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Scope of Study: Development of the idea of the use of a Biological Station for instruction of secondary school students in the natural sciences, giving them the opportunity to appreciate and enjoy natures processes, and to develop scientific methods and attitudes by working and studying in a research manner with students of similar interest, making use of flexibility in operation to serve the needs of students as well as the general public for the common educational desires. A four week intensive study in Botany, Zoology and Advanced General Biology areas planned to give special emphasis on direct observation of living material.

Findings and Conclusions: Students who study in the field with nature, apart from the usual activities of the regular school program, can develop greater appreciation for life and better understanding of natural processes as well as develop scientific attitude and methods by work and studying in a research manner. At the same time, this program gives interested boys and girls something to do during the summer months that will be constructive in mental development.

ADVISER'S APPROVAL L. Herbert Bruneau

DEVELOPMENT OF BIOLOGICAL STATIONS FOR SECONDARY SCIENCE EDUCATION

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DEVELOPMENT OF BIOLOGICAL STATIONS

FOR SECONDARY SCIENCE EDUCATION

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PREFACE

There are many educational advantages in studying Biological Science in the field where life is in its natural habitat.

This report is concerned with discussion of information concerning a Biological Station for use in teaching Biology in its natural surroundings and its development.

Indebtedness is acknowledged to Drs. Imy V. Holt, James H. Zant, and L. Herbert Bruneau for their valuable guidance; and to Lavon B. Ellis, and my wife, Lillie, for their advice and encouragement. I am also deeply indebted to the National Science Foundation and the members of the Summer Biology Institute, and Academic Year Institute Selection Committee, who materially aided in making this study possible.

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CHAPTER I

INTRODUCTION

[1]The needs of our time dictate that children be introduced to the ideas of science and the scientific methods at an early age. Science should become a great deal more than descriptive art. Pupils should have an opportunity to do experiments in a laboratory situation as well as to talk and read about science. Many schools do not have the needed instructional materials and equipment to accomplish this. It is important for the science student, at all levels, to become acquainted with the methods of science and with the broad underlying concepts of science.

Students should be taught how science and scientists can assist them in developing a sense of acknowledgeability of their own attributes toward scientific study. Working with others in the laboratory to follow through on experiments, sharing the results with others with a feeling that you are contributing to the safety of you and your neighbors, and submitting assigned work on time all contribute to the acknowledgement of their right or priviledge to assist in the uncovering of the many wonders of nature and life.

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[1]Council of Chief State School Officers, Improvement Of Instruction In Science, 1201 6th St. N.W. Washington, D.C., p.-6

The laboratory should be used to discover and prove the laws, concepts, and principles of science. The results of laboratory experiences can then be used as a basis for further discovery.

In a field laboratory students could better study and observe plants and animals in their natural habitats, than they would be able to do in a regular laboratory situation. A field laboratory with an abundant supply of plants and animals in their natural environment, could provide students the opportunity to discover the wonders of the world in which they live. These discoveries could lead to a greater appreciation for life and a greater understanding of life's functions.

After a prolonged study of plants and animals has been made in a field laboratory, one is apt to make more accurate evaluation later on in a regular laboratory.

Both laboratories are necessary. Earlier studies in a field laboratory could possibly make your regular laboratory comparisons faster, easier and more accurate.

CLARIFICATION OF TERMS

Biology, the study of living things, is the most complex of the sciences; it has the largest number of unknowns and the largest number of variables. [2]There is no question in the minds

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[2]U.S. Office of Education, Mathematics and Science Education In U.S. Public Schools, Circulor 533, U.S. Dept. of Health, Education, & Welfare, Washington, D.C., (1958), p.-3

of a great many very competent persons that there will be an increasing emphasis placed on research in the biological field.

Field Biology may be defined as the study of life under natural conditions, or in its own habitat. As opposed to the strictly experimental desciplines of the laboratory, Field Biology is first observational and secondarily experimental. Instead of removing organisms from their native environments to study them in the laboratory, you go where they are and observe them there.

[3]A Biological Station is a permanant field station designed and operated to offer opportunities for study and research in ecology and natural history, and those phases of taxonomy, evolution, morphology and physiology that requires extensive study of organisms in their natural habitats. A Biological Station may be an instructional research unit, useful in showing the relationships between the different sciences by the use of physical science as well as biological sciences in the studies of life's functions.

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[3]Bulletin of the University of Oklahoma, Biological Station, University of Oklahoma, Norman, Oklahoma. (1957) p.-3.

CHAPTER II

GENERAL INFORMATION

EDUCATIONAL ADVANTAGES OF BIOLOGICAL STATIONS

There are many educational advantages to be gained by taking students to where more examples of biological science are found, rather than giving them a neatly packaged course all wrapped up in a textbook.

Some of the advantages to be gained are:

1. A Biological Station would provide a place for those who are interested in studying natural science where it is found.
2. [1]A Biological Station could serve to fulfill the curosity of those whose formal education will terminate before or upon completion of high school work and those who will continue their education through college.
3. The biological principles could be selected to serve all students. However, principles, as such, are meaningless unless they arise from concrete data and

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[1] National Science Teachers Association, New Developments In High School Science Teaching, (1960) National Science Teachers Association, 1210 6th St., N.W. Washington, D.C., p.-49

can be applied to specific problems.

4. A Biology Station would give one a chance to do fieldwork during the time of year when plant and animal life is more abundant.

Almost everyone admits that field experience should be a part of the laboratory work in any introductory course in botany, zoology, or general advanced biology. Usually the time allotted to field trips is a small part of the total time given to laboratory work. In the usual course in biology, by the time the class is ready to study in the field, winter weather has begun, limiting the areas of study, so that fieldwork must be held in early fall before development of an introduction that may be necessary for better understanding of field trips or in early spring before the flora has fully developed and the fauna becomes abundant.

[2]Almost every phase of biological study can be illustrated by material found on field trips. An old board illustrates economic uses of plants, as well as forestry and conservation; the fungi under it illustrates the role of plants in decomposition. Dandelions in the lawn illustrate man's effect upon the

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[2]General Biological Supply House, Turtox News, Volume XXXVIII, (1960), General Biological Supply House, p.-26.

world wide distribution of plant species. Any cultivated field will show something of the selection and development of cultivated plants; The nearby week patch probably contains some wild relative of these same species. A tree may show Protococcus on the trunk (Microscopic plants); healed-over scars (growth and repair); galls on the leaves (parasitisms and ecology); and flowers or fruit (reproduction). Comparing two or three closely-related species (from the same genus or family) will illustrate the fundamentals of plant taxonomy. Sprouting tree seedlings or flowers may demonstrate genetic variation.

[3]The relations between animals and its environment may be found in the field by the water insects of the streams and ponds or the parasitic animals on plants, such as nematodes on plant roots. Snails and mussels in shallow water, where algae and water plants are abundant, or areas where larger animals eat the smaller ones, would show food relations. The spawning areas of fish and frog egg masses on plants in shallow water would show reproduction habits. The stages in the development of an animal such as a frog would provide study in life history. Birds eating insects or a hawk catching rabbits and rats would illustrate balance of nature. There are many more such relations in the plant and animal kingdom that may be found in various habitats.

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[3]Morgan, A. H., Field Book of Ponds and Streams, (1930), G. P. Putnam's Sons.

The key plants and animals in each community may be singled out for consideration, with particular attention given to adaptations which suit them for the environment in which they are found.

VALUES IN STUDENT RESEARCH

Research is seldom considered as a realm of endeavor to be introduced in the average high school. However, some technical, industrial and medical laboratories employ high school students for laboratory work during the summer. Reports of these experiences indicate that they are capable of many laboratory tasks and the experience gained by the student is an unforgettable one.

[4]Research and experimentation by high school students may be tremendously worthwhile:

1. Better students may seize the opportunity to do research and at the same time being stimulated to consider seriously science fields as careers.
2. A contribution may be made toward basic research, which is a systematic investigation of some phenomenan or series of phenomena by experimentation.
3. It may provide an example for other students to develop more interest in science.

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[4]Rasking, Abrahm, Selected Papers On Science Teaching, National Science Teachers Association, Washington, D.C..

4. It may give the average person a greater appreciation for science.
5. Students may search for information not found in standard text-books by reading more scientific publications. Text-books may be as far as 20 or more years behind scientific research.
6. Students may have opportunities to keep up with scientific development in the biological science as well as the closely related physical sciences.

In summary the student may have the opportunity to observe how dynamic biology is, and to appreciate and enjoy this great and expanding science.

USES AND VALUES OF BIOLOGICAL STATIONS

During the summer months when many children of the high school group are out of school, the plant and animal life of most localities are continuing to carry out their natural processes. During this time boys and girls have a great deal of idle time and their minds are idle. This is a good time to channel their energies into constructive behavior and attitude. With the use of a place where these students with scientific abilities can direct their energies, there is great probability that the development of attitude, thoughts, and responsibilities will be rewarding. This can be valuable in the growth and development of boys and girls to become responsible citizens

with an increased interest in science in the coming world of tomorrow.

A Biological Station if located in an area with varied habitat of hills, valleys and canyons, rivers and streams, lakes and ponds, with a variety of soil and vegetation, would provide a good possibility for the study and understanding of nature in its natural surrounding.

1. Biological Stations may give opportunity for increasing the development of scientific attitude and methods by work and studying in the field.
2. A Biological Station can provide opportunity for development and understanding of most of the areas of natural science.
3. It would help to develop an appreciation of the physical sciences as they apply to the natural sciences.
4. It would provide a place for students of like interest to study, work and exchange ideas with one another.
5. It may inspire the desire to study more broadly and deeply into all the sciences, and to obtain a better understanding of natural processes.
6. A Biological Station would provide a place where groups can go to find collection material and information.
7. It would provide a place for enjoyable studies of

nature with out the usual disturbance of regular school activities.

8. Studies at a well located Biological Station may be recreational as well as educational.

In summary, a Biological Station provides a place for a person to live with nature and to study and appreciate the natural processes of life as they occur. They can also study the modification of nature by man's own actions.

LIMITATIONS OF BIOLOGICAL STATIONS

The limitations of a Biological Station for studies by high school students, as well as college students, may be few or they may be many, depending on locality, support by student participation, financial assistance, and staffing of such a station.

In some states it may be a problem to find many places that would be desirable for a Biological Station. Oklahoma, with its varied climate and soils, provides suitable places for study of nature with varied ecological surroundings.

It is believed that student participation for a well-planned and well-located Biological Station, would be a problem that could be solved by careful selection of participants. From contacts with biology teachers at the National Science Teachers Convention, in Denver, Colorado, 1958, and from talking with

other biology teachers over the state, an expressed interest in a Biological Station for high school students and teachers to study nature some place other than in a text book was noted.

Staffing of a station is a major problem that could be solved by co-operative efforts of the school and teachers that are interested in helping to aid in the development of better education for students in science. Others outside the teaching field, who wish to help, could be placed as general supervisors.

The problem of financing a Biological Station seems to be the greatest limiting factor. However, it is believed that once the idea of a Biological Station, as a center of study of natural sciences, is well understood, that financial support will be forthcoming in substancial amounts to aid Biological Stations in becoming a valuable asset.

A growing number of business-industry organizations and other groups provide financial assistance for various science projects and activities through the National Science Teachers Association. Some other possible sources of financial aid may be obtained through the National Science Foundation, Fish and Game Department, as well as other national, state, and local organizations.

CHAPTER III

DEVELOPMENT OF BIOLOGICAL STATIONS

SELECTION AND EVALUATION OF SIGHTS FOR A BIOLOGICAL STATION

The location of a Biological Station is the key to its existence. A location adjacent to several schools and colleges that provides variation of habitats would be of advantage for the greatest use of a Biological Station. A Biological Station located at a sizeable lake provides a desirable place for study of life in its surroundings. The creeks and rivers flowing into the lake could provide a pollution-free water supply. This, along with the surrounding hills, mountains, praries, rock cliffs, and the variation of plant and animal life, adds to the desirability of such a location.

Within a given area there would be several different kinds of communities, depending on variation of the habitats, for example, hilly or mountainous regions are apt to have a wider variety of environmental conditions than flat areas.

There may be a greater opportunity for variation on moisture, altitude, light, and other factors; these environmental differences consequently produce different communities. North-facing

slopes of hills and sides of ravines will be cooler and therefore may possess slightly different communities of plants and animals than the South-facing side.

CREATING INTEREST IN BIOLOGICAL STATIONS

A Biological Station should be a place where students can find satisfaction and pleasure in their studies. These satisfying pleasures may be rewarding and of great value in creating wide-spread interest and acceptance of Biological Stations in science education.

Once a person finds enjoyment in studying science, often he may find many branches that are interesting in addition to the branch of original endeavor. This could aid in breaking the barrier that often arises between the different phases of scientific studies.

To further encourage students to do work at a Biological Station during summers, a program of acceptance for accrediting by State Department of Education would be of a great advantage. For a program to meet the regulations of State Department of Education the minimum time alloted for each half-unit or one credit course shall be seventy (70) clock hours. It is recommended that each session be of four-week terms for each half-unit, five days per week.

It is of considerable value for the general public to know that such stations will not take the place of the regular

high school program, but only supplement it to the extent that one may care to develop his studies.

One would get a more thorough understanding of biology under a program carried out at a Biological Station than at a high school, due to the fact that the student would be studying no other curricular subjects. The biology course offered in high school would serve those whose interest lie outside the scientific field. A sound, well organized plan of study, that provides pleasurable activities and satisfaction of mind cannot help but create a great deal of interest for students to do work and, in turn, tell their friends about their pleasurable work.

For science to advance in an increasing scientific society, it is of necessity that the general public be allowed to find an opening to break into the greatness of the studies of science for greater understanding and appreciation. For science to progress very rapidly, it should be understood and accepted by the public.

[1]As one reviews the works in all fields of science one can see that man is forever trying to find the secrets of nature. As we go forward, we find that we have only begun to find some of the unknowns of nature and we also find, in some instances, the public is not educated to these findings until many years later, due to various causes.

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[1]Hollmeyer, Lewis H., Design For A Better Science Program, "The Science Teacher", Volume XXV, (April 1958), National Science Teachers Association, Washington, D.C., p.-127.

FINANCING OF BIOLOGICAL STATIONS

The problem of financing is the problem which nearly all projects seem to have great difficulty. However, once the responsible people see the values of new projects, financing could be of a lesser problem.

There are many people who wish to help to do things that are of value to future society. This help may be through donation of sites for Biological Stations as well as other property that may be of great value to the effective operation of such a station. To many others, it may be money that they would wish to provide as their personal contribution.

The cost of establishing a Biological Station can be reduced to a great extent by purchasing much of the equipment that could be used through the donation program of the Surplus Property Utilization Division of the U.S. Department of Health, Education and Welfare.

Some of the equipment that may be purchased is, dissecting kit, auto-clave, incubation ovens, glassware, first aid kits, and supplies, centrifuges, magnifying lenses, life rafts, small boats, shallow-water diving outfits, tents, bottles, and containers for specimens, scales, balances, weights, thermometers, photography equipment, pH meters and binoculors.

There are many societies and organizations of local, state,

and national varieties, where-by financial assistance may be obtained. This problem must be also shared by the students who gain direct value from such a place of study. The students may give financial assistance by paying their tuition, room and board. As limiting as this problem may be, it is felt that it can be overcome in some way or perhaps a number of ways.

OPERATING A BIOLOGICAL STATION

The real challenge facing us is whether we can apply the knowledge biology has given us to practical problems, therefore it is essential there be improvement and modernization of education in biology. There are indications that we are entering an era of achievement in biology which is perhaps even more revolutionary than the activity in the physical science. With the changes that are taking place and the changes that will be forthcoming in education, it makes it difficult to attempt to cover all the necessities in the operation of a station.

If a program is to be accepted by the State Department of Education it would be necessary for the administration and operation of a station to be authorized by the superintendent and Board of Education of the school for which credit would be accepted. The general operation of a station could be left to a Director.

A Biological Station to be of greatest value, and have a great deal of flexibility for use, must be operated apart from

independent schools and at the same time must have the co-operation in order to provide students and possible staff members for a Biological Station during the summer months.

To gain the most support and educational value from a station it may be operated so as to allow those people who wish to contribute to its operation to do so with proper recognition for their efforts. If a station is to be operated as a co-educational institution, there develops a greater need for closer supervision. If the staffing for closer supervision becomes a limiting factor in the beginning of the operation, it may be advisable to have two sessions, one for boys and another for girls, or have separate camps for living quarters. To cut down on the cost it may be best to have separate sessions, if the number of students warrant.

A test operation should be made in the area before a permanent place is established with much expense. In a test operation for a Biological Station, use may be made of some of the state and national parks. In some cases it could be possible to obtain lodging at reasonable rates and provide fairly suitable conditions for field study. However, laboratories would be lacking and some degree of the effect of teaching may be lost.

In starting the operation of a Biological Station, a well-planned course of study of the area, with consideration of distribution of the time, should be established. Before a large

amount of money is spent in an operation, the operation should be carried on with only a few students and limited equipment with the idea of developing methods for controlling the operation with a larger number of students. When you have a smaller group you have few problems concerning material and equipment as well as having less trouble with student behavior.

It is not likely that a single book would be available that one would want to use for references and text. It would than be necessary for the use of several books in the different areas of biology. A suggested list of books is given in Appendix A. This is only for giving general ideas and could be changed to fit the area, the staffing and the facilities that are available.

FACILITIES AND EQUIPMENT

The facilities of a Biological Station vary according to the size of the station, and to what extent the studies are to be carried out. A permanent building for housing equipment and providing study area, as well as a building to house the participants, may be of frame construction or of concrete blocks. Septic tanks would be necessary for the buildings as well as an abundant supply of water for sanitation purposes.

The laboratory equipment should be of the nature to provide flexibility of use. Much of the equipment may be made or purchased inexpensively through the Surplus Property Program.

The size and amount of facilities would depend upon how advanced a study is to be undertaken.

CHAPTER IV

SCHEDULE OF PLANNED COURSES

INTRODUCTION

The operation could vary from predominantly field study to a combination of lecture, laboratory and field work. The course outlines are planned for the use of lectures, and laboratory work in the afternoon. This is what may be considered to be desirable, taking into account time that may be needed by the students to do some reading. The outlines are planned to give a general study of the plant and animal world and any part may be modified to fit the need or conditions that may exist.

GENERAL BOTANY

[1]Knowledge of the scientific principles of plant life can enhance an appreciation of the beauties and values of plant life in our society. The various methods of increasing the worlds food supply will require the efforts of many kinds of plant scientists and thus will offer numerous opportunities in research and in production to young men and women in the plant sciences.

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[1]Fuller, Harvey J., The Plant World, 3rd Edition, Henry Holt & Company, (1955).

To help students learn to study plants, a four week intense study of plants in general where they perform their functions, can have a permanent effect on their desires for knowing more about plants as well as having a greater understanding of our environment.

The following is an outline of a possible four week program that gives intense study of the plant world both in the morning and afternoon. A program should have flexibility so that the time, which is allowed for individual investigation, can be of greater value.

PLAN SCHEDULE OF TOPICS

FOR A

FOUR WEEK STUDY IN BOTANY

1st week	8 a.m. to 12 noon	1 p.m. to 4 p.m.
Monday	Economic values of flowering plants	Structure of leaves, flowers and fruit
Tuesday	Individual study	Collection and mounting methods
Wednesday	Study of plant kingdom	Plant groups
Thursday	Individual study	Collection and classification of trees & shrubs
Friday	Study of plant kingdom	Collection and classification of wild weeds.

2nd week	8 a.m. to 12 noon	1 p.m. to 4 p.m.
Monday	Variation and heredity in plants	Collection and classification of grasses
Tuesday	Individual study	General classification
Wednesday	Plant evolution	General classification
Thursday	Individual study	Methods of studying vegetation
Friday	Plant relations to environment	Survey of plant environment

3rd week	8 a.m. to 12 noon	1 p.m. to 4 p.m.
Monday	Water relation of plants	Measurement of water content of plants and soils
Tuesday	Individual study	Variation of temperature in different plant communities
Wednesday	Relation of plant parts to environment	Plant indicators of soil type
Thursday	Individual study	Succession study methods
Friday	Plant succession	Succession study methods

4th week	8 a.m. to 12 noon	1 p.m. to 4 p.m.
Monday	Ecology and Geographical distribution	Ecological Survey

Tuesday	Individual study	Ecological Survey
Wednesday	Forest-Prairie transition	Plant type in forests
Thursday	Individual study	Plant types in prairies
Friday	Plant and animal relationships	Summation

GENERAL ZOOLOGY

The fact that there is such an abundance of animal life has a very valuable effect in the planning of a zoology course, as they leave a great deal of room for individual investigation to meet whatever curosity may arise in the mind of a student.

A zoology course that is planned for a full day, however may be planned for general lectures in the morning with field trips in the afternoon. Collecting and preserving of all types of animals other than mammals, birds, and insects may be planned for the field trips.

[2]The study of animals has been of great intellectual and practical value to man. It has enabled him to recognize the unity of all living things and to determine his place in nature. Studies of living things have revealed the everchanging nature of the world of life. A student of zoology (1) learns about himself through the study of animals; (2) learns the scientific

[2]Moment, Gairdner B., General Zoology, (1956), Houghton Mifflin Company

method, which will effectively assist him throughout his entire life no matter what field his labors are devoted to; (3) gains an esthetic appreciation of nature that can be acquired in no other way.

The study of zoology embraces a bewildering array of species, as well as innumerable facts about them and the relationships between them.

[3]The teaching of zoology must be oriented to be a part of biology, not a self-limited discipline, and provide essential information concerning collecting, preserving and identifying animals. Students should spend some time studying the animals themselves and learn to recognize as many as possible. As students are collecting specimens, (1) they should observe how numerous they are; (2) what they are doing: (3) where else might similar animals be found; (4) where could they not be found; (5) under what environmental conditions they live and (6) that they are living in association with other animals or plants. The idea is not merely to collect, but to do careful observation and recording.

FOUR WEEK GENERAL ZOOLOGY TOPIC SCHEDULE

1st week	8 a.m. to 12 noon	1 p.m. to 4 p.m.
Monday	Introduction and primative forms of animal life	Collecting and preserving methods

[3]Dennis, Clifford J., Field Zoology Workbook, East Central State College, Ada, Oklahoma

Tuesday	Individual study	Taxonomy
Wednesday	Classification and organization of animals	Identification of invertebrates
Thursday	Individual study	Identification of invertebrates
Friday	Flat worms, round worms, Mollusks	Collection and itentification of collected specimens
2nd week	8 a.m. to 12 noon	1 p.m. to 4 p.m.
Monday	Mollusks and Crustaceans	Collection and identification of collected specimens
Tuesday	Individual study	Collection and identification of collected specimens
Wednesday	Spiders and ticks	Collection and identification of insects
Thursday	Individual study	Collection and identification of insects
Friday	Insects	Fishes identification and collection methods
3rd week	8 a.m. to 12 noon	1 p.m. to 4 p.m.
Monday	Fishes	Feeding and breeding habits of fish

Tuesday	Individual study	Turtle and Salamander studies
Wednesday	Amphibians	Methods of collecting and studying reptiles
Thursday	Individual study	Survey of bird population
Friday	Reptiles	Survey of Bird population
4th week	8 a.m. to 12 noon	1 p.m. to 4 p.m.
Monday	Birds and Mammals	Study of tracks
Tuesday	Individual study	Feeding areas of mammals
Wednesday	Animal behavior and ecology	Feeding areas of mammals
Thursday	Individual study	Maping of different habitats
Friday	The evolution of animal life	Summation

GENERAL BIOLOGY

[4]All biology courses should place special emphasis upon direct observation of living material as much as possible. A few facts thus learned by the student are worth a mass of information obtained by reading of a text.

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[4]Moon, Otto, Lowle, Modern Biology, (1960), Henry Holt and Company, Inc..

There may be many variations in a plan for studying biology, the following plan combines the zoology and botany field study with structural and functional effects as well as identification of species in relation to their habitat.

GENERAL BIOLOGY

1st week	8 a.m. to 12 noon	1 p.m. to 4 p.m.
Monday	Protoplasm--Its nature and composition	How to prepare microscope slides
Tuesday	The physical, Chemical and functional basis of life	Cellular microscopic studies
Wednesday	Similarities among living things	Study of fossil specimens
Thursday	Single-celled organisms	The culture and microscopy of molds
Friday	Multicellular organisms	Plants and animal cellular organization
2nd week	8 a.m. to 12 noon	1 p.m. to 4 p.m.
Monday	Classification of plants	Preserving botanical specimens
Tuesday	The lower plants	Non-flowering plants
Wednesday	Seed bearing plants	Fresh water plants.
Thursday	Plant behavior	Grow plants in nutrient culture media

Friday	Preservation of the species	Plant hormone experiments
3rd week	8 a.m. to 12 noon	1 p.m. to 4 p.m.
Monday	The invertebrates	Collection, care and culturing of protozoa, planaria, and hydra
Tuesday	Fish and Amphibia	Fish & Amphibia studies
Wednesday	Reptiles	Reptiles of the area
Thursday	Birds	Bird study of the area
Friday	Mammals	Mammals and their tracks.
4th week	8 a.m. to 12 noon	1 p.m. to 4 p.m.
Monday	Specialization in higher organisms	Skeletons of animals
Tuesday	Heredity and variation	Culturing of drosophila flies
Wednesday	Evolution in living things	Skeletal differences in animals
Thursday	Wild life populations	Wildlife census and their relationships
Friday	Safeguarding natural resources	Observations of conservation practices

[5]ONE WEEK GENERAL BIOLOGY SHORT COURSE

1 week	8 a.m. to 12 noon	1 p.m. to 3 p.m.	3 p.m. to 5 p.m.	7 p.m.
Monday	Botany	Projects & field trips	Recreation & reading	Seminar
Tuesday	Invertebrate Zoology and Entomology	Projects & field trips	Recreation & reading	Individual study
Wednesday	Vertebrate Zoology	Projects & field trips	Recreation & reading	Seminar
Thursday	Ecology	Projects & field trips	Recreation & reading	Individual study
Friday	Orinthology	Projects & field trips	Recreation & reading	Seminar

[5]Slesneck, Irwin, "Camping With Accent On Science", The Science Teacher, Volume XXVI, (1959), National Science Teachers Association, Washington, D.C., p.-11.

SUMMARY

The information contained in this report is intended to aid in the development of the idea of a Biological Station for the instruction of secondary school students in the Natural Sciences, which would provide an opportunity to appreciate natures processes, and to develop scientific methods and attitudes by working and studying in a research manner with students of similar interest.

The primary limiting factor in developing a Biological Station is substancial financial support, however, this may be overcome by private, local, state, and federal agencies, along with student tuition and room and board.

The operation of a station must be independent of individual schools and at the same time have approved authorization of the schools which provide student participation. This will allow credit to be acceptable by the Oklahoma State Department of Education.

The staffing of a Biological Station with natural science teachers from high schools and colleges would provide the students with experienced instructors. Therefore, the students would be more apt to receive a well planned study of the various

sciences, which would show relationship and understanding of science and a greater understanding of the environment in which one lives.

In an attempt to achieve this, a four week plan in botany, zoology, and general biology, as well as a one week general biology short course, is planned to allow general study in a very limited time.

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Hollmeyer, Lewis H., "Design For A Better Science Program", The Science Teacher, Volume XXV, (1958), National Science Teachers Association, Washington, D.C..

Moment, Gairdner B., General Zoology, (1956), Houghton Mifflin Company

Morgan, A.H., Field Book of Ponds and Streams, (1930), G. P. Putnam's Sons

Moon, Otto, Lowle, Modern Biology, (1960), Henry Holt and Company, Inc..

National Science Teachers Association, New Developments in High School Science Teaching, (1960), National Science Teachers Association, 1201 6th St., N.W. Washington, D.C..

Raskin, Abrahm, Selected Papers On Science Teaching, National Science Teachers Association, Washington, D.C., (1960).

Slesneck, Irwin, "Camping With Accent On Science", The Science Teacher, Volume XXVI, (1959), National Science Teachers Association, Washington, D.C..

State Of Oklahoma Department Of Education, Annual Bulletin For Elementary And Secondary Schools, (1959), Bulletin No. 113-G, State of Oklahoma Department of Education.

U.S. Office of Education, Mathematics and Science Education In U.S. Public Schools, Circulor 533, U.S. Department of Health, Education, & Welfare, Washington, D.C., (1958).

APPENDIX A

SUGGESTED LIST OF BOOKS

THAT COULD BE USED FOR

BIOLOGICAL STATION REFERENCE

Anthony, Fieldbook of North American Mammals, G. P. Putnam & Sons, 210 Madison Ave., New York 16, New York.

Baerg, How to Know the Western Trees, Wm. C. Grown Company, Dubuque, Iowa.

Blair, Blair, Brodkarb, Cagle & Moore, Vertebrates of the United States, McGraw-Hill Co. 330 W. 42nd St., New York 36, N. Y.

Breneman, Animal Form & Function, Ginn & Co., Statler Bldg., Boston 17, Mass.

Buchanan, Bacteriology, The MacMillan Company, 60 5th Ave., New York 11, New York

Buchsbaum, Animals Without Backbones, The University of Chicago Press, 5750 Ellis Ave., Chicago, Ill.

Burrows, Textbook of Microbiology, W.B. Saunders Company, Philadelphia, Penn.

Burt and Grossenheider, A Field Guide to the Mammals, Houghton Mifflin Co., 2 Park Street, Boston 7, Mass.

Bacq and Alexander, Fundamentals of Radio-Biology, Academic Press, New York, New York

Chu, How to Know the Immature Insects, Wm.C. Brown Co., Dubuque, Iowa

Colin, Elements of Genetics, McGraw-Hill Co., 330 W. 42nd St. New York 36, New York

Conant, A Field Guide to Reptiles and Amphibians, Houghton Mifflin Co., 2 Park St., Boston 7, Mass.

Conn, Biological Stains, Williams, & Wilkins Co., Baltimore, Maryland

Comstock, An Introduction to Entomology, Comstock Publishing Co. Ithaca, New York

Cunthbert, How to Know the Fall Flowers, Wm. C. Brown Co., Dubuque, Iowa

Cunthbert, How to Know the Spring Flowers, Wm. C. Brown Co., Dubuque, Iowa

Dawson, How to Know Seaweeds, Wm C. Brown Co., Dubuque, Iowa

Demerec & Kaufman, Drosophila Guide, Carnegie Institute of Washington, D.C.

Eddy-Oliver-Turner, Guide to Anatomy Study of Shark, Necturus, and Cat, John Wiley & Sons, 440 4th Ave., New York 16, New York

Elliott, Zoology, Appleton-Century-Crofts, Inc., New York, N. Y.

Emerson & Shields, Laboratory & Field Exercises in Botany, McGraw Hill Co., 330 W. 42nd St., New York 36, New York

Emerson, Basic Botany, McGraw-Hill Co., 330 W. 42nd St., New York, New York

Farris, The Care and Breeding of Laboratory Animals, John Wiley & Sons, 440 4th Ave., New York 16, New York

Featherly, Manual of the Grasses of Oklahoma, OAMC Bulletin, Stillwater, Oklahoma

Fenton, Field Crop Insects, The MacMillan Co., 60 5th Ave., New York 11, New York

Fernald & Shepard, Applied Entomology, McGraw-Hill Co., 330 W. 42nd St., New York, New York

Glass, A Key to the Skulls of North American Mammals, Burgess Pub. Co., Minneapolis, Minn.

Goldstein, How to Do An Experiment, Harcourt, Brace & Company, 383 Madison Ave., New York 17, New York

Gray, Handbook of Basic Microtechnique, McGraw-Hill Co., 330 W. 42nd St., New York 36, New York

Gray, Manual of Botany, American Book Co., 55 Fifth Ave., New York 3, New York

Ham, Histology, J. B. Lippencott Company, East Washington Square, Philadelphia 5, Penn.

Haupt, Plant Morphology, McGraw-Hill Co., 330 W. 42nd St. New York 36, New York

Hawk-Oser-Summerson, Practical Physiological Chemistry, McGraw-Hill Co., 330 W. 42nd St., New York 36, New York

Hegner & Stiles, College Zoology, The MacMillan Co., 60 5th Ave. New York 11, New York

Hercules Powder Company, Handbook of the Insect World, Wilmington, Delaware

Hill, Overholtz, & Popp, Botany, McGraw-Hill Co., 330 W. 42nd St., New York 36, New York

Holland, The Butterfly Book, Doubleday and Co., Garden City, New York

Holmes, The Biology of the Frog, The MacMillan Co., 60 5th Ave., New York 11, New York

Hyman, Lab. Manual for Elementary Zoology, The University of Chicago Press, 5750 Ellis Ave., Chicago 37, Ill.

Hyman, Comparative Vertebrate Anatomy, The University of Chicago Press, 5750 Ellis Ave., Chicago 37, Ill.

Jaeger, Source Book of Biological Names and Terms, C. C. Thomas, Pub., Springfield, Ill.

Jahn, How to Know Protozoa, Wm. C. Brown, Co., Dubuque, Iowa

Jaques, How To Know The Insects, Wm. C. Brown Co. Dubuque, Iowa

Jaques, Living Things--How To Know Them, Wm. C. Brown, Company Dubuque, Iowa

Jaques, How To Know The Trees, Wm. C. Brown Co., Dubuque, Iowa

Jaques, Plant Families - How To Know Them, Wm. C. Brown Co., Dubuque, Iowa

Jaques, How To Know The Beetles, Wm. C. Brown Co., Dubuque, Iowa

Jaques, How To Know The Land Bird, Wm. C. Brown Co., Dubuque, Iowa

Kaston, How To Know The Spiders, Wm. C. Brown Co., Dubuque, Iowa

Kendall, Microscopic Anatomy of Vertebrates, Lea & Febiger, Philadelphia, Penn

Klots, A Field Guide To The Butterflies, Houghton Mifflin Co., 2 Park St., Boston 7, Mass

Kudo, Protozoology, C.C. Thomas, Pub., Springfield, Ill.

Lillie & Moore, Lab. Outline of Embryology, University of Chicago Press, 5750 Ellis Ave., Chicago 37, Ill.

MacGinitie & MacGinitie, Natural History of Marine Animals, McGraw-Hill Co., 330 W. 42nd St., New York, New York

Marsland, Principles of Modern Biology, Henry Holt & Co., New York, New York

Millen & Lanier, 1001 Questions Answered About Your Aquarium, Dodd, Mead & Co., 432 4th Ave. New York, New York

Miller & Blaydes, Methods and Materials for Teaching Biological Sciences, McGraw-Hill Co., 330 W. 42nd St., New York, N. Y.

Moon, Mann & Otto, Modern Biology, Henry Holt Co., New York, N.Y.

Morgan, Field Book Of Ponds & Streams, G. P. Putnam's Sons, 210 Madison Ave., New York, New York

Murie, A Fieldguide To Animal Tracks, Houghton Mifflin Co., 2 Park St., Boston 7, Mass.

Needham, Guide to Study of Fresh Water Biology, Comstock Pub. Co., Ithaca, New York

Nelson, Comparative Embryology of the Vertebrates, McGraw-Hill Co., 330 W. 42nd St., New York 36, New York

Obtained through U.S. Congressman of this District, USDA Agricultural Year Books.

Palmer, Fieldbook of Natural History, McGraw-Hill Co., 330 W. 42nd St., New York 36, New York

Park, Allee & Shelford, A Laboratory Introduction To Animal Ecology and Taxonomy, University Of Chicago Press, 5750 Ellis Ave., Chicago 37, Ill.

Pennack, Fresh-Water Invertebrates of the U.S. , The Roland Press, Chicago, Ill.

Peterson, A Field Guide To The Birds, Houghton Mifflin Company, 2 Park St., Boston 7, Mass.

Peterson, A Field Guide To The Western Birds, Houghton Mifflin Company, 2 Park St., Boston 7, Mass.

Phillips, Forest Trees of Oklahoma, Div. of Forestry Oklahoma City, Oklahoma

Pohl, How to Know The Grasses, Wm. C. Brown Co., Dubuque, Iowa

Pratt, Manual of Common Invertebrate Animals, McGraw-Hill Co. 330 W. 42nd St., New York 36, New York

Prescott, How To Know the Fresh-Water Algae, Wm. C. Brown Co., Dubuque, Iowa

Romer, Vertebrate Paleontology, University of Chicago Press 5750 Ellis Ave., Chicago 37, Ill.

Russell, Soil Conditions and Plant Growth, Langmans, Green & Company, New York, New York

Sawits, Medical Parasitology, McGraw-Hill Co., 330 W. 42nd St., New York 36, New York

Sharp, Fundamentals of Cytology, McGraw-Hill Co., 330 W. 42nd St., New York 36, New York

Shunway, The Frog, The MacMillan Co., 60 5th Ave., New York, N.Y.

Simon and Schuster, Entire Golden Nature Series of Guides, Simon and Schuster, New York, New York

Spector, Handbook Of Biological Data, W. B. Saunders Co., Philadelphia, Penn.

The Upjohn Co., The Cell--A Scope Monograph on Cytology, Chicago, Ill.

Turtox, Lab. Experiments in Nutrition, Gen. Biological Supply House

U.S. Atomic Energy Comm., Lab. Experiments With Radioisotopes, Washington, D.C.

Ward & Whipple, Fresh Water Biology, John Wiley & Sons, 440 4th Ave., New York 16, New York

Wells, The Collection and Preservation of Animal Forms, General Biological Supply House

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Professional experience: Began teaching science and chemistry in September, 1955; has taught biology in high school for five years; at present is a member of Oklahoma State Teachers Association and National Science Teachers Association; has been a member of Summer Biology Institute at Oklahoma State University for the past two summers and at present is a member of the Academic Year Institute at Oklahoma State University.