master's degree is sufficient educational preparation for the majority of entry positions, including those in research and college teaching. However, training at this level is insufficient for persons to advance to high-level positions, especially in the field of experimental biology, where employment opportunities have had the greatest expansion in recent years.[3]

It is highly desirable for a student who plans to work for an advanced degree to get the broadest possible foundation in the humanities, the scientific field in general, and in the fundamentals of biology during his undergraduate education, and to begin his specialization at the graduate level. The more a student knows about his intended career goal, the better he can plan the area in which he wants to specialize. After the student has determined the area in which he wants to specialize, he is in a better position to choose a school which provides a good program

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[3]Educational Requirements for Employment of Biological Scientists, p. 1.

in his chosen specialty.

The course of study of a candidate for an advanced degree in any of the basic biological sciences will be largely determined by the following three factors: (1) the ultimate occupational goal of the student, (2) the requirements which the university has established for the degree sought, and (3) the breadth and depth of the individual courses which the university offers.

Cost of Formal Education

As the student continues his formal education, the cost falls more and more on him. High school is his for the asking. College must be paid for and requires several hundreds of dollars each year at the least. All college students and graduate students in particular, have access to many forms of financial assistance if they need it. This assistance may be in the form of scholarships, assistantships, part-time work of various kinds, and loan funds.

The student should realize that it isn't necessary or even always desirable to continue an unbroken program of formal education. Many of the successful biologists have taken time off for various paying jobs or finished their training on a part-time basis. It is often desirable to try working at biology for a while before one's investment in time and money is complete.

Self-Education of the Biologist

The present-day enthusiasm for formal education and college degrees has obscured one very important point. Namely, it is easier to get an education the ordinary way, by going to school, but it is very possible

for a person to educate himself. In order for a person to do this, it takes a lot more drive, a lot more time, and a lot less money. A person willing to do this must want to be a biologist more than anything else.

Another kind of self-education applies to any good biologist. This is the self-education that keeps a biologist learning, thinking, and discussing biology during most of his free time as well as during his working hours. This kind of self-education includes reading, discussions with a number of other biologists, and attending biological conventions.

One of the greatest rewards of a career in biology is its ever-expanding horizon, the realization that there is a lot more to learn, and that learning and participating in the progress of the world is a great satisfaction in itself.

CHAPTER III

CAREERS IN ZOOLOGY

Zoology is the biological science which deals with the study of animal life. The zoologist is concerned with every aspect of animal life including classification, structure, development, inheritance, function, behavior, and disease.[1]

The Scope of Zoology

There is a wide variety of careers available in zoology. Zoologists may specialize in invertebrates or vertebrates. Those who specialize in invertebrates, and the forms of life that they study are as follows:

1. Entomologists specialize in insects.
2. Helminthologists specialize in worms.
3. Protozoologists specialize in protozoa.
4. Arachnidologists specialize in spiders.

Among those who specialize in vertebrates and their subjects of study are as follows:

1. Ornithologists specialize in birds.
2. Mammalogists specialize in mammals.
3. Ichthyologists specialize in fish.
4. Herpetologists specialize in amphibians and reptiles.

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[1] Zoologist-Career Summary, Careers Publication No. 35 (Largo, Florida; 1958), p. 1.

These are not nearly all of the specialties which are available to the zoologist. However, if it was attempted to list all the specialties and the opportunities for a career in them it would constitute a large book. Instead of attempting to cover all of the various specialties, the opportunities in the field of zoology have been dealt with as a whole. The opportunities in one specialty are basically the same as in any other specialty. This should be borne in mind by the reader. If this is done, the next section may serve as a guide for opportunities in any of the specialties in the field of zoology.

Employment Opportunities

By far the greatest number of zoologists today are employed as teachers by colleges and universities. In many of these positions, they serve as biologists first and zoologists second. This means that they may be employed primarily to teach biology courses of all sorts. Those who are employed by the larger universities, however, usually teach only zoology courses. If he has a specialty, he may continue his work in that area as a result of teaching assignments being deliberately kept low enough that he is able to do research work. In many institutions, research productivity is expected from every staff member, and zoologists are encouraged to carry on their studies in many ways.

A great untapped field of jobs for zoologists lies in high school biology teaching. If the student interested in zoology would complete the necessary education courses, he could contribute much to the improvement of biology instruction in the secondary schools.

The zoologist may find a position in research. Many full-time research positions are available in both government and industry. Research

positions are available for zoologists with the United States Fish and Wildlife Service or State Wildlife Departments. Industrial research positions are occaasionally open to zoologists. Many of these industries employ relatively few zoologists, and many individual companies employ only one or two. Nevertheless, when all of these jobs are added together, the total is quite large. Such positions usually demand that the research performed have some relationship to the goals and services of the industry concerned, and completely independent selection of research subjects is often impossible. Zoologists who have taken such positions have, however, found it possible to continue contributing to their field.

Among laboratories in private industry, there is considerable variation in working arrangements, depending on the size and function of an organizational unit, and more particularly on the specific problem at hand. In one place, a zoologist may work alone on a project, and in another he may have the assistance of other zoologists, technicians, or aids. In a few situations, zoologists may be engaged in solving a problem which will require cooperating with persons trained in other fields, such as physics, chemistry, medicine, or veterinary science.

The zoologist may be employed as a museum curator. These museums are usually operated by government or nonprofit private organizations. They are located throughout the country, and most are in major metropolitan centers. Large museums or zoological parks usually maintain curators ranging from assistant to head curator. A specialist in some group of animals, each curator spends his time studying his specialty, caring for collections, preparing exhibits, and communicating knowledge to his colleagues and to the public. Curators who demonstrate outstanding ability in public relations and administration may advance to a directorship. The

total number of curator positions is small and the competition for them is great.[2] Consequently, it is advisable for those interested in this career to prepare themselves for teaching as well as research so as to insure a wider choice of job possibilities.

Employment as a zoo curator is another possibility for the zoologist. Many zoos employ zoologists as curators. Most of the remarks made above concerning the museum curator could be repeated here. In general, the responsibilities of the zoo curator include maintaining attractive exhibits and informing the public about the zoo.

In addition to the professionally trained personnel, many people with less training and experience in zoology or the other basic biological sciences are employed to fill supporting jobs. Among these are the laboratory technicians, animal caretakers, and research aids. In some places, these employees are required to have a bachelor's degree; in others, to have some college training; and in others, only a high school education.

Wildlife management offers a source of employment in the area of applied zoology. It is the science and technology devoted to the production, regulation and utilization of game, fur animals, and other wildlife. All human activity involving the care, protection, increase, use, or control of wild animals in their natural habitat is a part of wildlife management.[3] The maintenance of habitats favorable to survival of wild-

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[2]James A. Peters, Career Opportunities for the Herpetologist, American Society of Ichthyologists and Herpetologists Publication (Northridge, California), p. 2.

[3]Charles M. Kirkpatrick, Training and Employment of Wildlife Biologists and Fishery Biologists, National Wildlife Federation Publication (Washington, 1961), p. 2.

life and the furnishing of many kinds of recreation is a chief responsibility of the wildlife manager. This requires trained wildlife scientists, including technologists, research workers, teachers, administrators, and public relations personnel. The recognition of the need for technical knowledge about wildlife has opened unusual opportunities for college graduates in this field. There are numerous and varied opportunities for employment available. Graduates may be employed by such governmental agencies as the United States Fish and Wildlife Service, the National Park Service, and other federal agencies. State departments of conservation have many openings for young men in wildlife research, management, and administration. New developments providing employment opportunities in the field of wildlife management are with hunting clubs, private land owners, and operators of forest properties and other wild lands. In these areas, the wildlife manager is responsible for producing and harvesting wildlife crops.[4]

It can be readily seen by the reader, that there are many and varied jobs available to the zoologist in research, teaching, industry, curators of zoos and museums, and outdoor positions such as wildlife management. Career opportunities are available at any educational level, but for the better positions, a college degree is necessary. An advanced degree is a necessity for advancement to the top positions.

4"Careers in Biology: Wildlife Management," The Biologist, May, 1959, p. 64.

CHAPTER IV

CAREERS IN BOTANY

Botany deals with all plants and all phases of knowledge pertaining to plants. Plants vary greatly in size, from bacteria to large forest trees. They may be studied for their own intrinsic values and importance in the general life cycle of nature or, more specifically, in regard to their innumerable uses to man.

The Scope of Botany

Botanists, like zoologists, often work in a certain area of special interest. The specialists in botanical investigation and study are as follows:

1. Plant taxonomists specialize in the identification and classification of all plants.
2. Plant ecologists specialize in the relationships of plants with the environment.
3. Plant cytologists specialize in cellular structure and phenomena.
4. Plant morphologists specialize in plant structures.
5. Plant embryologists specialize in the early development of plants.
6. Plant geneticists specialize in plant heredity and breeding.
7. Paleobotanists specialize in fossil plants.
8. Medical botanists specialize in the uses of plants in medicine.
9. Bacteriologists specialize in bacteria.

10. Forestry botanists specialize in bacteria.
11. Plant anatomists specialize in internal structure.
12. Plant physiologists specialize in functions of plants.
13. Plant chemists specialize in elements and compounds present in plants.
14. Plant pathologists specialize in plant diseases.
15. Economic botanists specialize in the uses of plants and plant products.
16. Agronomists specialize in crop plants.
17. Horticulturists specialize in garden plants, whether ornamental or for fruits and vegetables.

Employment Opportunities

Career opportunities in botany have recently developed along several different lines. At the same time, certain of the traditional areas of employment have failed to maintain their former level. The recognition of such facts is important in considering a botanical career. Only the most dedicated approach will win entrance into a field that is becoming more restricted.

At the present time, the fields most open for botanists are those with commercial application. The pharmaceutical industry is still employing a number of people with backgrounds in mycology and bacteriology. Physiology laboratories have some openings for those interested in flowering plants. There will always be some openings in horticulture for plant geneticists. Forestry is a promising field for those interested in forest management and sustained-yield cropping of trees, as some of the larger wood pulp and lumber companies maintain special forestry staffs. There

are positions open for pharmacognocists, who deal with the recognition of plants from fragments in drug shipments, and who are needed to maintain crude drug standards. For those who wish to combine botany with chemistry or physics in the areas of physiology, biochemistry, or biophysics, there are opportunities for employment in agricultural chemical industries, and research in plant growth controls.[1]

One of the largest employers of botanists in both practical and theoretical fields is the United States Department of Agriculture. State governments also employ many botanists, particularly at agricultural experiment stations. Some work on biological warfare problems for the United States Department of Defense.[2] Since this source of employment may vary widely from time to time, depending upon governmental appropriations and the research programs decided upon, it is well to determine the permanence of the available positions before entering. There are a number of permanent positions in many fields of botany in government service, but these are already largely staffed to the limit of available positions except in a few of the newer fields of experimental botany. Normal turnover of personnel in the agricultural sciences, plant quarantine, medical botany, and other related fields is to be expected, so that opportunities will always recur.

For persons interested in research in the theoretical fields of botany, the greatest opportunities are in college and university teaching with research being done on the side. Some educational institutions are

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[1]"Botany as a Profession," Chicago Natural History Museum Publication (Chicago, 1961), p. 2. (Mimeographed.)

[2]Careers in Plant Pathology, American Phytopathological Society Publication (Madison, Wisconsin; 1959), p. 4.

able to place research first and teaching second, but these are few. While specialists in all the fields of theoretical botany and many of the fields of practical botany will be required for personnel replacement in existing positions and to provide for increase in faculty at growing colleges, nevertheless, the experimental fields sponsored by industry and government offer the most encouraging outlook for employment. Emphasis on plant taxonomy, plant morphology, and other observational sciences has declined for more than a quarter century. Genetics and cytology offer good opportunities as these areas continue to be actively explored. Recent developments in the oil and related industry require experts in fossil pollen and spore identification. The number of job opportunities in this vocation will probably increase.

There are few openings for employment as botanists in museums and research institutions. Most museums are unable to expand in botanical fields as they would like, and the number of staff openings in taxonomy and economic botany remains about the same or decreases. Some botanical gardens with taxonomic collections maintain botanical research staffs, but the job openings here tend to be fewer rather than to increase.

Executive positions for botanists are limited, although some botanists hold important executive posts in government, institutions, and industry. In nearly all cases, they have advanced to these executive positions because of their demonstrated knowledge of the science and their proven abilities to organize and execute their scientific responsibilities.

There are job opportunities including selling and the physical handling of plants and plant materials for people still in high school or with no more than a high school diploma. With experience alone, there are certain opportunities for advancement, but the acquisition of a formal

education in a chosen subject will enable a person to advance more rapidly. In scientific laboratories and organizations dealing with plants, a high school education is not considered sufficient training for employment in other than the most routine tasks. Persons with a bachelor's degree in botany, with or without some specialization, will still be restricted to largely routine jobs. Advanced degrees are nearly mandatory for persons interested in making a career of botanical research or teaching.

CHAPTER V

CAREERS IN PHYSIOLOGY

Physiology is the science of living nature. In other words, it is the study of the physical and chemical processes of living matter in action. It is a discipline concerned with the life processes of living beings, living organs, and living cells. It is, in fact, dynamic biology.

The Scope of Physiology

Physiology is a part of basic biology. It is concerned with living matter from single bacterium to giant sequoia tree, from amoeba to caterpillar, and from algae to man. It can therefore be considered as functional biology for it delves into the function of organisms and how life goes on. It cuts across the lines of all the traditional biological disciplines. The range of physiology is as great as the diversity of life itself, and it is limited only by the imagination and ability of the biologist.[1]

As a biological discipline, physiology is related to the health sciences. Physiology is, however, much more than a health science. For practical reasons, it is often associated with a school of medicine. Many discoveries by physiologists lead to the diagnoses and cures of diseases by practicing physicians. The physiology of today is the medi-

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[1]Milan Herzog, A Career in Physiology, American Physiological Society Publication (Washington, 1960), p. 2.

cine of tomorrow.

Physiology is also a research science. As an illustration of this fact, the work of one research physiologist may be examined. The research physiologist might have the responsibility for planning and executing experiments concerned with the relationship between availability of oxygen and the metabolic rate in insects. In carrying out this phase of research, the physiologist might measure the metabolic rate of various insects in relation to age, nutritional condition, temperature, and respiratory systems in general.[2]

Employment Opportunities

The careers in physiology are expanding much faster than the number of physiologists coming out of the universities. The need for physiologists in the many branches of research in which physiology plays a role will increase in the future.

Physiologists may work in the academic world. A majority of them are employed in colleges and universities. They have the opportunity to foster new scientific talent and to use the well-equipped research laboratories for independent work of their own choosing. In some dental schools, there are separate physiology departments. They may be employed in hospitals to teach basic physiology to clinical men and resident physicians or to do physiological observations on patients for diagnostic purposes and research. Medical schools have physiology departments which are responsible for teaching medical students. In these schools, teaching and research are oriented towards mammalian, human, and medical physiology.

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[2]Murphy and Spiro, p. 24.

There are many opportunities open to physiologists in research laboratories and hospitals which may or may not be associated with universities and medical schools. In these laboratories, the physiologist may concentrate on pure, applied, or developmental research problems. Various nationally supported, government financed or subsidized agencies have strong physiology research departments.

The need of our government for good physiologists is increasing more rapidly now than ever before. Research projects which allow the maximum of self-expression in individual work or collaborative programs of considerable magnitude are available for physiologists depending on their own desires. There are opportunities with the federal government in the United States Civil Service Commission and the Public Health Service. At the state level, most projects are associated with the universities or agricultural colleges.

There are numerous opportunities for the physiologist in agriculture. There are opportunities in agriculture and veterinary colleges, or in agricultural and veterinary departments of universities. The plant physiologist in agriculture is concerned with the development of better agricultural plant products. The animal physiologist helps develop better animal products.

A relatively new career in physiology is in military research. The recent emphasis on space exploration has been responsible for the development of this area of research. The need for physiologists in the Armed Forces, both in uniform as officers and in professional civilian positions, is growing rapidly. Laboratories in the Arctic, the Antarctic, at missile and air bases, and in cities located over the continental United States and abroad have need of physiologists. These positions should

rapidly increase in number in the future.[3]

Not only in research and clinical sciences, but in the equally important area of professional education, opportunities occur throughout the nation and the world. Universities, industries, government research installations, foundations, research programs in hospitals, state research institutions and health centers, world-wide research programs of the United Nations, and other international cooperative programs are examples of the broad field in which physiologists operate. There are many federal grants available for research in the field of public health. Federal grants make it possible for many physiologists, in hundreds of institutions, to proceed with their own independent and infinitely varied studies. The person who earns the doctor's degree will be ready to take his place in any of these institutions. He can rest assured that a career in physiology will always provide him with employment.

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[3]Herzog, p. 30.

CHAPTER VI

CAREERS IN ENTOMOLOGY

Entomology is that branch of science that deals with the study of insects and with the ways in which they affect human, animal, and plant welfare.

Scope of Entomology

In many ways, insects are the most important group of animals that influence man's welfare on the earth today. They are surely the most numerous. Approximately seventy-five thousand species of insects are known from the United States and Canada.[1]

For many people, entomology is a fascinating hobby or an intensely interesting study. Some collect insects such as butterflies or beetles. Others spend much time observing the habits and behavior of insects and their relatives. For many people, however, entomology is also a career. Some entomologists specialize in identifying and classifying insects, a tremendous task in view of the large number of species. Their accurate identification is basic to controlling them and, thus, to the preservation of our food supply and to the control of disease. Many entomologists are teachers, some enforce quarantine rules, some work in extension services, and others furnish pest-control services. These are only some

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[1] Educational Requirements for Employment of Biological Scientists, p. 6.

examples of what entomologists do and will be discussed later in greater detail.

Employment Opportunities

Entomologists may be employed by the United States Department of Agriculture and other federal agencies, State colleges and experiment stations, insecticide manufacturers, commercial pest-control firms, privately endowed colleges, museums, and private research foundations.

There are numerous opportunities available for entomologists in research. Among the numerous areas of research specialization are: (1) insect control, (2) insect toxicology, (3) insect taxonomy, and (4) insect morphology.

More entomologists are engaged in research on the control of insects than in any other branch of entomology.[2] Their aim is to find more effective and more economical ways to combat the numerous species of insects that are enemies of man, his animals, and his cultivated plants. They develop ways to apply insecticides with greater efficiency, economy, and safety, and to minimize the danger of poisonous residues on fruit, vegetables, and livestock feed. Biological control entails the control of insects by utilizing their natural enemies, including other insects.

Insect toxicology is a vital field of research. It is concerned with the effects of toxic substances on insects. Those working in this field conduct research on how chemicals kill insects. Openings for toxicologists exist in a wide variety of research projects. These are in endowed

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[2]P. J. Chapman et al., Opportunities in Professional Entomology, Entomological Society of America Brochure No. 1 (College Park, Maryland; 1955), p. 3.

organizations, government, industry, and in the teaching field.

Entomologists who specialize in identifying, classifying, and describing insects are taxonomists. A related field is insect morphology. It is concerned with the origin and significance of form in insect structures, both internal and external. Many entomologists with specialized interests in taxonomy and morphology are employed by colleges and universities, museums, the United States Department of Agriculture, and other government agencies in this and other countries.

There are career opportunities for entomologists in the prevention of insects being introduced from other countries and the retardation of those which have been accidentally introduced. Inspectors are employed by both the Federal and State Governments for the enforcement of quarantines. These inspectors must have an educational background in biology, particularly those subjects dealing with insects, plant diseases, and the identification of plants.

Entomologists are employed to supervise and assist in control programs carried on over wide areas by official agencies. The object of these programs is the prevention of spreading of recently introduced insects which are still limited in distribution. Such programs are almost always carried on cooperatively by State, Federal, and local agencies. A disadvantage of this kind of work is that it is often of an emergency nature. It sometimes involves numerous changes of residence and considerable travel.

Employment is available in the extension services of land-grant colleges and State universities. The entomologists carry to the public the results of research and help people apply such information to meet their local situations. They also supply county extension agents with current

subject matter pertaining to their field.

Another opportunity for entomologists is in the field of pest control. Many of the pest control operators work primarily in cities or on pests that inhabit buildings. Some extend their services to include control of pests affecting shade trees and ornamental shrubs. Others spray farm crops and buildings for control of crop pests. The entomologists in this field may work for a company, establish their own company, or work for large farm operators.[3]

Apiculture, or beekeeping, is a field in which some entomologists find employment. For many years, the primary work of apiculturists was to conduct research and education for the production of honey and beeswax. The increase in the importance of bees in pollinating crops has caused a shift in emphasis in the type of research and educational programs. The apiculturist may do research, teach, or carry on extension duties. Others with training in apiculture operate their own bee yards.

The teaching of entomology offers excellent opportunities for the person with the proper qualifications. Some teachers who have a broad training help students to appreciate the interrelation of entomology to other sciences. Others restrict their teaching to one or more specialized phases of entomology. Nearly all teachers in the specialized fields conduct research work as a part of their regular duties. Teachers of entomology are employed in nearly all the State colleges and universities and in many publicly and privately supported colleges.

There will always be a need for qualified entomologists. Insect problems are steadily increasing in number and complexity. Although it

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[3]Ibid., p. 9.

is impossible to say just how many entomological positions will be open at any time, there has been a steady growth in the field, and this growth will no doubt continue. Preference in the filling of positions is often given to persons holding the doctor's degree.

CHAPTER VII

CAREERS IN MICROBIOLOGY

The science of microbiology includes the study of algae, bacteria, fungi, protozoa, rickettsiae, viruses, yeasts, and various other microorganisms.

Scope of Microbiology

The microorganisms which are studied by microbiologists are sometimes grouped into harmful and harmless types. It is a fact, however, that only about one hundred of the approximately fifteen hundred known species of bacteria can cause disease in human beings. Similarly, only a few of the twenty thousand recognized types of protozoa are harmful.[1] It would be impossible for man and other forms of life to exist on this planet without the harmless microorganisms which convert complex materials into the simple substances necessary for life.

Although the science of microbiology has developed only in recent decades, microorganisms are ancient forms of life that have affected man's destiny from prehistoric time to the present. Microorganisms may have been among the earliest forms of life to inhabit the surface of the earth. Interest in how microorganisms affect human existence has been the foundation of microbiology. The fermentation of fruit juices and

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[1] Microbiology in Your Future, American Society for Microbiology Publication (Detroit, 1961), p. 1.

the souring of milk are natural processes long known to man. Yet, why these changes occurred was unknown until Louis Pasteur, in the last part of the nineteenth century, showed a skeptical world that yeasts and bacteria converted sugars to alcohols and acids.

Microbiology offers many fields of specialization and a variety of opportunities in related areas. Some of these fields are characterized by the types of organisms studied. Virology is concerned with the study of viruses, bacteriology with bacteria, mycology with molds and yeasts, phycology with algae, and protozoology with protozoa. Bacteriology was formerly considered a separate field but is presently considered to be a part of microbiology. Microbiology is a broader term than bacteriology and includes the study of medical and health problems of animals through experiments with cells or other microscopic components of the body.[2]

The microbiological specialties are sometimes designated in terms of the areas in which these activities are of particular importance. For example, medical and veterinary microbiology are concerned with those microorganisms responsible for diseases of man and animals, industrial microbiology with the utilization of microorganisms in industrial processes, and agricultural microbiology with the role of microorganisms in various aspects of agriculture.

Employment Opportunities

Some of the places a microbiologist may work are Federal, State, city, and county health departments; municipal and county water and sewage disposal departments; dairies; the entire food preserving, canning,

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[2]Educational Requirements for Employment of Biological Scientists, p. 8.

and packing industries; various agricultural organizations; in teaching; in hospital laboratories; in pharmaceutical supply houses; and in space biology laboratories.

There are opportunities for the microbiologist in public health microbiology. The science of public health includes the study of the effects of the environment on community health. The centralization of human population and industry, coupled with advances in atomic, chemical, and food technology, have created such potential hazards for the community as outbreaks of food-borne disease, water pollution, and air pollution by human, chemical, and radioactive wastes. Public health microbiology plays a vital role in determining the cause, prevention, and control of these conditions.

Working very close to the public health official is the sewage disposal microbiologist. He must be certain, at all times, that the waste material of sewage is safe to come in contact with civilization. Many epidemics have been prevented by their rigid control measures. There is room for expansion in the army of public health microbiologists guarding the supply lines for human life.

Agricultural microbiology is an area where employment may be considered by those having training in microbiology and an interest in agriculture. The agricultural microbiologist is concerned with the large variety of microorganisms present in the soil, their relationships to the soil system, and with other problems relating to both the health and effective production of farm crops. Microbiologists have contributed much knowledge to agriculture and continue to play a significant role in providing for the food needs of the world.

Microbiologists may find employment in various industries. The

industrial microbiologist may work in any industry where the material produced or objects used in production may involve the growth of microorganisms.

The general food industries are protected and developed by microbiologists. These individuals maintain laboratories for both control and research. They not only safeguard the salable product of the food industry in which they work, but they cooperate with the chemists and engineers of the company in the development, production, and protection of new products and of improved old products. The food microbiologist is one of the key men in an organization preparing products for daily living.

In the dairy industry, the processing of milk, cheese, and milk products requires a knowledge of the role of microorganisms. The microbiologist is responsible for the elimination of undesirable microorganisms, the control of the number and types of helpful organisms, and the testing and certification of the products.

In the fermentation industries, the microbiologist reigns supreme. He controls the processing of many products through a series of reactions motivated by bacteria, molds, and yeasts. His place in the alcohol beverage industry is well known to all. Of even greater importance is his work in the production of vital organic acids, alcohols, and other products which are produced by fermentation processes.

In the pharmaceutical industry, the mass production of antibiotics used for the treatment of bacterial diseases of man, animals, and plants, and exploration for new antibiotics for the treatment of viral diseases and cancer are the everyday concern of microbiologists. Many important chemicals, solvents, food supplements, and enzymes are produced by them.

A career in medical microbiology may be appealing to many people. The medical microbiologist deals with the microorganisms which are responsible for the infectious diseases of man. The control of such diseases is very important. The microbiologist is concerned with the isolation, identification, and distribution of disease-producing organisms and in the manner in which they gain entry into the body, establish themselves, and produce disease.

Possibly the newest field in which a career in microbiology is available is in space microbiology. Space biology, sometimes referred to as astrobiology or exobiology, is concerned with the biology of organisms outside this planet and attempts to answer questions concerning the types of life possible on other planets. There are, as yet, no programs in colleges or universities devoted primarily to space biology, although microbiologists are starting investigations of certain phenomena having a direct relationship to space environment.[3] Since some microbes can thrive under extreme environmental conditions, studies with such microorganisms certainly will be important in space biology. There should be many career opportunities in this field in the future.

There is room for the microbiologist in various levels of the teaching profession. Teaching high school biology classes offers a career opportunity, but few microbiologists are so employed. Many microbiologists are employed as teachers in medical, veterinary, and agricultural colleges, and in microbiology departments of universities. Many of them carry on extensive research programs in addition to their teaching, and this feature is often of prime importance to the worker who likes the

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[3]Microbiology in Your Future, p. 11.

more or less exclusive life of the combined college professor and man of science. There will be a continuing need for teachers with training in microbiology at both the high school and college levels.

In the past forty years, microbiology has developed into an outstanding scientific profession. More and more students have devoted educational time to this as a major field of study. The worker in this field is required to have specialized training in his particular branch of microbiology. The minimum requirement for placement as a microbiologist at the professional level is a college course leading to the bachelor's degree. Persons with the bachelor's degree perform a large proportion of the diagnostic tests in hospital and public health laboratories, quality control tests in various industrial processes, and technical procedures associated with research problems. Usually this is done under supervision, but often, with increasing experience, the amount of supervision is reduced, and the individual may assume certain responsibilities of his own. A graduate degree is highly desirable and often essential for teaching at the college level, for independent research, and for positions which demand the maximum responsibility.

Positions in microbiology offer excellent financial reward and security. The demand for microbiologists now greatly exceeds the supply, and with the continued expansion of our nation's industry, the increased demand for medical care, the expansion of teaching and research facilities, and our nation's increasing interest in world health, there is much to indicate that there will be a continuing shortage of microbiologists at all levels of training for many years.

CHAPTER VIII

CAREER OPPORTUNITIES FOR WOMEN

Unlike some of the other science fields, a sizable number of women are employed in the basic biological sciences. Biology is a large occupational field, and one in which women play an important role. There is much to indicate that this role can become even more prominent in the future if enough capable young women choose and obtain sufficient training and education for the field. Relatively few of the fairly large group of women in this field have prepared themselves to be professional biological scientists. They are better represented in the ranks of research assistants and biology technicians and in the somewhat related occupations of X-ray technician and medical technologist. Since the number of jobs as research assistant and biology technician is quite large, women do, in fact, represent a significant proportion of the total number of workers in the overall biological sciences field. In many places, turnover is relatively high so that a number of well-trained persons are needed to replace those who leave the field as well as to staff newly created jobs.

Perhaps one-half of all the college-trained men and women working in the field of biology are teachers. Women comprise a relatively small proportion of the biological science faculties of colleges and universities. They probably make up only about 15 per cent of the total number, although this percentage appears to be growing gradually. On the other hand, about one-half of all secondary school teachers are women and about

one-half of all the biology teachers in these fields are women.[1]

In colleges, teachers of biology or one of its specialties are primarily concerned with classroom teaching of undergraduates and supervision of laboratories. In universities, professors often teach some classes, spend a considerable amount of time working with graduate students, and perhaps supervise or conduct one or more research projects. Colleges and universities usually require that their teachers have either a master's or a doctor's degree. Most new faculty members are hired as instructors or assistant professors, depending on their level of education and the amount of their experience. As they advance up the academic scale to the associate professor and professor levels, they assume more advanced and independent duties.

The duties of high school biology teachers vary markedly from school to school and depend on a number of factors, such as the organizational structure of the school, the size of the student body, and the curriculum. In a very large school, a teacher may teach only biology. In most schools, she also teaches one or more other science subjects, such as general science, chemistry, physics, mathematics, or some other subject unrelated to science. The line of promotion for a high school biology teacher may be progressively from head of the science department to assistant principal, principal, or superintendent of schools. At each succeeding level of responsibility, she is expected to assume an increasingly heavy load of administrative duties and to perform fewer activities normally associated with classroom teaching. Generally, only a bachelor's degree is required for high school teaching. A master's degree is

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[1]Murphy and Spiro, p. 6.

often a requisite for advancement. In a few schools, a master's degree is required even for beginning teaching in high school.

The second largest employer of women with training in the biological sciences is government. About two-thirds of this group work for the Federal Government and the remainder for State and local governments. Many of the jobs in government agencies are in laboratory research and related activities and are currently filled by women.

Among professional job categories of the Federal Government, by far the largest number of women are classified as bacteriologists and the next largest number, as general biologists. Well over one-third of all women in these groups work as medical technicians. For appointment to positions such as aid and technician, a college degree is not required. In most cases, high school graduation with courses in subjects such as biology, chemistry, and physics is sufficient. To qualify for most entrance level professional positions, applicants must have a bachelor's degree. The top level professional positions, particularly in research, are held by experienced biologists who usually have the doctor's degree.

Women comprise a significant proportion of the work force in State public health laboratories. In some places, almost all the technician jobs and a substantial number of the higher level jobs are filled by women.

Women biologists are employed by many industrial and business concerns, especially in laboratory activities, but their representation is believed to be smaller than in education and government. Laboratories run by private industry utilize the skills of persons possessing a wide range of biological specialties, including entomology, genetics, microbiology, pharmacology, zoology, and physiology. Research aids, laboratory aids,

and other personnel not professionally trained are also employed by industrial companies.

Many women with a college background in biology or one of its specialties are also employed in any number of nonlaboratory jobs. Among these jobs are medical and biological illustrators, writers and editors, librarians, and statisticians.

Medical and biological illustrators prepare book illustrations, charts, films, models, and exhibits. This work may be performed for physicians, scientists, publishing houses, manufacturers of pharmaceuticals, medical schools, and advertising agencies.

Writers and editors are in considerable demand to prepare television and radio scripts, for writing science books and magazine articles, and to cover science developments for newspapers. Technical writers are in demand for company publications and for journals of professional societies and other scientific organizations.

Librarians who are trained in the biological sciences may be employed by government agencies, by large public libraries which have specialized departments, by medical schools, by biological societies, and by some of the larger pharmaceutical firms.

Statisticians are employed in growing numbers in all segments of work connected with the biological sciences. They are primarily employed by Federal and State governments, nonprofit organizations, and hospitals. Those in most demand have had training in biology or one of its specialties. They collect and analyze information concerning many types of activity, and most often are engaged in correlating data and measurements relating specifically to scientific studies and experiments.

Although teaching and laboratory work seem to be the most popular

types of assignment for women biologists and biological technicians, they are employed in many other types of jobs. The young woman who desires a career in biology should have very little trouble in finding a career opportunity which is suited to her. In fact, women are often preferred over men because of their careful handling of detail and their patience, dexterity, and reliability.

perhaps, average a little more than those of sociologists and historians. Biologists with less training may expect incomes comparable to those of average salaried high school or college graduates, as the case may be. The rising demand for biologists has created a general trend toward increases in salary all along the line, and this trend may be expected to continue.

The major agencies employing biologists are educational institutions, government, and private industry. Smaller numbers work for research foundations and professional associations or operate their own businesses. There are considerable differences in the proportion of people working for the three major employers among the various specialties. For example, more than two-thirds of the botanists are in colleges, universities, and research institutes, while less than one-third of the agricultural scientists are in educational establishments. In every field, there are opportunities in all three of the major areas of employment. In general, it can be said that the income is higher in private industry than in government, and the income in government is higher than in educational institutions. Any statistics stating the specific salaries in any field would be out of date even before they were stated. Most salaries are now accompanied by employee benefits such as pension funds, health and life insurance, paid vacations, and sick leave allowances.

Social Significance

While the greatest appeal of the sciences is essentially as an intellectual search for truth, the changing face of the world bears evidence of the usefulness of the things that biologists do. Not only the conquest of disease and the improvement of food supplies for multiplying populations

of people, but also contributions to the pleasures and satisfactions of mankind rank as prime considerations.

A measure of this is the place that biologists hold in the opinions of their associates. The point will tend to make itself if the reader will think of the persons he knows who might be called biologists. A favorable opinion will probably be held of these people, and this is important in the lives of biologists even though they may not always willingly admit it. It might be added that there are tangible evidences of such recognition open to everyone who makes a good effort. Membership in professional societies marks the respect of professional colleagues.

Personal Satisfaction in the Work

Another reward of a life spent in the biological sciences is that, for many, it turns out to be a career they truly enjoy. This is not quite the same thing as social prestige, which has to do with what other people think of you, or self-esteem, which has to do with what you think of yourself. It is the opportunity, in biology, to receive pleasure in the day-to-day execution of one's work. Being a biologist is at least as rewarding in this way as any career one could choose.

Self-Development and Self-Esteem

The hardest thing of all to evaluate is what biology means to the individual who has chosen a career in the biological sciences. This is true because doing so necessitates getting over into the realm of ideals. However, most biologists take pretty seriously the matter of being useful and of leaving the world a little different and a little better for having lived in it. Many of them have probably had a chance for a higher

income in some other career, but if they could have the same chance again, they would still be biologists.

As for self-development, the opportunities here are unlimited. So great is the volume and diversity of the biological sciences that no one individual can even begin to cover the field. Biology needs observers, experimenters, statisticians, theorists, technical experts, interpreters, teachers, and writers. A person can go as far as he likes in any one of these directions; he can combine them in any number and sequence; he can emphasize any one or more as he wishes; and make a valuable contribution to the biological sciences in doing so.

CHAPTER X

SUMMARY AND CONCLUSIONS

The purpose of this report is to find what career opportunities are available in the basic biological sciences. These are zoology, botany, physiology, entomology, and microbiology.

Perhaps all the opportunities which have been proposed may be summarized into one statement. Biology is a fairly conservative field, seldom subject to wholesale demand, yet almost always with positions open for young men and women who are qualified to fill them.

Most important of all is the fact that there are shortages in the present supply of biological scientists. As far as can be determined, these shortages will continue unless some success is achieved in attractable young people to careers in the biological sciences. Indeed, there is a growing shortage of specialized and scientific personnel of all kinds. Whether these needs can be fully met is another question. A complex technological society such as ours needs all the able young people it can find to serve in scientific and specialized fields. Today, there isn't a single branch of biology that doesn't have space for a good new applicant. In some, such as teaching, the shortages are alarming.

As to the future, it is hard to specify what new demands will appear, only that they will appear. The student should study and train for the kind of biological job that attracts him most, but he should allow enough breadth in his education to be prepared for new fields as they open up.

Genetics, conservation, antibiotics, radiation biology, and isotope research are among the dramatic developments of the first sixty years of this century. Who can tell what the last forty years may bring? We may be supplementing man's food supply with algae as more traditional food items are in short supply, directing the pathways of inheritance, farming the arctic and the tropics, capturing the energy of the sun in the laboratory, or investigating the biology of another planet.

In the future, there must be enough young biologists to fill the gaps opened up by the retirement of older men and women. More than that, there must be a continuing supply of additional workers to meet a dual challenge: (1) the growing demands in established branches of biology, and (2) the new fields of biology which will be opening up in the future. The United States and the world are growing ever more populous and more demanding of the goods and services which biology helps make possible. Biology is one of the oldest fields of human knowledge. It has now become one of the newest and most dynamic as well. For the young men and women with an urge to build a career in the basic biological sciences, there will be numerous career opportunities in this new dynamic biology.

A SELECTED BIBLIOGRAPHY

American Phytopathological Society. Careers in Plant Pathology. Madison, Wisconsin: 1959.

American Society for Microbiology. Microbiology in Your Future. Detroit, Michigan: 1961.

"Botany as a Profession." Chicago Natural History Museum. Chicago, Illinois: 1961. (Mimeographed.)

"Careers in Biology: Wildlife Management," The Biologist, XLI (May, 1959), 64.

Chapman, P. J., et al. Opportunities in Professional Entomology. Entomological Society of America, Brochure No. 1. College Park, Maryland: 1955.

Franklin, Zilpha C. New Careers in the Health Sciences. National Health Council. New York: 1961.

Herzog, Milan. A Career in Physiology. American Physiological Society. Washington, D. C.: 1960.

Kirkpatrick, Charles M. Training and Employment of Wildlife Biologists and Fishery Biologists. National Wildlife Federation. Washington, D. C.: 1961.

Murphy, Mary C., and Evelyn S. Spiro. Careers for Women in the Biological Sciences. Women's Labor Bureau, United States Department of Labor, Bulletin No. 278. Washington, D. C.: 1961.

Peters, James A. Career Opportunities for the Herpetologist. American Society of Ichthyologists and Herpetologists. Northridge, California.

Schlessinger, Fred R. Careers in Science Teaching. National Science Teachers Association. Washington, D. C.: 1962.

United States Department of Labor. Educational Requirements for Employment of Biological Scientists. Washington, D. C.: 1955.

Zoologist - Career Summary. Careers Publication No. 35. Largo, Florida: 1958.

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